EXPERIMENTAL GLAUCOMA;
ANIMAL MODELS: OTHER
EFFECT OF GROSS SAPONINS FROM TRIBULUS TERRESTRIS L (GSTT) ON THE CONCENTRATION OF GLUTAMIC ACID IN THE RETINAL IN RABBITS WITH CHRONIC HIGH INTRAOCULAR PRESSURE (IOP)

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Background: Glutamate is one of the components of the retina, under normal circumstances, Glutamate make retina neurons against damage, while in ischemia, anoxic condition, retinal neurons release glutamic acid increase and heavy absorbs less, high levels of glutamate cause neurons damage, therefore, restrain the excitability of glutamate toxic become glaucoma optic protect one of the main ways.

Methods: New Zealand rabbits 24 only were randomized into control (A group), high intraocular pressure group (B group), Erigeron brevissatus (Vant.) Hand-Mazz (EBHM) treatment group (C group), GSTT treatment group (D group), the 20 g/L methylcellulose into anterior chamber of the high intraocular pressure group and the two treated groups, Group C, group D daily rabbit ears margin veins push note respectively EBHM 4.5 mg/kg, GSTT 5 mg/kg. High-performance liquid chromatography (HPLC) was utilized to measure the concentration of glutamic acid in retina after 4 weeks.

Results: The concentration of glutamic acid in retina of rabbits in the high intraocular pressure group were significantly higher than those in control group and treated group (p < 0.05). Significant difference appeared between the treated group C and treated group D (p < 0.05).

Conclusion: Higher concentration of glutamate damaging retina was induced by chronic high IOP. Extract of GSTT can significantly inhibit the retina glutamate concentration.

Key words: chronic high intraocular pressure; retina; glutamic acid; High-performance liquid chromatography; GSTT.
CLINICAL EXAMINATION METHODS: INTRAOCULAR PRESSURE MEASUREMENT; DEVICES, CONTINUOUS IOP MONITORING, FACTORS AFFECTING IOP, 24-HOUR IOP, FLUCTUATION
FALSELY HIGH INTRAOCULAR PRESSURE IN MUCOPOLYSACCHARIDOSIS I AND VI

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Background/aims: Glaucoma is often suspected in children with mucopolysaccharidosis (MPS). The purpose of the present study is to determine the intraocular pressure, corrected with corneal hysteresis, in these children.

Methods: IOP was measured with ocular response analyzer (ORA) in seven children, five MPS I-H and two MPS VI. ORA measurements were made at a median age of 8.7 years in the patients with MPS I-H and at a median age of 9.3 years in the MPS VI patients.

Results: The ORA showed an increased corneal hysteresis and a falsely high IOP values in all 14 eyes. The re-calculated IOP were normal in all these eyes. Mild to severe corneal opacities were present in all 14 eyes. Optic disc were clinically normal in all 12 of 14 eyes possible to examine. Severe corneal opacities hampered optic disc evaluation in the older patient with MPS VI.

Conclusion: The IOPs are often falsely high due to an increased resistance of the cornea and correlate to the extent of corneal clouding. A corrected IOP, considering the corneal hysteresis, can avoid unnecessary hypotensive treatment.
THE GUARANTEE OF QUALITY STANDARDS FOR THE TONOMETRY IN OPHTHALMOLOGY
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Background: Impression tonometers are used for fast measurements of intraocular pressure on lying patients but also during surgery on the human eye. These mechanically very delicate devices have to be checked by metrological controls according to the German Medical Devices Act (“Medizinproduktegesetz”) and the German Ordinance on Operators of Medical Devices (“Medizinprodukte-Betreiberverordnung”) every two years. These controls are carried out by independent testing agencies and are mandatory for all ophthalmologists in Germany using impression tonometers. For this purpose, special test devices have been developed by Physikalisch-Technische Bundesanstalt, Germany's national metrology institute. A large number of these test devices is in use at private test agencies and verification offices since 1975.

Procedure and Method: Eighteen test devices for impression tonometers from private test agencies, verification offices, or Physikalisch-Technische Bundesanstalt were investigated. The instruments were checked for their measurement accuracy and their suitability to perform metrological controls. An impression tonometer of Schiötz design served as reference instrument. The test devices were investigated with respect to parameters like tonometer mass, mass of the plunger-lever-pointer system, plunger displacement, or correlation of the curvature between foot plate and plunger. The findings were analysed by statistic methods.

Results: The main outcome of the present work is the conclusion that the investigated test devices are generally suitable to perform metrological controls on impression tonometers. For certain parameters some instruments reached the error tolerances, but the majority was inside permissible limits. For one parameter (effective mass of plunger-lever-pointer system for scale value 10) the reference tonometer itself was not within permissible tolerances. This was correctly determined by all test devices. Failures of test devices due to damages or maladjustment were not observed.

Conclusion: Test devices for impression tonometers are mechanically delicate instruments. They have to be recalibrated in fixed intervals in order to remain suitable for metrological controls. If regularly maintained and recalibrated at least every three years, even devices with an age of 20 years or more are still absolutely fit for this purpose.
DIURNAL VARIATION OF CORNEAL HYSTERESIS, THICKNESS, RESISTANCE FACTOR AND INTRAOCULAR PRESSURE IN NORMAL AND GLAUCOMA PATIENTS

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Purpose: To estimate of diurnal variation of the biomechanical properties of the cornea, IOP level and its relevance to glaucoma progression.

Methods: 58 patients (106 eyes) were divided into 3 groups: 1 group - 39 patients with open-angle glaucoma (68 eyes); 2 group - 10 young healthy volunteers (20 eyes); 3 group - 9 older healthy volunteers (18 eyes). All patients were undergone IOP measurement at 8.00, 12.00, 16.00, 20.00 by transpalpebral tonometer, Goldmann tonometer (GAT), i-care tonometer and evaluation of biomechanical eye properties by Ocular Response Analyzer (ORA).

Results: Minimal IOP fluctuations (corneal compensated IOP) were revealed in older healthy volunteers group, maximal – in treated glaucoma patients (p < 0.05). In advanced glaucoma stages IOP level got highest value in morning, than decreased in daytime and rose again towards evening. Patients with moderate and advanced glaucoma had lower data of corneal hysteresis (CH) and corneal resistance factor (CRF), and it's getting lower from stage to stage. Peak value of biomechanical eye properties was observed in morning (in advanced glaucoma patients - in daytime) and minimal value was in daytime (in moderate glaucoma patients - in evening).

Conclusion: Therefore patients with moderate and advanced glaucoma had qualitative and time shift in changes of biomechanical eye properties. They also had more significant diurnal changes in CH, CRF and IOP fluctuations and minimal CCT fluctuations in comparison with control groups (p < 0.05).
REPRODUCIBILITY OF THE 24-HOUR DAILY CURVE OF INTRAOCULAR PRESSURE
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Background: Intraocular pressure (IOP) is the main risk factor for the development of glaucoma and the only factor that can be treated. IOP varies over a 24-hour period, but it is generally evaluated by measurements performed in the diurnal period; however, peak IOP commonly occurs outside this period. Thus, the best method for IOP evaluation is the 24-hour daily curve of intraocular pressure (DCIOP). Knowledge regarding the variability of the nycthemeral profile is important to determine individualized treatment of the patient; however, it is not known whether the DCIOP is reproducible when performed on different days.

Methods: Twenty-eight eyes of 14 patients not in treatment were studied. Of the 14 patients, 8 were diagnosed with primary open angle glaucoma (16 eyes) and 6 had suspected glaucoma (12 eyes). Seven patients were males and seven females. Age ranged from 45 to 72 years-old, with a mean of 58.5 years-old. Three DCIOP were performed on each patient, with a minimum interval of 1 week and maximum of 3 weeks. The DCIOP consisted of 8 measurements of IOP at the following times: 9:00 a.m., 12:00 p.m., 3:00 p.m., 6:00 p.m., 9:00 p.m., 12:00 a.m. and 6:00 a.m. using a Goldmann applanation tonometer. At 6:00 a.m., IOP was measured in bed using a Perkins hand-held applanation tonometer before measuring in a seated position using the Goldmann tonometer. The IOP value was considered reproducible when the variation between the three DCIOP measurements was \( \leq 3 \) mmHg at each of the times and for each of the patients. Descriptive analyses of IOP variation were conducted according to the eyes, complemented with the Student t test for paired samples (right and left eyes).

Results: Considering the time of measurement, reproducibility varied from 57.1 to 100\% (mean of 76.8 \( \pm \) 13.6\%) in the right eye (RE) and from 64.3 to 92.9\% (mean of 84.9 \( \pm \) 10.4\%) in the left eye (LE). No significant difference was verified between the means of the two eyes (\( p = 0.195 \)). In the individual examination of each patient, reproducibility ranged from 50\% to 100\% (mean of 80.4 \( \pm \) 19.4\%) in the RE and from 62.5\% to 100\% (mean of 84.8 \( \pm \) 14.0\%) in the LE. No significant difference was verified between the two eyes (\( p = 0.266 \)).

Conclusion: The DCIOP presents good reproducibility when performed at up to three weeks intervals, both regarding the time of measurement and in each individual patient.
THE CONFLATED CLASSIFICATION FOR METHODS OF IOP MEASUREMENT
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**Background:** Different methods have been described for the measurement of intraocular pressure (IOP), and due to the on-going advances in technology, the list of measuring devices is growing. This necessitates the presence of a combined classification that includes all these devices and is able to accommodate future ones.

**Methods:** We searched MEDLINE, EMBASE and LILACS for years 1988 to 2010. This search included published clinical studies and reviews for the different methods of measurement of IOP. In addition, we reviewed ophthalmology textbooks for the same topic. We also reviewed physics textbooks for the principles of measurement of pressure and tension. To avoid performance bias, all searches were performed by ophthalmologists who did not participate in setting the classification.

**Results:** Based on physical principles, “Manometry” is direct measurement of the fluid pressure, while tonometry is the measurement of tension induced by the substance (fluid) on the surface (corneo-scleral shell). We further divided tonometry into 'Direct Tonometry'; in which measurement is directly on the surface on which the fluid is acting on to produce tension (corneo-scleral shell), and “Indirect Tonometry”; when measurement is through an additional interface (eye lids). Tonometry devices which have been described and classified by previous reviewers now fit in the title of “Direct Tonometry”. We reduced their lists into a classification which includes the devices that are most important historically and those used in current clinical practice. Our classification is arranged to include devices representing all principles of measurement of IOP, so that each device falls in one of the 3 main categories: manometry, indirect tonometry and direct tonometry. We named this list “The Conflated Classification for methods of IOP measurement”.

**Conclusion:** This review is able to provide a simple evidence based classification that does not only consider current clinical practice, but also historical devices and futures ones.
COMPARISON OF CORNEAL BIOMECHANICAL PARAMETERS OF CASES WITH BEHÇET’S DISEASE AND NORMAL SUBJECTS

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Background: To compare the corneal biomechanical parameters of cases with Behçet’s disease (BD) and age and sex-matched normal subjects by ocular response analyzer (ORA).

Methods: 43 eyes of 43 cases with BD (mean age: 34.83±6.74) and 43 eyes of 43 normal subjects (mean age: 34.97 ± 6.62) were included to this prospective study. None of the cases with BD had glaucoma and taken any anti-glaucoma treatment before. Corneal hysteresis (CH), corneal resistance factor (CRF), corneal-compensated intraocular pressure (IOPcc) and Goldmann-correlated intraocular pressure (IOPg) of the cases were measured by ORA. The comparison of the results were performed by tests for statistical analysis.

Results: There were no statistically significant differences in CH (p = 0.27), CRF (p = 0.06) and IOPcc (p = 0.08) between the cases with BD and normal subjects. But the mean IOPg lower in cases with BD than normal subjects and the result was statistically significant (p = 0.01).

Conclusion: The mean IOPg of the cases with BD had statistically significantly lower than the normal subjects and it should be related with uveitis. But the differences between the other corneal biomechanical parameters with BD and normal subjects were not statistically significant.
CENTRAL CORNEAL THICKNESS AND CORRECTION OF INTRAOCULAR PRESSURE IN PATIENTS WITH NORMAL TENSION GLAUCOMA, PSEUDOEXFOLIATION GLAUCOMA, OCULAR HYPERTENSION AND PRIMARY OPEN ANGLE GLAUCOMA

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**Purpose:** We research significance of central corneal thickness (CCT) and correction of intraocular pressure (IOP) in patients with normal tension glaucoma (NTG), pseudoexfoliation glaucoma (PEXG), ocular hypertension (OH) and primary open angle glaucoma (POAG).

**Method:** CCT was measured in 146 eyes with glaucoma and 38 eyes without glaucoma (control group) using ultrasound pachymetre. IOP was measured by Goldman applanation tonometer (GAT). The values of IOP were corrected using correction formula by Ehlers et al. The results were statistically tested with t-test.

**Results:** Group 1 (NTG): 26 eyes, mean CCT is 492 ± 36.91 µm. Mean IOP is 18.27 ± 2.42 mmHg and correction of IOP is 21.18 ± 2.28 mmHg. IOP difference value is 2.91 ± 1.84 mmHg (p < 0.0001). Group 2 (PEXG): 18 eyes, mean CCT is 574.44 ± 31 µm. Mean IOP is 19.83 ± 4.0 mmHg and correction of IOP is 18.59 ± 3.81 mmHg. IOP difference value is 1.18 ± 1.59 mmHg (p < 0.004). Group 3 (OH): 14 eyes, mean CCT is 599.14 ± 24.8 µm. Mean IOP is 21.42 ± 2.5 mmHg and correction of IOP is 18.95 ± 2 mmHg. IOP difference value is -2.47 ± 1.2 mmHg (p < 0.0001). Group 4 (POAG): 88 eyes, mean CCT is 559.29 ± 34.4 µm. Mean IOP is 21.47 ± 4.5 mmHg and correction of IOP is 21.03 ± 5 mmHg. IOP difference value is -0.44 ± 1.68 mmHg (p < 0.01). Control group: 38 eyes, mean CCT is 559.18 ± 39 µm. Mean IOP is 18.65 ± 2.37 mmHg and correction of IOP is 18.14 ± 2.34 mmHg. IOP difference value is -0.61 ± 0.9 mmHg (p < 0.001).

CCT at NTG (492.15 ± µm) compare to control group, PEXG, OH and POAG was p < 0.001. CCT at PEXG (574.44 µm) compare to NTG was p < 0.001 and to OH p < 0.02 but compare to control group and POAG were p = 0.08. CCT at OH (599 µm) compare to NTG, control group, POAG were p < 0.001 and to PEXG p < 0.02. CCT at POAG (559.29 µm) comparing to NTG and OH is p < 0.001 and there was no statistically difference to PEXG to control group.

**Conclusions:** CCT was significantly thinner in cases with NTG and significantly thicker in cases with OH. In all groups we found statistically different in actual and adjustment IOP. CCT measurement have a significant effect on the clinical management of patients with glaucoma and glaucoma suspect.
CENTRAL CORNEAL THICKNESS BEFORE AND AFTER INTRAOCULAR PRESSURE REDUCTION

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Background: To investigate the possible difference between central corneal thickness during intraocular pressure rise and after intraocular pressure reduction by medications.

Methods: 30 newly diagnosed primary open angle glaucoma patients underwent central corneal thickness measurements (ultrasonic pachymetry) while their intraocular pressures were high and those measurements were repeated after the intraocular pressure reduction was accomplished by medication. Statistical analysis was performed with commercial software (SPSS 15.0).

Results: Thirty eyes of thirty patients were included in this study. Out of 30 tested subjects 16 (53.33%) were male, the mean age of all participants was 68.40 ± 10.10 (range 45-82). Central corneal thickness measurements during intraocular pressure rise ranged from 492 to 630 µm, with mean ± standard deviation 550 ± 24.80 µm. Intraocular pressure was 28.36 ± 7.10 mmHg during the rise faze, and 19.40 ± 5.12 mmHg after the reduction which was achieved by medication. Central corneal thickness after the intraocular pressure reduction ranged from 489 to 632 µm, with mean ± standard deviation 552 ± 23.12 µm. The difference between central corneal thickness measurements during the high intraocular pressure faze and after intraocular pressure reduction was not statistically significant (p = 0.33).

Conclusion: In our case series, no significant change in central corneal thickness measurements was found after intraocular pressure reduction.

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FACTORS ASSOCIATED WITH 24-HOUR FLUCTUATION OF INTRAOCULAR PRESSURE IN NORMAL-TENSION GLAUCOMA
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**Background:** It is well known that intraocular pressure (IOP) varies throughout day and night. High IOP is a major risk factor for the development and progression of glaucoma; however several studies have shown that short-term IOP fluctuation is also an independent risk factor for glaucoma (Ishida K: 1998, Asrani S: 2000, Baskaran M: 2009). Nevertheless, the factors associated with 24-hour fluctuation of IOP have not been fully investigated. Here, we investigated retrospectively the factors associated with 24-hour fluctuation of intraocular pressure in normal-tension glaucoma (NTG).

**Methods:** The subjects were 223 eyes of 223 patients with previously unoperated NTG (108 males and 115 females) whose mean age was 55.5 ± 12.8 years. Patients who had been previously receiving topical ocular hypotensive agents were asked to withdraw their use for ≥ 4 weeks. The patients were hospitalized for 24 hours to measure baseline IOP. IOP data were obtained in the sitting position by the same physician using a Goldmann applanation tonometer at 10 am, 1 pm, 4 pm, 7 pm, 10 pm, 1 am, 3 am, and 7 am. Standard deviation of IOP at all measurement time-points was used as an indicator of 24-hour fluctuation of IOP. Stepwise regression analysis was performed by using 24-hour fluctuation of IOP as an objective variable and age, gender, refractive error, IOP at 10 am, mean deviation as explanatory variables.

**Results:** Single regression analysis showed 24-hour fluctuation of IOP had the significant negative correlation with age (β = -0.006, r² = -0.02, p = 0.03), IOP at 10 am (β = 0.077, r² = 0.12, p < 0.0001) and refractive error (β = -0.025, r² = 0.12, p = 0.03). IOP at 10 am and refractive error were selected as explanatory variables associated with 24-hour fluctuation of IOP by stepwise multiple regression analysis.

**Conclusion:** Patients with higher IOP or a higher degree of myopia had bigger 24-hour fluctuation of IOP in NTG.
COMPARISON STUDY OF THE IOP REDUCTION EFFICACY AND SAFETY BETWEEN LATANOPROST AND TAFLUPROST IN JAPANESE NORMAL TENSION GLAUCOMA PATIENTS

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**Background:** To evaluate and compare the intraocular pressure (IOP) reduction efficacy and safety between latanoprost (Lat) and tafluprost (Taf) in Japanese normal tension glaucoma patients, prospectively.

**Methods:** We enrolled 25 Japanese normal tension glaucoma (NTG) patients who had used Lat monotherapy for more than 4 weeks, and divided into the two groups randomly; Lat to Taf group (LT group) and Taf to Lat group (TL group). At the beginning, both groups were switched from initial Lat to Lat or Taf for 12 weeks, and then switched over each drug (crossover) and used for 12 more weeks. Written informed consent was obtained from all participants. We evaluated IOP at 0, 4, 12, 16, and 24 weeks from the first switching, respectively. We also evaluated the conjunctival injection score (0-3 grade), corneal epitheliopathy score (area density classification; AD score), and the changes of eyelashes and pigmentation of eyelids or irises at 12 and 24 weeks, respectively.

**Results:** The mean IOP of TL group (13 eyes) were 11.1, 10.8, and 10.4 mmHg, while that of LT group (12 eyes) were 10.4, 10.8, and 11.1 mmHg at 0, 12 and 24 weeks respectively. There were no significant differences between two groups and intra-group comparisons. The conjunctival injection score were 1.0 ± 0.4 at baseline, 1.0 ± 0.5 (Taf group) and 0.9 ± 0.5 (Lat group) at 12 weeks. The corneal AD score (total score of area and density grade) were 0.9 ± 1.2 at baseline, 0.8 ± 1.1 (Taf) and 0.6 ± 1.1 (Lat) at 12 weeks. There were no significant differences between the two drugs. The changes of eye lashes, pigmentation of eyelids and irises showed similar expressions in both groups.

**Conclusion:** Tafluprost and latanoprost are considered to have the equivalent efficacy and safety in the Japanese normal tension glaucoma patients.
CENTRAL CORNEAL THICKNESS AND INTRAOCULAR PRESSURE IN CHILDREN UNDERGOING CONGENITAL CATARACT SURGERY: A PROSPECTIVE, LONGITUDINAL STUDY

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**Background:** Several studies, all of them retrospective, have demonstrated that central corneal thickness (CCT) is increased after surgery in children with congenital cataract. We designed a prospective study to investigate changes in CCT and intraocular pressure (IOP) in children after congenital cataract surgery, as well as risk factors associated with these changes.

**Methods:** 37 eyes of 26 children with congenital cataract undergoing surgery were prospectively recruited and followed for a mean of 30.5 ± 10.6 months. IOP and CCT measurements were performed before the surgery and every 6 months for 3 years. IOP measurements were performed with Goldmann or Perkins aplanation tonometry and CCT was measured with an ultrasound pachimeter (Ocuscan RXP, Alcon Laboratories Inc, USA) by the same observer. Changes in IOP and CCT were analyzed with the Mann-Whitney U test, and linear regression analyses were performed to investigate the influence of age and IOP on CCT changes.

**Results:** Among the 37 eyes, 15 became aphakic and 22 pseudophakic. One eye (2.7%) developed glaucoma and had to undergo an Ahmed valve implantation. Mean CCT significantly increased from 556.24 ± 44.19 µm to 585.07 ± 56.45 µm (p = 0.003). Mean IOP significantly increased from 12.05 ± 2.3 mmHg to 13.89 ± 2.96 mmHg (p = 0.037). Age at the time of surgery was inversely correlated to CCT change (r = -0.34, p = 0.04), but not to IOP change (r = -0.18, p = 0.27). When surgery was performed between 0-1 year of age, mean CCT change was 53.25 µm, compared to 14.0 µm, 13.8 µm, and 14.33 µm when surgeries were performed between 1-5 years, 5-10 years and > 10 years old, respectively (p = 0.015). IOP change was not correlated to CCT change (r = 0.31, p = 0.06).

**Conclusions:** CCT increases in eyes undergoing congenital cataract surgery, especially when the surgery is performed at an early age (before 1-year old).
24-HOUR IOP CONTROL WITH THE BRINZOLAMIDE/TIMOLOL OR BRIMONIDINE/TIMOLOL FIXED COMBINATIONS IN GLAUCOMA PATIENTS INSUFFICIENTLY CONTROLLED WITH TRAVOPROST MONOTHERAPY

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**Background:** To determine the adjunctive 24-hour intraocular pressure (IOP) efficacy of brinzolamide/timolol, or brimonidine/timolol fixed combinations (FCs) in open-angle glaucoma patients who were insufficiently controlled on travoprost monotherapy.

**Methods:** A prospective, observer-masked, active-controlled, crossover, comparison. Qualified primary open-angle or exfoliative glaucoma patients with a baseline IOP > 18 mm Hg at 10:00 on travoprost monotherapy were randomized for 3 months to brinzolamide/timolol, or brimonidine/timolol FCs adjunct to travoprost. Patients were then crossed over to the opposite treatment for another 3 months. At the end of the travoprost run-in and after each 3-month treatment period patients underwent 24-hour IOP monitoring.

**Results:** Fifty patients completed this study. The mean 24-hour baseline IOP on travoprost was 20.1 ± 1.8 mmHg. Both adjunctive FC therapies significantly reduced the IOP at each time point and for the mean 24-hour curve compared with travoprost monotherapy (p < 0.01). The addition of brinzolamide/timolol FC to travoprost provided significantly lower mean 24-hour IOP (17.1±2.6 mm Hg) versus the addition of brimonidine/timolol FC (18.0 ± 2.6 mmHg) (p < 0.001). Mean 24-hour fluctuation was significantly lower with travoprost monotherapy (3.7 ± 1.0) and after the addition of brinzolamide/timolol FC (3.6 ± 1.5) than the addition of brimonidine/timolol FC (4.3 ± 1.7) (p = 0.03 and 0.02 respectively). Both fixed combinations reduced oxygen saturation values compared with travoprost baseline (p < 0.001).

**Conclusions:** This crossover study showed that the addition of brinzolamide/timolol FC to travoprost significantly decreased 24-hour IOP with less fluctuation than the addition of brimonidine/timolol FC.
REPRODUCIBILITY OF DIURNAL INTRAOCULAR PRESSURE PATTERNS EVAULATED BY TWO CONSECUTIVE DAY MEASUREMENTS
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**Background:** Diurnal intraocular pressure (IOP) measurement at baseline provides information about diurnal IOP curve as well as the range of IOP fluctuation and helps to set target IOP in each patient. Reassessment of diurnal IOP curve after initiation of therapy is considered to be useful to confirm the therapeutic effects. Because diurnal IOP measurements require the time and costs, IOP profiles at a single day are commonly used. However, reproducibility of diurnal IOP curves was reported to be poor. In this study, we examined the reproducibility of the diurnal IOP curve of two consecutive days in patients with normal-tension glaucoma (NTG).

**Methods:** Hospital records from 86 Japanese patients (50 men, 36 women; mean age, 49.4 years) with NTG were reviewed. All subjects had no history of ocular surgery and were not treated with any antiglaucoma medications for more than 4 weeks before diurnal IOP measurements. IOPs of both eyes were measured with a Goldmann applanation tonometer at 3-hour intervals from 6:00 to 24:00 for two consecutive days. On each day, a single experienced doctor measured IOP at all time points. IOP data from the eye with greater visual field defect were used for statistical analysis. Intraclass correlation coefficient (ICC) was used to assess the agreement of IOP at each time point and IOP changes between time points. The interpretation scheme for ICC was "excellent" agreement beyond chance (ICC > 0.75), "fair to good" (0.4 < ICC < 0.75) and "poor" (ICC < 0.4).

**Results:** Seven patients showed an IOP > 21 mmHg through two consecutive measurements (i.e., primary open-angle glaucoma). For these 7 patients, the mean diurnal IOP was 18.1 ± 1.8 mmHg (range, 15.8 - 20.3). In 86 patients, the differences of mean, peak, trough IOP and IOP range (peak - trough) between two days were insignificant (p = 0.13, 0.24, 0.40, 0.76; paired t test). Brand-Altman plot demonstrated that mean IOP differences between two days were not statistically significant at each time point except for 6:00 (Day 1 - Day 2 = +0.79 mmHg [95% Confidence Interval (CI) 0.29 - 1.3 mmHg]). Intrapatient variability: ICCs [95%CI] of mean, peak, trough IOP and IOP range were 0.86 [0.79 - 0.91], 0.76 [0.66 - 0.84], 0.74[0.63 - 0.83] and 0.31 [0.10 - 0.49]. Agreement of IOP at each time point was generally fair to good, with ICCs ranging from 0.51 to 0.68. However, agreement of IOP change between time points was uniformly poor, with ICCs ranging from 0.043 to 0.15.

**Conclusions:** Untreated NTG patients do not manifest reproducible IOP curve even in two consecutive days. Single-day IOP measurement is valuable in examining the mean, peak and trough IOP, but does not fully characterize IOP fluctuation of an individual patient.
REPEATABILITY OF DIURNAL INTRAOCULAR PRESSURE MEASUREMENTS IN GLAUCOMA PATIENTS
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Purpose: To evaluate the short-term repeatability of diurnal intraocular pressure (IOP) pattern in subjects with primary open angle glaucoma on chronic ocular hypotensive therapy.

Method: Thirty cases of primary open angle glaucoma (POAG) underwent diurnal IOP estimation (7am to 10 pm; every 3 hrs) using Goldman applanation tonometer on 2 visits, 1 week apart. One eye of each patient was analyzed to determine the agreement of individual diurnal IOP patterns from the first visit to the second visit. Intervisit agreement of IOP by time point and of IOP change between time points was assessed using intraclass correlation coefficients (ICCs).

Results: Mean age of the patients was 59.15 ± 11.12 yrs (45% females). Between-visit agreement of IOP values at each time point generally was poor to fair, with ICCs ranging from 0.04 to 0.56. The correlation between visits was lowest at 7 am (0.04) and highest at 1pm and 7 pm (0.56). Between-visit agreement of IOP change over time between time points was uniformly poor and often below that expected by chance alone, with ICCs ranging from -0.23 to 0.33.

Conclusions: POAG patients do not manifest reproducible diurnal IOP pattern when measured by Goldmann tonometry over a short time period. A single-day assessment of IOP is not adequate to evaluate adequacy of IOP control.

Table 1: Mean intraocular pressure values at each time point among glaucoma patients

<table>
<thead>
<tr>
<th>Time</th>
<th>Visit 1</th>
<th>Visit 2</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 am</td>
<td>16.7 ± 4.0</td>
<td>15.3 ± 3.0</td>
<td>1.4</td>
</tr>
<tr>
<td>10 am</td>
<td>17.9 ± 3.5</td>
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Table 3: Interclass correlation coefficients for comparison of intraocular pressure changes between time points from Visit 1 to Visit 2 among glaucoma patients

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Table 3: Interclass correlation coefficients for comparison of intraocular pressure values at each time point from Visit 1 to Visit 2 among glaucoma patients

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ABSTRACT WITHDRAWN
THE EFFECT OF THE CORNEAL EDEMA AFTER CATARACTS SURGERY ON PASCAL DYNAMIC CONTOUR TONOMETER, GOLDMANN APPLANATION TONOMETER AND PNEUMOTONOMETER

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¹Department of Ophthalmology, Hospital del Tajo, Madrid - Spain

Purpose: To determine the effect of corneal edema after phacoemulsification cataract surgery on measurements of intraocular pressure (IOP) using the Pascal dynamic contour tonometer (DCT), compared with the Goldmann applanation tonometer (GT) and pneumotonometer (PT).

Methods: Prospective study of a cohort of 97 patients who underwent phacoemulsification cataract surgery with intraocular lens (IOL) implantation. IOP (Pneumotonometer, Goldmann and Pascal DCT), ocular pulse amplitude (OPA), and central corneal thickness (CCT) were measured in the operated eye one day before and one day, one week and one month after cataract surgery. 54 patients finished the study. Paired t-tests, Spearman correlation, and Bland-Altman plots were used to identify changes in, and relationships between these parameters.

Results: Corneal edema induced by phacoemulsification cataract surgery resulted in statistically significant increases in CCT (87.8 μm SD 56.8; p < 0.001), Pascal DCT IOP (4.8 mmHg, SD 8.0; p < 0.001), Goldmann IOP (1.4 mmHg, SD 5.1; p < 0.015) and OPA (0.9 mmHg, SD 3.5; p < 0.025) but not in pneumotonometer IOP (1.1 mmHg, SD 5.3; p = 0.065). Changes in IOP measured by GT and PT were less than those measured by the Pascal DCT. The Pascal DCT provided higher IOP readings than GT and PT (p < 0.01) in every evaluation, with large deviations in the highest IOP readings. The variation between the Pascal DCT (Rho 0.247; p = 0.038), and Pneumotonometer (Rho 0.358; p = 0.002) was strongly correlated to the change in CCT, but not in GT measurements (Rho 0.197; p = 0.094).

Conclusions: Corneal edema after phacoemulsification cataract surgery increased IOP readings in the three tonometer compared, this increment is bigger in Pascal DCT readings. Changes in CCT are statistically significant associated with increased Pascal DCT IOP readings. Goldmann tonometry IOP measurements performed on edematous corneas are the most reliable, and furthermore, are less affected by corneal edema changes involved in cataract surgery.
CORNEAL HYSTERESIS PREDICTS INTRAOCULAR PRESSURE REDUCTION FROM MEDICAL AND SURGICAL REDUCTION OF INTRAOCULAR PRESSURE

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¹Weill Cornell Medical College, New York - USA; ²New York Medical College, New York - USA

Purpose: To determine whether a baseline corneal hysteresis (CH) measurement was associated with intraocular pressure (IOP) reduction from medical and surgical therapy.

Design: Retrospective cohort study.

Participants: Records from 61 consecutive patients with newly diagnosed open angle glaucoma who were initiated on pressure lowering therapy with a prostaglandin analogue (PGA) from an untreated baseline were reviewed (PGA group), as were records from 18 eyes of 13 patients undergoing surgical IOP reduction from a variety of techniques (surgery group).

Methods: Included patients underwent CH measurement (Ocular Response Analyzer; Reichert, Buffalo, NY) and IOP assessment (IOPg) at baseline (untreated for the PGA group and on medical treatment for the surgery group) and during a subsequent follow-up visit at least 2 weeks after the initiation of therapy. Patient records were reviewed for demographic, medical and ocular data including most recent corneal thickness (CCT) measurement.

Main outcome measure: The association between the percentage of IOP reduction and the baseline CH, controlling for baseline IOP.

Results: Intraocular pressure measured by GAT was reduced by 3.2 mm Hg (17.0 mmHg at baseline to 13.8 mmHg; p < 0.001) for the PGA group and by 18.0 mm Hg (29.3 mmHg to 11.3 mm Hg for the surgery group; p < 0.001). Corneal hysteresis increased by 0.64 mmHg (from 9.51 mmHg to 10.14 mmHg; p = 0.003) for the PGA group and by 3.5 mmHg (6.1 to 9.6 mmHg; p < 0.01) in the surgery group. Baseline CH (but not baseline CCT) was a significant predictor of the magnitude of IOP response for both groups. Because baseline IOP differed between CH quartiles for both groups, a multivariate analysis controlling for baseline IOP was performed that demonstrated that baseline CH independently predicts the percentage of IOP reduction in the PGA group (p = 0.01) and in the surgical group (p = 0.04), although baseline IOP remained a significant predictor of percentage IOP reduction (p = 0.002) in the PGA group.

Conclusion: Although CH is influenced by IOP, baseline CH is independently associated with the magnitude of IOP reduction from topical PGA therapy and from surgical IOP reduction.
INTRAOCULAR PRESSURE ALTERATION FOLLOWING ROUTINE VISUAL FIELD EXAMINATION
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Purpose: To assess whether the Intraocular pressure (IOP) would change after visual field (VF) test in eyes with open-angle glaucoma (OAG).

Methods: This was a prospective clinical trial of 92 OAG patients without any previous surgical interventions. The IOP and subjective refraction was measured with a non-contact tonometer and with an autorefractometer before and immediately after VF test of the first eye (right), and again immediately after the second eye (left).

Results: The baseline subjective refraction was -3.81 ± 3.58 diopters (D) in the right, and -3.77 ± 3.56 D in the left eye. The mean VF testing time was 7 minutes and 28 seconds in the right and 7 minutes and 41 seconds in the left eye. The baseline IOP was 12.6 ± 2.8 mmHg in the right and 12.4 ± 2.7 mmHg in the left eye. After VF test in the first eye, the right IOP decreased significantly to 12.1 ± 2.6 mmHg (p = 0.0001), whereas the left IOP (12.1 ± 2.6 mmHg) had a similar tendency (p = 0.0277). Following VF test in the second eye, the IOP in the right and left eye was 12.1 ± 2.6 mmHg and 12.1 ± 2.7 mmHg, respectively. There was no significant difference in the right and the left IOP between following VF examination in the right and left eye (p = 0.9567, p = 0.8042, respectively). Regarding subjective refraction, no significant difference was found.

Conclusion: In eyes with OAG, VF testing makes a slightly, but significant decrease in IOP. It might be unlikely that this phenomenon results from sustained accommodation.
COMPARISON OF THE EFFECT OF CENTRAL CORNEAL THICKNESS DETERMINED BY ULTRASOUND PACHYMETRY AND BY PENTACAM ON GOLDMANN APPLANATION TONOMETRY AND ON DYNAMIC CONTOUR TONOMETRY
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Background: to compare the effects on dynamic contour tonometry (DCT) and Goldmann applanation tonometry (GAT) of central corneal thickness (CCT) determined by ultrasound pachymetry (UP) and Pentacam (PC).

Methods: 65 consecutive patients with primary open-angle glaucoma (POAG) were examined. The agreement between the pachymetric instruments was assessed by calculating intraclass correlation coefficients (ICC) and Passing-Bablok regression line. Four linear regression models were constructed, (each tonometry system as dependent variable and each pachymetric system as predictive variable).

Results: Intraclass correlation coefficient between UP and PC were 0.778 (CI 95%: 0.661-0.859). Passing-Bablok regression line (x = UP; y = PC) revealed a systematic (A=-122 μm; CI 95%: 258 - 37) and a proportional bias (B = 1.22; CI 95%: 1.07-1.48). The regression analysis revealed that DCT was not influenced by UP and PC while GAT is affected by UP (adjusted $r^2 = 0.3; B = 0.043; CI 95%$ for $B: 0.024-0.063$) and PC (adjusted $r^2 = 0.25; B = 0.036; CI 95%$ for $B: 0.021-0.052$).

Conclusions: although CCT measurements obtained using PC and UP are not completely interchangeable, the method used to determine this parameter has not relevant repercussion on GAT and TCD.
REPRODUCIBILITY OF CORNEAL BIOMECHANICAL FACTORS MEASURED BY OCULAR RESPONSE ANALYZER
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¹Department of Ophthalmology, Ewha Womans University Medical Center, Seoul - Korea Republic; ²Department of Ophthalmology, Sanggye Paik Hospital, Inje University College of Medicine, Seoul - Korea Republic; ³Department of Ophthalmology, School of Medicine Chungbuk National University, Cheongju - Korea Republic; ⁴Department of Ophthalmology, The Catholic University of Korea, Seoul - Korea, Republic

Background: To evaluate the inter- and intra-observer variability of Ocular Response Analyzer (ORA, Reichert Ophthalmic Instruments, Depew, NY) measurements, namely corneal-compensated intraocular pressure (IOPcc), Goldmann-correlated intraocular pressure (IOPg), corneal hysteresis (CH) and corneal resistance factor (CRF) and to evaluate the relationships among the IOPs obtained by ORA, Goldmann application tonometer (GAT) and non-contact tonometer (NCT).

Methods: This is an observational clinical study including 41 normal eyes from 26 healthy volunteers. 3 clinical observers performed 4 repeated ORA measurements with 1 to 2 minute-intervals. 3 consecutive NCT and GAT measurements were performed by 1 masked observer respectively. Central corneal thickness (CCT) was measured by ultrasonic pachymetry (Tomey, Japan). The inter- and intra-observer reproducibility for IOPcc, IOPg, CH and CRF was assessed by ANOVA-based intraclass correlation coefficient (ICC) and coefficient of variation (CV).

Correlation between IOP measurements and other continuous parameters was calculated using Pearson’s correlation coefficient.

Results: The mean ICC for inter-observer reproducibility was 0.89 for IOPcc, 0.93 for IOPg, 0.87 for CH, and 0.91 for CRF. The corresponding CV values were 17.09%, 19.29%, 12.82% and 15.41% respectively. The intra-observer ICC values for IOPcc were 0.77 for the first observer, 0.85 for the second. CV was 16.83% and 14.91% respectively. For IOPg, the intra-observer ICC values were 0.85 and 0.89. The corresponding CV values were 15.21% and 16.38%. For CH, the intra-observer ICC values were 0.74 and 0.84 and corresponding CV values were 12.48% and 13.19%. The intra-observer ICC for CRF was 0.80 for the first observer, 0.86 for the second. The respective CV values were 11.77% and 15.20%. The mean IOP values for GAT, NCT, IOPcc and IOPg were 13.55±2.23mmHg, 13.38±2.28mmHg, 13.64 ± 2.33 mmHg and 13.04 ± 2.51 mmHg. The differences in mean IOP values between GAT and IOPcc, between GAT and IOPg, between NCT and IOPcc, and between NCT and IOPg were not statistically significant (p > 0.05). But the difference in mean IOP values between IOPcc and IOPg was statistically significant (p = 0.02). The correlations of CCT with GAT, NCT and IOPg were significant (p < 0.05), but there was no significant correlation between CCT and IOPcc (p > 0.05).

Conclusion: The ORA provides reproducible data on biomechanical factors of normal cornea notably IOPcc, IOPg and CH. The intra-observer reproducibility was substantial for IOPcc, IOPg, CH and CRF, for all observers. Also, the average IOP measured with ORA did not result in significant differences from GAT and NCT. In conclusion, ORA provides valid, reproducible measures of IOP and biomechanical factors of cornea.
RELATIONSHIP BETWEEN CORNEAL BIOMECHANICAL PROPERTIES, CENTRAL CORNEAL THICKNESS AND INTRAOCULAR PRESSURE IN NORMAL, GLAUCOMA SUSPECTS AND GLAUCOMATOUS EYES

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Background: Goldmann applanation tonometry (GAT) is regarded as the reference standard by which to measure intraocular pressure (IOP). Although GAT may be less prone to biomechanical influence than Schiotz tonometry, it is affected by corneal biomechanical influences such as hydration, elasticity, hysteresis and rigidity. Achieving accurate estimates of IOP remains difficult. Until recently, corneal biomechanical properties could not be measured in vivo. The Ocular Response Analyzer (ORA; Reichert Ophthalmic Instruments, Inc., Buffalo, NY, USA) is a new, non-invasive device that analyses corneal biomechanical properties simply and rapidly. The ORA allows cornea compensated IOP measurements and can estimate corneal hysteresis (CH) and rigidity. It is designed to improve the accuracy of IOP measurement by using corneal biomechanical data to calculate a biomechanically adjusted estimate of intraocular pressure. The ORA generates two separate IOP output parameters: Goldmann-correlated IOP (IOPg), and the Corneal-compensated IOP (IOPcc). In this study we evaluated corneal hysteresis (CH), corneal rigidity factor (CRF), corneal compensated IOP(IOPcc) and Goldman correlated IOP (IOPg) and correlated these values with routinely measured GAT IOP readings and central corneal thickness (CCT) measurements in normal, glaucoma suspects [including ocular hypertensives (OHT) and primary angle closure (PAC)] and glaucomatous eyes.

Methods: This cross-sectional study included 216 eyes of 216 participants who had received no ophthalmic treatment in the forms of drops, laser or surgery. 93 normal, 62 glaucoma suspects with suspicious discs, 40 primary angle closure (PAC), 11 OHT and 10 primary open angle glaucoma (POAG) eyes were studied. All recruited subjects underwent measurement of corneal hysteresis (CH), corneal rigidity factor (CRF), corneal compensated IOP(IOPcc) and Goldmann correlated IOP(IOPg) by the ORA, CCT measurement by ultrasonic pachymetry and IOP measurement by GAT. Pearson’s correlation coefficient was used to correlate ORA measurements, IOP measured by GAT, and CCT in all groups. Bland-Altman’s plots used to assess agreement between IOP measured by GAT and the ORA. Receiver Operating Characteristics (ROC) curves and areas under these curves (AROCs) calculated for CH, CRF, IOPcc and GAT-IOP to assess the ability of each measured parameter to differentiate healthy from glaucoma suspect, OHT and glaucomatous eyes.

Results: IOPg and IOPcc measurements were significantly higher (p < 0.001) than GAT-IOP in all groups of patients. The corneal resistance factor (CRF) measurements were significantly higher in the OHT group compared to normal (p = 0.002), disc suspect (p = 0.001) and PAC (p = 0.046) groups. CCT correlated significantly with all parameters except the IOPcc. The mean difference between IOPg and GAT-IOP was 1.1 mm Hg, but the 95% limits of agreement between the two instruments were poor (between -6.5 and 8.7 mm Hg; Figure 1). CRF had the highest AROC (0.879; p < 0.001) followed by the CCT (0.781; p = 0.002) between OHT and normals.

Conclusions: Corneal biomechanical data appear to be a promising addendum to the complex issues of glaucoma occurrence and prognosis. Corneal factors such as CCT, corneal hysteresis and CRF may constitute a pressure-independent risk factor for glaucoma. However, IOP measurements from the ORA are not interchangeable with, and are unlikely to replace Goldmann Applanation Tonometry in the present time.
Bland Altman Plot showing agreement between IOP measured by Ocular Response Analyzer and Goldmann Applanation Tonometer

Diagnosis
- Disc suspect
- Normal
- OHT
- PAC
- POAG

Limits of Agreement
- +1.96 SD
- -1.96 SD

Mean
- 1.1

Average of IOPg and GAT-IOP
- 5 to 40

Difference between IOPg and GAT-IOP
- -8 to 12
DOES PHACOEMULSIFICATION REALLY LOWER IOP? OR CAN IT BE EXPLAINED BY CORNEAL BIOMECHANICAL CHANGES? A 3-MONTH ASSESSMENT USING GOLDMANN, ORA AND PASCAL TONOMETRY IN PATIENTS WITHOUT GLAUCOMA

O. Albis-Donado, J.D. de la Torre-Tovar, F. Gil-Carrasco, G. Lazcano-Gomez, J. Jimenez-Roman

Glaucoma department - asociación para evitar la ceguera en Mexico, Mexico

Background: Cataract removal by phacoemulsification has been long described as a procedure that lowers intraocular pressure (IOP) in patients with and without glaucoma. Since this has been studied using Goldmann Applanation Tonometry (GAT) and cataract surgery is related to changes in central corneal thickness (CCT), a possible explanation of the observed IOP lowering could be changes in CCT and other corneal biomechanical properties. The objective was to establish the difference between IOP measurements with the dynamic contour tonometer (DCT-Pascal tonometer) and ocular response analyzer (ORA) as compared with GAT, and describe changes in CCT, corneal hysteresis (CH) and corneal resistance factor (CRF) after uneventful phacoemulsification in patients without glaucoma.

METHODS: We included 46 eyes of 46 patients with visually significant cataract but visual acuity of at least 20/800, without history of glaucoma or ocular hypertension, axial length between 21 and 25 mm and less than 2D of keratometric cylinder (to avoid disturbing GAT measurements) that signed an informed consent to participate in the study. Six patients were excluded from the analysis due to complications. We measured CCT, CH, CRF and IOP, using GAT, DCT and ORA (both cornea-corrected (ORA-PCC) and Goldmann-equivalent IOP (ORA-GCC) before surgery and at postoperative days (POD) 7, 30 and 90. The study was approved by our institution’s ethics committee before enrollment began.

RESULTS: Mean basal CCT was 529 µm, increased to 556 at POD 7 (p < 0.001), improved to 536 at POD 30 (p = 0.114) and became 524 at POD 90 (p = 0.211, figure 1). Mean basal CH and CRF were 8.1 and 9.1 respectively, and both were initially lowered to 7.2 and 8.2 at POD 7 (p < 0.001), 7.6 and 8.7 at POD 30 (p = 0.008 and p = 0.016), returning to near basal values of 8.8 and 9.3 (p = 0.133 and p = 0.338, figure 2). Mean basal GAT IOP was 14.1 mmHg, and was initially unchanged at 13.4 on POD 7 (p = 0.147), 13.8 on POD 30 (p = 0.634) and lowered to 11.2 on POD 90 (p < 0.001, figure 3). Mean basal ORA-PCC was 20.4 mmHg and mean basal ORA-GCC was 17.7 mmHg, both were also initially unchanged at 20.7 and 17.2 on POD 7 (p = 0.674 and p = 0.408), 21.0 and 18.0 on POD 30 (p = 0.207 and p = 0.668), and also lowering to 18.6 and 16.1 on POD 90 (p = 0.022 and p = 0.016, figure 4). Finally, more closely resembling GAT changes, mean basal DCT was 18.3 mmHg, was also unchanged initially at 17.6 on POD 7 (p = 0.135), 18.5 on POD 30 (p = 0.259) and lowered to 15.6 on POD 90 (p < 0.001, figure 5).

CONCLUSIONS: Uncomplicated phacoemulsification in normal patients induces transient corneal biomechanical changes that return to basal after 3 months, and IOP is effectively lowered a mean 3 mmHg as measured with GAT and DCT, and 2 mmHg as measured with ORA.
Dynamic Contour Tonometry (DCT) basal IOP and changes

Basal DCT IOP  DCT IOP day 7  DCT IOP day 30  DCT IOP day 90

18.3  17.6  18.5  15.6

p=0.135  p=0.259  p<0.001
FACTORS EFFECTING OCULAR PULSE AMPLITUDE
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\textsuperscript{1}Department of Ophthalmology, Ufuk University, Ankara - Turkey

Purpose: To define the correlation between ocular pulse amplitude and intraocular pressure (IOP), central corneal thickness (CCT) and measurement quality score (QS) in eyes that dynamic contour tonometry (DCT) was used to obtain IOP rates.

Method: Eyes diagnosed as primary glaucoma or glaucoma suspect were evaluated via Goldmann applanation tonometer (GAT), non-contact puff tonometer (NCT), DCT and pentacam after complete ophthalmological examination. Cases that showed any corneal abnormality on topography or biomicroscopy were excluded. DCT measurements taken from one eye per patient that have QS of 1-3 have been included.

Results: Sixty-three eyes of 63 cases with a mean age of 56 years were enrolled into the study. Mean IOP readings using DCT, GAT, NCT were obtained as 20.2 ± 4.4, 17.5 ± 4.4, and 18.0±5.1mmHg respectively. Mean QS was 2.1 ± 0.8 and mean CCT was 558.7 ± 40.0 µm. IOP readings acquired with DCT were significantly higher than values taken with GAT and NCT. There was no significant difference between the mean IOP values attained via GAT and NCT. A negative weak correlation was observed between OPA and QS in regression model (p < 0.05 r\textsuperscript{2} = 0.09). The correlation between DCT and OPA was below the statistical significance.

Conclusion: IOP readings obtained via DCT are higher than both GAT and NCT. OPA values may be influenced by DCT measurement quality.
REPRODUCIBILITY OF MODIFIED DIURNAL TENSION CURVE AND WATER DRINKING TEST
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Purpose: to verify the reproducibility of IOP parameters from the water drinking test (WDT) and modified daily tension curve (mDTC) in patients with ocular hypertension (OH) or open-angle glaucoma (OAG).

Methods: prospective analysis of 88 eyes from 88 OH or OAG patients submitted to mDTC (IOP measured at 8:00, 11:00, 14:00 and 16:00 hours) followed by the WDT performed by the same examiners in two consecutive days. For statistical analysis, the intraclass correlation coefficient test (ICC) was used. Poor, fair and excellent reproducibility were considered when ICC values were below 0.4, from 0.4 to below 0.75 and above 0.75, respectively.

Results: mDTC analysis: IOP at 8:00, 11:00, 14:00 and 16:00 hours presented ICC levels of 0.80, 0.82, 0.83 and 0.76, respectively. Mean mDTC IOP, maximum IOP, minimum IOP and fluctuation during mDTC presented ICC values of 0.91, 0.85, 0.83 and 0.60, respectively. WDT analysis: IOP peak and IOP fluctuation during WDT presented ICC values of 0.79 and 0.37, respectively. Diurnal fluctuation, calculated as the difference between the IOP peak detected by the WDT and the minimum IOP detected by the mDTC presented an ICC value of 0.84 (all ICC values, p < 0.001).

Conclusion: IOP peaks detected by the WDT and mDTC as well as mean mDTC IOP presented excellent reproducibility parameters. mDTC fluctuation and WDT fluctuation were the least reproducible parameters. However, diurnal fluctuation (difference between WDT IOP peak and minimum mDTC IOP) presented an excellent reproducibility level.
TRABECULECTOMY AUGMENTED WITH MITOMYCIN C IS PROTECTIVE AGAINST INTRAOCULAR-PRESSURE RISE IN THE SUPINE POSITION

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Background: The intraocular pressure (IOP) increases substantially in the supine position. A new system (patent pending) was developed that enables accurate measurement of the IOP in the side-lying position using the standard Goldmann applanation tonometer.

Purpose: To measure and compare the amount of IOP elevation in the supine position between operated and medically treated glaucoma eyes.

Patients: Ten patients with chronic simple glaucoma or exfoliation glaucoma in whom only one eye was operated and their fellow-eye was treated with various topical preparations.

Methods: The IOP was first measured in the sitting position. It was then measured in side-lying position after 15 minutes of lying supine.

Results: In the medically treated glaucoma eyes the IOP increased 5.7 ± 1.3 mmHg (range 4 to 8 mmHg) while in their fellow post-trabeculectomy eyes the increase in IOP while supine was only 1.8 ± 1.6 mmHg (range 0 to 5 mmHg) (p = 0.000, paired t-test). There was no significant correlation between the IOP elevation in the supine position in the glaucomatous eyes and their fellow trabeculectomy eyes.

Conclusion: Trabeculectomy but not topical anti-glaucoma medication may prevent IOP increase in the supine position.
NURSE LED INTRAOCULAR PRESSURE MEASUREMENTS IN MOORFIELDS AT ST GEORGE'S HOSPITAL: AN AUDIT
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¹Department of Ophthalmology, Moorfields at St George's Hospital, London - United Kingdom

Objective: The aim of this audit was to assess and improve the accuracy of intraocular pressure (IOP) measurements performed by the nurses both at the glaucoma clinics and on the wards at the Moorfields St George’s Hospital. Spot checks had revealed discrepancies in these measurements and the purpose of this study was to identify and address potential areas of concern.

Methods: The methods we used included a questionnaire completed by the nurses, in order to highlight areas of weakness, in which further training was required, as well as IOP spot checks and 1-1 observation and feedback from the supervising ophthalmologist. The ST1 standards served as the gold standard (max score 9) [1].

Results: In the first cycle 22 nurses were assessed. Their mean score was 7.5 and in 37.5% of the cases IOPs were more than 2mmHg away from the assessor. The mean difference from the assessor was 3.8 mmHg. Errors in technique included using too thick a mire (56%), non-central apposition (50%), being unclear of measurement end point (31%), pressing too hard on the cornea (12%) and using too thin a mire (6%). Following constructive feedback the audit cycle was repeated including again 22 nurses. Interestingly, the mean score achieved this time was 8.5, with only 12% of IOPs being more than 2 mmHg away from the assessor and the mean difference from the assessor being reduced to 3 mmHg.

Conclusions: Our questionnaire and our 1-1 training and direct feedback led to significant improvement in the accuracy of the nurses’ IOP measurements.

HOW ACCURATE ARE DISPOSABLE PRISMS AN ADEQUATE ALTERNATIVE TO STANDARD GOLDMANN TONOMETRY PRISMS IN GLAUCOMA PATIENTS?
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¹Department of Ophthalmology, Worcester - United Kingdom

**Purpose:** To evaluate the accuracy and reliability of 2 single-use tonometry devices (Tonosafe and Tonojet) as an alternative to standard Goldmann prisms in patients attending dedicated glaucoma clinics.

**Design:** Prospective experimental study with human subjects.

**Participants:** One hundred glaucoma patients who attended 2 glaucoma clinics at the Worcester Royal Hospital between September & December 2010.

**Methods:** During each examination, intraocular pressure (IOP) was measured 3 times, using the standard Goldmann prism, Tonosafe, and Tonojet, respectively. The prism sequence was predetermined with random table, and the measurements were taken at 5-minute intervals.

**Main outcome measure:** Intraocular pressure.

**Results:** Intraocular pressure ranged from 04 to 52 mmHg. Analysis indicated that there was a good agreement between Goldmann and Tonosafe (average difference = 0.53). On the other hand, Tonojet under-recorded the eye pressure (average = 1.43) in significant number of cases (p = 0.013).

**Conclusions:** Caution should be exercised when using Tonojet prisms as they tend to record eye pressure lower than standard goldmann prism.
COMPARISON OF SUPINE AND SITTING INTRAOCULAR PRESSURE IN PATIENTS UNDERGOING DIURNAL CURVES
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Purpose: To compare supine and sitting intraocular pressure in patients undergoing diurnal curves. Methods: 100 consecutive patients undergoing diurnal intraocular pressure (IOP) monitoring were included in the study. Patients were diagnosed with normal tension glaucoma (NTG) or primary open angle glaucoma (POAG) showing progression or were NTG suspects. IOP was measured with Goldmann tonometry (GAT) at 8.30, 10.30, 12.30, 14.30 and 16.30. At 12.30, IOP was measured by Tonopen with the patient supine after staying supine for 30 minutes; IOP was then measured in sitting position with Tonopen and GAT.

Results: Mean supine IOP at 12.30 was significantly higher (p < 0.001) than mean IOP by Tonopen or by GAT in sitting position. There was no significant difference between mean Tonopen and GAT IOP in the sitting position (p > 0.05). Supine IOP was increased in 77% of right eyes (RE) and 82% of left eyes (LE) compared to the sitting IOP and was more than 20% higher than sitting IOP in 29% of RE and 23% of LE. The highest IOP values (p < 0.001) during the whole monitoring period (60% of RE and 56% of LE) were obtained in the supine position. Change in diagnosis from NTG or NTG suspects to POAG or POAG suspects was made in 9% of patients based on the sitting IOP diurnal curve; however, when supine IOP values were included, a change in diagnosis occurred in an additional 12% of patients.

Conclusion: Supine IOP is significantly higher than sitting IOP in POAG, NTG and NTG suspects undergoing diurnal IOP monitoring. The diagnosis and management of an additional 12% of our patients changed based on supine IOP elevation.

Boxplot of Right Eye Phasing
CONTINUOUS IOP MONITORING IN GLAUCOMA PATIENTS TREATED WITH TAFLUPROST
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¹Glaucoma Sector, Department of Neurosicence, Hopitaux Universitaire De Geneve, Geneve - Switzerland

Background: Intraocular pressure (IOP) is recognized as a major risk factor for the development of glaucoma and is at present the only modifiable risk factor. IOP varies throughout the diurnal and nocturnal periods and according to body posture. Studies have shown that an IOP variation of 1 mm Hg produces a change of central corneal curvature radius of approximately 3 µm. The SENSIMED Triggerfish® sensor (sensor) is a disposable silicone contact lens with an embedded micro-electromechanical system, which measures changes in corneal curvature induced by variations in IOP. An antenna, mounted around the eye, receives the data, which are then transmitted to a recorder. This technology has the potential to provide hitherto unobtainable data on the chronobiology of IOP, possibly leading to improved care of glaucoma patients. The aim of this study was to investigate the ability of the sensor to continuously monitor IOP fluctuations throughout 24-hours.

Methods: Fifteen patients with open angle glaucoma underwent 24-hour monitoring with the Sensor. All patients were treated with once-daily tafluprost drops (Santen Inc). Goldmann applanation tonometry (GAT) was done before and after Sensor monitoring.

Results: GAT was 12 and 13 mm of Hg before and after monitoring, respectively. A 24-hour SENSIMED Triggerfish® sensor output signal was recorded for all patients. The Sensor was well tolerated by patients as no complaints and serious adverse effects were recorded.

Conclusion: The Triggerfish® sensor allowed monitoring IOP throughout 24-hours in glaucoma patients providing clinically useful data.
ASSESSING THE RELATIONSHIP BETWEEN CORNEAL BIOMECHANIC PROPERTIES AND CORNEAL CURVATURE, AXIAL LENGTH, CENTRAL CORNEAL THICKNESS AND REFRACTIVE ERRORS IN THE HEALTHY SUBJECTS

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¹Ulucanlar Eye Education and Training Hospital, Ankara - Turkey

Purpose: To compare the relationship between corneal biomechanic properties and corneal curvature (CC), axial length (AL), central corneal thickness (CCT) and refractive errors (RE) in the healthy subjects.

Methods: 79 eyes from 40 healthy subjects elderly than 40 years were enrolled in this prospective study. The subjects with corneal pathologies, refractive errors higher than 3 D, history of ocular surgery, uveitis, diabetes mellitus and glaucoma were excluded. Best-corrected visual acuity, refractive errors, CC, CCT and AL of the subjects were evaluated. Corneal hysteresis (KH), Corneal Resistance Factor (CRF), cclOP, glIOp measurements were measured by Ocular Response Analyzer (ORA). CCT was determined by ultrasound pachymetry.

Results: Between -3.0 D ± 2.5 D and -2.5 D ± 1.5 D were the spherical and cylindrical errors respectively. The values of mean keratometry 7.71 ± 0.4 mm, mean CCT 539 ± 32.1 µm and mean AL 23.14 ± 1.6 mm were recorded. CH and CRF the data provided by the ORA were 9.7 ± 1.6 mmHg and 9.9 ± 2.2 mmHg respectively. CCT showed significant correlation with CH and CRF. There was no correlation between keratometry and CH and CRF. Significant negative correlation was defined between AL and CH measurements. Significant negative correlation was seen between CRF and spherical values.

Conclusion: There was a correlation between CCT, CH and CRF. Negative correlation was defined between AL and CH measurements. Negative correlation was also found between CRF and spherical values.
ABSTRACT WITHDRAWN
COMPARISONS BETWEEN APPLANATION TONOMETER, NON-CONTACT TONOMETER AND REBOUND TONOMETER IN HEALTHY SUBJECTS AND PATIENTS WITH GLAUCOMA OR OCULAR HYPERTENSION

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Purpose: To determine Goldmann applanation tonometer (GAT), non-contact tonometer (NCT) and iCare® rebound tonometer (RT) agreement in the measurement of intraocular pressure (IOP) of healthy subjects and the patients with glaucoma or ocular hypertension (OHT).

Methods: Seventy eyes of 35 healthy subjects (group 1) and 70 eyes of 35 patients with glaucoma or OHT (group 2) were enrolled and IOP measured between 1 and 4 pm. Non-contact tonometer was performed first, and then rebound tonometer was performed second, followed by 3 consecutive GAT measurements. Agreement between three tonometers was evaluated using the Bland-Altman method and the mean IOP values were compared by one-way ANOVA test.

Results: In group 1, mean IOP (±SD) taken with RT, GAT, and NCT was 13.7 ± 4.0, 16.3 ± 3.7, and 15.8 ± 3.0 mmHg, respectively. Mean difference between IOP values was GAT-RT 2.6 ± 2.7 mmHg (p < 0.001) and GAT-NCT 0.6 ± 2.1mmHg (p = 0.154). The Bland-Altman plot revealed that RT underestimated IOP compared to GAT in healthy subjects (95% limits of agreement: -2.7/7.9 mmHg). In group 2, mean IOP (±SD) measured by RT, GAT, and NCT was 15.2 ± 5.7 mmHg, 17.7 ± 5.4 mmHg, and 15.8 ± 5.2 mmHg, respectively. Mean difference of IOP values was GAT-RT 2.6 ± 2.4mmHg (p < 0.001) and GAT-NCT 2.0 ± 2.5mmHg (p < 0.001); underestimation of IOP by both RT and NCT compared to GAT was noted on Bland-Altman plot (95% limits of agreement: -2.1/7.2 mmHg for RBT, -3.0/6.9 for NCT).

Conclusions: RT and NCT underestimated IOP similarly in group 2 as compared with GAT. The iCare® rebound tonometer is not a substitute for the GAT measurement, when an accurate IOP is needed.
AGREEMENT BETWEEN REBOUND TONOMETER, OCULAR RESPONSE ANALYZER, DYNAMIC CONTOUR TONOMETER, AND GOLDMANN TONOMETER IN MEASURING INTRAOCULAR PRESSURE

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Background: To evaluate the agreement between rebound tonometer (RBT), ocular response analyzer (ORA), dynamic contour tonometer (DCT), and Goldmann applanation tonometer (GAT) in measuring intraocular pressure (IOP), and the influence of the corneal properties on the difference in IOP measurements between these tonometers.

Methods: A total of 57 eyes of 18 healthy individuals and 39 glaucoma patients were included. Central corneal thickness (CCT) was obtained using ultrasonic pachymetry (mean of 3 measurements) and keratometry (central corneal curvature) readings were based on the automated keratometry. Corneal hysteresis (CH) was obtained using the ORA. IOP measurements were taken using iCare RBT (mean of 6 readings), corneal-compensated ORA IOP (mean of 4 readings), Pascal DCT (mean of 2 readings) and GAT (mean of 2 readings) in random order with an interval of 10 minutes among the devices.

Results: The mean (SD) IOP obtained with RBT, ORA, DCT and GAT was 15.2 (6.5) mmHg, 18.7 (6.8) mmHg, 16.5 (3.9) mmHg and 15.3 (5.7) mmHg respectively. The mean (SD) CCT was 538.2 (37.9) µm. The mean (SD) keratometry was 44.35 (1.64) diopters. The mean (SD) CH was 9.00 (1.72) mmHg. The agreement between tonometers is shown in Table 1 (image 1). The correlation between differences in IOP measurements and corneal properties is shown in Table 2 (image 2).

Conclusions: Poor agreement was found between tonometers. The CCT was correlated with the difference between RBT and DCT measurements, and between DCT and GAT measurements. The CH is correlated with the difference between RBT and GAT measurements.

<table>
<thead>
<tr>
<th>IOP measurement difference</th>
<th>Mean (SD)</th>
<th>95% limits of agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>iCare - ORAcc, mmHg</td>
<td>-3.5 (3.7)</td>
<td>(-10.8 to 3.9)</td>
</tr>
<tr>
<td>iCare - Pascal, mmHg</td>
<td>-1.3 (4.4)*</td>
<td>(-9.9 to 7.3)</td>
</tr>
<tr>
<td>iCare - Goldmann, mmHg</td>
<td>-0.1 (3.3)</td>
<td>(-6.6 to 6.3)</td>
</tr>
<tr>
<td>ORAcc - Pascal, mmHg</td>
<td>2.2 (4.6)*</td>
<td>(-6.8 to 11.1)</td>
</tr>
<tr>
<td>ORAcc - Goldmann, mmHg</td>
<td>3.3 (2.9)</td>
<td>(-2.3 to 9.1)</td>
</tr>
<tr>
<td>Pascal - Goldmann, mmHg</td>
<td>1.2 (3.7)*</td>
<td>(-6.0 to 8.3)</td>
</tr>
</tbody>
</table>

SD = standard deviation; ORAcc = corneal-compensated intraocular pressure obtained by Ocular Response Analyzer; * = significant correlation between the difference and the mean intraocular pressure readings of the tonometers.
Table 2: Correlations between difference in intraocular pressure (IOP) measurements and corneal properties

<table>
<thead>
<tr>
<th>IOP measurement difference</th>
<th>Mean keratometry $r$ (p)</th>
<th>Central corneal thickness $r$ (p)</th>
<th>Corneal hysteresis $r$ (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>iCare - ORAcc</td>
<td>-0.16 (0.24)</td>
<td>-0.16 (0.25)</td>
<td>NA</td>
</tr>
<tr>
<td>iCare - Pascal</td>
<td>-0.05 (0.73)</td>
<td>0.42 (0.001)</td>
<td>-0.01 (0.92)</td>
</tr>
<tr>
<td>iCare - Goldmann</td>
<td>-0.13 (0.32)</td>
<td>0.13 (0.32)</td>
<td>0.29 (0.03)</td>
</tr>
<tr>
<td>ORAcc - Pascal</td>
<td>0.14 (0.31)</td>
<td>0.19 (0.16)</td>
<td>NA</td>
</tr>
<tr>
<td>ORAcc - Goldmann</td>
<td>0.04 (0.75)</td>
<td>-0.08 (0.55)</td>
<td>NA</td>
</tr>
<tr>
<td>Pascal - Goldmann</td>
<td>-0.11 (0.42)</td>
<td>-0.37 (0.005)</td>
<td>0.25 (0.06)</td>
</tr>
</tbody>
</table>

$r = $ Spearman rank correlation coefficient; ORAcc = corneal-compensated intraocular pressure obtained by Ocular Response Analyzer; NA = not applicable.
INTRAOCULAR PRESSURE CHANGES DURING AN ACROBATIC ROUTINE
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Background: There are many articles describing posture-induced intraocular pressure changes. Pole fitness is a form of physical training that is gaining great acceptance. It combines elasticity, flexibility and strength. Pole fitness routines include inverted positions. The purpose of this study is to determine the intraocular pressure (IOP) changes during an acrobatic routine of pole fitness.

Methods: This is a prospective case observational series. Eleven subjects (9 women and 2 men) from a pole fitness studio volunteered for the study. All participants underwent an ophthalmic examination. Intraocular pressure was recorded using a Tonopen after 10 min of rest (baseline), 1 min of decubitus prone position, 1 min of sitting position in the pole and 1 min of outside hook position in the pole. Cardiac frequency and blood pressure were also recorded. Statistical analysis was performed with the Kruskal-Wallis and Wilcoxon tests.

Results: Compared with baseline IOP, all other positions showed significant increase in IOP (p < 0.05). There were statistical differences between outside hook position IOP and baseline, and decubitus prone and sitting positions IOP (p < 0.05). There was no statistical difference between prone position and sitting position IOP (p = 0.168). Median IOP increase was 8 mmHg for outside hook position, 2 mmHg for prone position and 1 mmHg for sitting position. For cardiac frequency, there were no statistical differences between baseline and prone positions (p = 0.121), outside hook and baseline positions (0.068), and outside hook and sitting positions (p = 0.114). For mean blood pressure, there were no statistical differences between baseline and prone positions (p = 0.064), nor between outside hook and sitting positions (p = 0.091).

Conclusion: There is a significant change in the IOP during a pole fitness routine, particularly during outside hook position.
SENSIBILITY AND SPECIFICITY OF ICARE® REBOUND TONOMETER COMPARED TO Goldmann Applanation Tonometer

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Background: Goldmann applanation tonometry (GAT) has been considered the gold standard in the measurement of intraocular pressure (IOP) in the past time. The aim of the study was to evaluate the accuracy of measurement of IOP using a new induction/impact rebound tonometer (ICare®) compared with GAT. The systematic and random errors (bias) of the two methods had been quantified, to evaluate the sensitivity and specificity of the ICare® tonometer in identifying patients with 21 mmHg or more obtained with GAT, and to consider the influence of corneal thickness on IOP measurement with the two devices.

Methods: The IOP values obtained with the two instruments in 97 patients were compared and processed with Bland and Altman methods.

Results: The analysis revealed that the IOP values recorded with the ICare® tonometer were slightly higher than those obtained with the GAT. The estimated bias for right-eye measurements was 0.78 mmHg with 95% limits of agreement ±3.55 mmHg. This overestimation, which is not clinically relevant, was confirmed when we used the IOP values corrected according to central corneal thickness for data analysis. The sensitivity and specificity were 0.90 and 0.95, respectively.

Conclusions: The accuracy of ICare® tonometer seems to be comparable with GAT and can be used also by non ophthalmologist and paramedics. Therefore, ICare® tonometer could be considered a valid alternative to the GAT in large population screening or when the condition of the patient do not allow the use of GAT.
DIURNAL VARIATION IN GOLDMANN APPLANATION TONOMETRY DOES NOT CORRELATE WITH DIURNAL VARIATION IN CORNEAL HYSTERESIS IN NON-GLAUCOMATOUS INDIVIDUALS
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Purpose: To determine whether the diurnal variability of Goldmann applanation tonometry (GAT) and corneal hysteresis (CH) are correlated in non-glaucomatous individuals.

Methods: Thirty-five non-glaucomatous individuals were recruited within an academic ophthalmology practice. Participants underwent GAT and CH assessment every two hours from 8AM until 8PM on a single day.

Results: Both GAT and CH exhibited diurnal variation. The mean range for GAT was 4.5 (OD) and 4.1 (OS). The mean range for CH was 1.9 (OD) and 2.7 (OS). These values were significantly greater than zero (p < 0.05). To assess whether GAT and CH exhibit diurnal co-variability, the change in GAT and change in CH between consecutive time points were calculated for each participant. GAT and CH change scores for each time interval were then correlated, with separate correlations performed for each time interval and eye. None of these 12 correlations reached statistical significance when Type I error was controlled at 0.05.

Conclusions: Both GAT and CH exhibit diurnal variability in non-glaucomatous individuals; however, the present study produced no evidence of co-variability between them.
CLINICAL EXAMINATION METHODS:
TONOGRAPHY, AQUEOUS FLOW MEASUREMENT
CORRELATION BETWEEN INTRAOCULAR PRESSURE AND OCULAR PULSE AMPLITUDE MEASURED WITH PASCAL DYNAMIC CONTOUR TONOMETER AND CHOSEN BIOMETRIC PARAMETERS OF THE GLOBE IN GLAUCOMA PATIENTS AND HEALTHY SUBJECTS

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Background: Pascal Contour Dynamic Tonometer (DCT) is a diagnostic tool developed for precise, digital intraocular pressure measurements, irrespectively of individual corneal parameters: central corneal thickness and corneal curvature. The DCT operating principle is based on evaluating the corneal surface tension by the chip implemented in the sensor tip. Pascal DCT is also able to measure the ocular pulse amplitude (OPA) – the diastolic/systolic fluctuation in IOP caused by changes in pulsatile choroidal blood circulation. There are no clear-cut normal ranges of OPA. Studies have shown several conditions influencing this parameter, e.g. arrhythmia, same surgical procedures and others. The aim of this study was to evaluate the influence of 2 chosen biometric parameters: central corneal thickness (CCT) and ocular axial length (AXL) on intraocular pressure (IOP) and ocular pulse amplitude (OPA) in POAG patients and healthy subjects.

Material and Methods: 57 primary open angle glaucoma patients and 108 healthy subjects were included in this prospective, non-randomised clinical study. One (right) eye in each subject was evaluated. AXL was measured with non contact immersion biometry and CCT was measured using ultrasound pachymetry. Intraocular pressure and ocular pulse amplitude measurements were performed with Pascal Dynamic Contour tonometer.

Results: Several significant correlations were found. In the group of healthy subjects - AXL/IOP 0.374 (T-test, Pearson, p = 0.01), AXL/OPA -0.514 (T-test, Pearson, p = 0.01), AXL/IOP 0.211 (Tau b Kendall, Pearson, p = 0.05), AXL/OPA -0.335 (Tau b Kendall, Pearson, p = 0.01). In the POAG group – AXL/OPA -0.435 (T-test, Pearson, p = 0.01), IOP/OPA 0.504 (T-test, Pearson, p = 0.01), AXL/OPA -0.362 (Tau b Kendall, Pearson, p = 0.01), IOP/OPA 0.299 (Tau b Kendall, Pearson, p = 0.01).

Conclusion: We found that axial length of the globe seriously influences ocular pulse amplitude readings. Regarding this finding, one must consider it, while interpreting OPA values in patients with atypical AXL. Correlation of IOP measurements with AXL in healthy subjects needs further studies, we found no explanation of this relationship. Individually different central corneal thickness does not affect IOP nor OPA readings in both groups.
CLINICAL AQUEOUS HUMOR DYNAMIC EFFECTS OF 360- DEGREE SELECTIVE LASER TRABECULOPLASTY (SLT)
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Background: Numerous studies have compared the efficacy of 180° vs 360° primary Selective Laser Trabeculoplasty (SLT). This study sought to demonstrate the aqueous humor dynamic effects of using 360° SLT on aqueous dynamics parameters in patients with primary open angle glaucoma (POAG) or ocular hypertension (OHT).

Methods: A prospective, non-controlled study on 18 eyes (9 OHT and 9 POAG). All patients were followed for three months following laser treatment. Patients with intraocular pressures (IOP) > 21-35 mmHg were treated with 360° SLT after an assessment that included baseline measurement of IOP, tonographic outflow facility and morning aqueous humor production, using an electronic Schiøtz tonometer to measure the outflow facility of the eye. The aqueous flow rate was measured by fluorophotometry and a pneumotonometer was used to measure the IOP.

Results: The mean age of the study population was 56.72 ± 12.41 years. Three months after SLT treatment, there was a significant reduction in IOP from baseline, with a 21% reduction from 24.04 ± 3.07 mmHg to 18.98 ± 2.76 mm Hg (p < 0.001). The tonographic outflow facility showed a 55% increase in outflow from 0.09 ± 0.05 µL/min/mmHg to 0.14 ± 0.08 µL/min/mmHg (p = 0.003). No statistically significant changes in aqueous humor production (p=0.46).

Conclusions: Although no significant effects on the aqueous flow rate were found, results using 360° SLT demonstrate that it lowered the IOP by increasing outflow through the trabecular meshwork.
CLINICAL EXAMINATION METHODS:
BIOMICROSCOPY (SLITLAMP)
THE REPRODUCIBILITY OF THE DISC DAMAGE LIKELIHOOD SCALE (DDLS) IN OPTIC NERVE EVALUATION

B. Gesite

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Background: The disc damage likelihood scale (DDLS) is a new method of clinical disc evaluation that considers disc size and rim thinning. The objective of this study is to determine and compare the inter-observer and intra-observer agreement using the DDLS and the vertical cup-to-disc ratio (VCD) as tools to evaluate the optic disc.

Methods: This is an institutional observational case series wherein the inter-observer and intra-observer agreement using two optic disc grading systems (DDLS and VCD ratio) were measured by two observers in three sessions grading 41 eyes of 24 patients. Percent agreement and Kappa statistic were calculated for both the inter- and intra-observer agreement for each of the grading systems.

Results: Mean inter-observer agreement was 51% (DDLS) and 40% (VCD). Kappa for inter-observer agreement using the DDLS was fair to moderate (0.570, 0.345, 0.251). Kappa for inter-observer agreement using the VCD ratio was fair (0.298, 0.281, 0.264). Mean intra-observer agreement (observer 1) was 54.7% (DDLS) and 62.7% (VCD). Mean intra-observer agreement (observer 2) was 50.3% (DDLS) and 41.3% (VCD). Kappa for intra-observer agreement using the DDLS (observer 1) was moderate (0.438, 0.290, 0.308); for observer 2 was fair to moderate (0.438, 0.290, 0.308). Kappa for the intra-observer agreement using the VCD ratio (observer 1) was moderate to substantial (0.496, 0.616, 0.495); for observer 2 was fair (0.313, 0.383, 0.372).

Conclusion: Utilizing the DDLS revealed consistently higher inter-observer agreement compared to the VCD ratio in optic nerve evaluation however, intra-observer agreement utilizing the DDLS had less consistent agreement compared with utilizing the VCD ratio.
CLINICAL EXAMINATION METHODS:
GONIOSCOPY
CLASSIFYING JUVENILE ONSET PRIMARY OPEN ANGLE GLAUCOMAS BASED ON GONIOSCOPIC FEATURES
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¹Dr Rajendra Prasad Centre for Ophthalmic Sciences, AIIMS, New Delhi, India

Background: Gonioscopic features in eyes with juvenile onset primary open angle glaucoma (JOAG) include, prominent iris processes, a high insertion of the iris or a featureless angle that appears like a membrane. The aim of our study was to evaluate the frequency of gonioscopic anomalies in eyes with juvenile onset open angle glaucoma and relate them with clinical characteristics.

Methods: Goniophotographs of 73 JOAG patients were evaluated. Age at presentation, baseline IOP, visual field defect (mean deviation) at presentation and the treatment needed to control IOP were analysed and correlated with the gonioscopic features.

Results: Of 73 patients, 25 had a normal looking open angle; group 1 while 48 were classified into Group 2 (36 with high iris insertion and or prominent iris processes and 12 with a featureless angle). Those in group 2 presented with a higher mean IOP (43.5 ± 14.3 vs 34.4 ± 12.2; p = 0.04) and greater visual field defect compared to those in group 1 (MD -25.5 ± 10.5 VS -14.8 ± 13dB; p = 0.009). The odds of the eyes in group 2 presenting with an untreated IOP > 35 mmHg was 11.5 (CI 2-65), presenting with a MD worse than -18dB was 5.1 (CI 1.1-22.1) and requiring surgical reduction of IOP was 15.1 (CI 1-148) compared to group 1.

Conclusions: JOAG can be gonioscopically sub classified as those with a normal appearing angle or those with gonioscopic abnormalities such as a high iris insertion or a featureless angle. The latter are more likely to present with higher baseline IOP, greater visual field defect and needing surgery to control their IOP.
CLINICAL EXAMINATION METHODS:
OPHTHALMOSCOPY
MORPHOMETRIC DIFFERENCES BETWEEN CONGENITAL, JUVENILE AND ADULT ONSET PRIMARY OPEN ANGLE GLAUCOMA OPTIC DISCS USING SCANNING LASER OPHTHALMOSCOPY

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\textsuperscript{1}Department of Ophthalmology, Dr. R.P. centre, AIIMS, DELHI - India

**Background:** No study has compared the morphometric features of optic disc in the eyes of congenital, juvenile and primary open angle glaucoma (POAG) patients. We aimed to evaluate the morphometric features of the optic disc in congenital glaucoma and juvenile onset open angle glaucoma (JOAG) patients and compare these with adult onset open angle glaucoma optic discs using scanning laser ophthalmoscopy (HRT3).

**Methods:** Optic discs of 25 congenital glaucoma, 146 bilateral juvenile onset and 142 adult onset POAG eyes were morphometrically compared using the HRT 3. One eye of each patient was analysed in the study.

**Results:** Congenital glaucoma and JOAG discs were significantly larger in size compared to adult POAG (2.9 ± 0.92 mm\textsuperscript{2} and 2.6 ± 0.5 mm\textsuperscript{2} vs 2.4 ± 0.57 mm\textsuperscript{2}), had greater cup area (1.68 ± 0.78 mm\textsuperscript{2} and 1.49 ± 0.56 mm\textsuperscript{2} vs 1.32 ± 0.63 mm\textsuperscript{2}) and a greater horizontal cup disc ratio (0.81 ± 0.10 and 0.77 ± 0.14 vs 0.72 ± 0.17). JOAG had a significantly greater cup volume (0.61 ± 0.40 mm\textsuperscript{3} and 0.62 ± 0.46 mm\textsuperscript{3} vs 0.48 ± 0.53 mm\textsuperscript{3}), greater cup depth (0.34 ± 0.16 mm and 0.42 ± 0.16 mm vs 0.36 ± 0.14 mm) and greater cup disc area ratio (0.56 ± 0.16 and 0.57 ± 0.17 vs 0.52 ± 0.17) compared to adult POAG discs. However there was no significant difference in the rim area (1.26 ± 0.55 mm\textsuperscript{2} and 1.13 ± 0.48 mm\textsuperscript{2} vs 1.12 ± 0.38 mm\textsuperscript{2}), RNFL thickness (0.12 ± 0.12 mm and 0.17 ± 0.09 mm vs 0.15 ± 0.11 mm), and vertical cup disc ratio (0.68 ± 0.19 and 0.71 ± 0.15 vs 0.69 ± 0.15) between the three groups.

Table: “p” values of independent sample t-test between the three groups.

<table>
<thead>
<tr>
<th></th>
<th>Congenital Glaucoma vs POAG</th>
<th>JOAG vs POAG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc area</td>
<td>0.02</td>
<td>0.007</td>
</tr>
<tr>
<td>Cup area</td>
<td>0.01</td>
<td>0.017</td>
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<tr>
<td>Rim area</td>
<td>0.13</td>
<td>0.883</td>
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<td>Cup depth</td>
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<td>0.001</td>
</tr>
<tr>
<td>Cup volume</td>
<td>0.29</td>
<td>0.023</td>
</tr>
<tr>
<td>Cup disc area ratio</td>
<td>0.36</td>
<td>0.040</td>
</tr>
<tr>
<td>Horizontal C:D ratio</td>
<td>0.002</td>
<td>0.024</td>
</tr>
<tr>
<td>Vertical C:D ratio</td>
<td>0.69</td>
<td>0.441</td>
</tr>
<tr>
<td>Mean RNFL</td>
<td>0.20</td>
<td>0.177</td>
</tr>
</tbody>
</table>

**Conclusions:** The discs of congenital glaucoma patients and those with juvenile onset primary open angle glaucoma are larger in size than adult POAG discs. Possibly due to higher IOP, JOAG and congenital glaucoma discs have a greater cup area. The greater horizontal cup disc ratio compared to adult POAG discs in JOAG and congenital glaucoma discs is indicative of a concentric enlargement of the cup.
CLINICAL EXAMINATION METHODS: VISUAL FIELD EXAMINATION AND OTHER VISUAL FUNCTION TESTS
COMPARISON OF MACULAR SENSITIVITY IN EARLY AND MODERATE STAGE OPEN-ANGLE AND ANGLE-CLOSURE GLAUCOMA WITH MICROPERIMETRY
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Background: Glaucoma has traditionally been thought to affect peripheral visual function in its early stages and to spare central visual function until late in the disease process. Recent investigations of central visual functions and macular structures in glaucoma have challenged this assumption. Fundus perimetry (also known as microperimetry) innovated recently is a precise, functional test that quantifies differential light threshold at selected areas. Several studies demonstrated that microperimetry can detect more subtle glaucoma functional damage than standard automated perimetry. Previous studies of macular structure and function in glaucomatous eyes included mostly participants with POAG. Primary open angle glaucoma (POAG) and primary angle closure glaucoma (PACG) are the two main types of primary glaucoma with different mechanism and different clinical course. It has been speculated increase intraocular pressure (IOP) is the proximal cause of damage in PACG, but that other factors may predominate in at least some patients with POAG. In the present study, we will investigate and compare the macular sensitivity on early and moderate stages POAG and chronic PACG patients with fundus perimetry.

Methods: A total of 126 eyes from 113 subjects including 53 normal eyes, 50 POAG eyes and 23 CACG eyes were prospective enrolled in this study. Subjects with Mean defect (MD) of the standard automatic perimetry (SAP) no worse than 10 dB were enrolled in this study. Macula 10° program with 40 stimuli was performed with MP-1 microperimetry. The mean sensitivity of central 1°, 3°, and 5° visual field were calculated and compared among POAG, CACG, and normal controls respectively. Correlation analysis between mean sensitivity in MP-1 and mean defect in SAP was performed.

Results: The average light sensitivity at central 1°, 3°, 5°, and total macular area in POAG patients was significantly decreased compared to normal controls, respectively (p = 0.000, p = 0.000, p = 0.000, p = 0.004). The average sensitivity at central 3° (p = 0.004), 5° (p = 0.013) and total (p = 0.024) in CACG patients were significantly declined compared to normal controls. However no significant difference at central 1° was observed in CACG patients (p = 0.145) compared to normal controls. Macular sensitivity was significantly correlated with mean defect in SAP in POAG (p < 0.05 at central 3°, 5° and total area respectively). But this correlation was only found at central 5° in CACG (p < 0.05). The macular sensitivity in MP-1 was significantly correlated to the mean defect in SAP in quadrants in POAG group (p < 0.01 in four quadrants respectively), but no correlation was found in CACG group (p > 0.05 in four quadrants respectively).

Conclusions: The amount of macular sensitivity reduction is different between POAG and CACG, which provides new evidence to the different pathogenesis between POAG and CACG.
PATTERNS OF VISUAL DYSFUNCTION IN GLAUCOMA IN DIFFERENT AGE GROUPS
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1
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Background: The pathogenesis of glaucoma depends on the onset of glaucoma. Congenital glaucoma is different from juvenile and adult-onset glaucoma whether it is high pressure or normal pressure glaucoma. Visual field examination is an indispensable tool for diagnosis of glaucoma and the visual dysfunction that accompanies it.

Methods: 80 glaucoma patients were examined and their visual fields were plotted using Octopus 101 Automated Perimetry white on white test. Patients were classified as 20 cases of congenital glaucoma, 10 cases of juvenile glaucoma, 30 cases of open angle glaucoma and 20 cases of normal-tension glaucoma.

Results: Visual field examination of the patients revealed no significant differences in the mean deviation and loss variance among the different groups but the pattern of field loss was different in age groups and it was well correlated to the pathogenesis and natural disease history.

Conclusion: Visual field examination is an essential diagnostic tool in glaucoma. It shows the pattern of visual dysfunction in glaucoma patients and helps us to understand the pathophysiology of this disease with many enigmatic aspects.
A NEW GLAUCOMA STAGING SYSTEM BASED ON VISUAL FIELD INDEX
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Background: We newly developed a simple glaucoma staging system (GSS) comprised of stages 0 to 5 which are divided into visual field index (VFI) and retinal sensitivity within central 5° on the basis of Bascom Palmer GSS. The purpose of this study is to present the new GSS and to assess its staging performance.

Methods: 725 eyes of 486 glaucoma patients were enrolled in this study. The VFI cut-off values of the stages 1 to 4 were derived from Receiver Operating Characteristic curve on basis of mean deviation criteria in Bascom Palmer GSS, and also, the staging criteria of stages 0, 5, and central retinal sensitivity are referred to Bascom Palmer GSS. The staging performance of new GSS was assessed in kappa coefficient (κ), and additionally, unmatched patients were studied further.

Results: The calculated cut-off values of VFI was 81.5% between stages 1 and 2 (area under the curve: AUC = 0.972), 62.5% between stages 2 and 3 (AUC = 0.960), and 40.5% between stages 3 and 4 (AUC =0.983). The new GSS and Bascom Palmer GSS classified 8 eyes each into stage 0, 187 and 105 eyes into stage 1, 133 and 188 eyes into stage 2, 185 eyes and 226 into stage 3, 198 and 184 eyes into stage 4, and 14 eyes each into stage 5, respectively. The new GSS somewhat agreed with Bascom Palmer GSS (κ = 0.745). When classifying all patients by the new GSS, 69 out of 82 eyes (84.1%) in stage 1 and 16 out of 29 eyes (55.2%) in stage 2, which did not match for their stages, were recognized to be overestimated while 20 out of 20 eyes (100%) in stage 4, which did not match for their stage, were recognized to be underestimated with Bascom Palmer GSS.

Conclusion: The new GSS can be easily applied and more practical compared with Bascom Palmer GSS as the new system considerably reduces overestimation or underestimation of visual field defects.
RISK OF WIPE-OUT PHENOMENON AFTER TRABECULECTOMY WITH RELEASABLE SUTURES WITH MITOMYCIN-C IN ADVANCED GLAUCOMA WITH TUBULAR FIELDS AND SPILT FIXATION

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Aim: To study the risk of wipe-out phenomenon after Trabeculectomy with releasable sutures with mitomycin-C in advanced glaucoma with tubular fields and spilt fixation

Method: In a prospective study, patients with POAG, PACG, juvenile open angle glaucoma, pseudoexfoliation glaucoma and elevated episcleral venous pressure glaucoma who had uncontrolled IOP with maximum medical management were included. 50 eyes of 39 patients with advanced disc damage showing tubular fields with split fixation on field analysis (Humphrey 30-2 and Macular threshold test) underwent trabeculectomy with releasable sutures with mitomycin-C. These patients were evaluated post operatively for fall in IOP, maintenance of aided distant and near visual acuity, any progression of defect on the same field tests as done pre-operatively to assist the risk of wipe-out phenomenon.

Results: After 1 and 3 months post operatively, mean reduction of IOP was 14.83 (58.82%) mmHg, macular threshold test did not show any deterioration in the threshold values. No case of wipe out phenomenon was recorded.

Conclusion: As the incidence of wipe out phenomenon is rare, trabeculectomy with releasable suture with mitomycin-C can be safely considered as a treatment option in advanced glaucoma with tubular fields and spilt fixation.
COMPARISON OF LATANOPROST, BRIMONIDINE TARTRATE AND BIMATOPROST PLUS TIMOLOL MALEATE FIXED COMBINATIONS

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Background: To compare the intraocular pressure (IOP) lowering efficacy of latanoprost 0.005% - timolol maleate 0.5% fixed combination, brimonidine tartrate 0.2% - timolol maleate 0.5% fixed combination and bimatoprost 0.03% - timolol maleate 0.5% fixed combination and to evaluate the changes in visual field.

Methods: This study was performed retrospectively. Fifteen eyes receiving latanoprost 0.005% - timolol maleate 0.5% fixed combination, 14 eyes receiving brimonidine tartrate 0.2% - timolol maleate 0.5% fixed combination and 6 eyes receiving bimatoprost 0.03% - timolol maleate 0.5% fixed combination were included in the study. No subject had any systemic or ocular disease except glaucoma that could effect IOP or visual field test. All subjects used antiglaucoma drugs for a mean period of 12.54 ± 8.4 months (4 months - 26 months). Intraocular pressure was measured using Goldmann applanation tonometer and visual fields test was performed using Humphrey visual field analyzer. Examinations were performed before the initiation of antiglaucoma drugs and at the end of follow-up period. Results were compared using Kruskal-Wallis test and Wilcoxon test and p values lower than 0.05 were determined to be significant.

Results: Latanoprost 0.005% - timolol maleate 0.5% fixed combination, brimonidine tartrate 0.2% - timolol maleate 0.5% fixed combination and bimatoprost 0.03% - timolol maleate 0.5% fixed combination significantly reduced IOP as compared with baseline (from 21.2 ± 2.2 mmHg to 16.2 ± 3.3 mmHg, from 20.3 ± 3.1 mmHg to 16.3 ± 2.5 mmHg, and from 25.8 ± 3.8 mmHg to 16.8 ± 2.4 mmHg respectively). There was no difference in the IOP lowering efficacy among three groups (p = 0.084). Significant improvement in visual field was seen in subjects using latanoprost 0.005% - timolol maleate 0.5% fixed combination and in the group receiving brimonidine tartrate 0.2% - timolol maleate 0.5% fixed combination whereas there was no significant change bimatoprost 0.03% - timolol maleate 0.5% fixed combination (for mean deviation p = 0.003, p = 0.028, p = 0.40 respectively).

Conclusion: All three fixed combinations have similar IOP lowering efficacy whereas the effect of latanoprost 0.005% - timolol maleate 0.5% fixed combination on visual field is more pronounced. The effects of fixed combinations on visual field need to be evaluated in larger and prospective series.
A COMPARISON OF FOCAL AND NOISE-CORRECTED GLOBAL CHANGE OF AUTOMATED VISUAL FIELDS
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Background: There is a clinical need to quantitate the relative contributions of diffuse and focal change to glaucomatous visual field progression. (Caprioli, J AJO 2008, 145, 191; Artes, P et. al Archives of Ophthalm 2010, 128,1528; Richards et. al ARVO 2010 Abstract # 5497; EGS 2010 Poster # P2.51). We have compared noise-corrected maximum-likelihood (NCML) global progression of the Zeiss-Humphrey (ZH) parameter Total Deviation (TD) with focal progression as measured by the ZH parameter Pattern Deviation (PD).

Methods: We retrospectively analyzed 92 ZH 24-2 Sita-Standard Visual Fields of 10 eyes of 10 glaucoma patients. There were 7 to 11 serial VF’s per eye extending over 4 to 8 years. Mean Defect (MD) ranged from -19 to 0. All eyes had corrected acuities of 20/40 or better and combined false positive and false negative error rates of < 20%. We calculated the NCML global slope in db/year (abstract submitted to ARVO 2011) of TD for the 10 eyes and compared this with slope of the standard deviation (as a measure of focal irregularity) of PD (abbreviated SDPD).

Results: Slope of SDPD and negative slope by NCML were well correlated (Pearson r = 0.861). By Mann-Whitney U Test, the two sets of slopes were not statistically different (p = 0.322). By T-Test, none of the 10 pairs of slopes differed at the p = 0.05 level.

Conclusions: NCML analysis reduces the noise of TD progression analysis and makes it possible to quantitatively compare slopes, in db/year, of global and focal VF change. In the present limited study, we found that global slope by NCML and focal slope by SDPD are essentially equivalent.
FREQUENT LOCATION OF VISUAL FIELD DEFECTS IN GLAUCOMA SUSPECTS AS EVALUATED BY SITA-SWAP

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Background: Short wavelength automated perimetry (SWAP) can predict visual field defects in glaucoma patients earlier than standard white-on-white perimetry. SITA-SWAP is a novel strategy that reduces test time. The purpose of the study was to ascertain the preferential location of visual field defects in glaucoma suspects as detected by SITA-SWAP.

Methods: SITA-SWAP reliable exam printouts of 86 eyes from 43 patients with suspicious optic discs were analyzed. All 52 non-blind spot locations in the 24-2 SITA-SWAP were clustered into six areas corresponding to six topographic sectors of the optic disc (supero-temporal, supero-nasal, temporal, infero-nasal, infero-temporal and nasal). Number of points depressed (p < 5%) on the pattern deviation probability plot in each of the six areas were recorded and adjusted by the total number of points in each area. The frequency of depressed points was compared among all areas.

Results: The visual field area with higher number of depressed points was that corresponding to the infero-temporal aspect of the disc (21.4%), whereas the area with less depressed points was that corresponding to the nasal aspect of the disc (1.7%).

Conclusion: The inferior hemifield seems to be the preferential location of visual field defects in glaucoma suspects as evaluated by SITA-SWAP. This observation helps differentiate possible artifacts from highly possible visual field defects.
EFFICACY OF FUNDUS-ORIENTED PERIMETRY FOR DETECTION OF VISUAL FIELD ABNORMALITIES IN PRE-PERIMETRIC GLAUCOMA

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Background: Conventional automated perimetry threshold examinations have a relatively low spatial resolution with 6 degrees separating adjacent test locations. The sparse number of the test points may be one of the reasons why glaucomatous visual field defects are not detected in eyes with pre-perimetric glaucoma. Therefore, the aim of this study is to report the usefulness of Kowa AP-6000 (Kowa, Japan), fundus-oriented perimetry, for detection of visual field abnormalities in retinal nerve fiber layer defect (RNFLD) area in eyes with normal standard automated perimetry (pre-perimetric glaucoma).

Methods: Twenty-two eyes of 22 pre-perimetric glaucoma subjects who had glaucomatous optic disc abnormalities with a localized RNFLD were included in this study. None of reliable Humphrey Field Analyzer (HFA) test results showed glaucomatous visual field defects, which were determined according to Anderson’s criteria. Reliable HFA test results were defined as a false-positive error $< 15\%$, a false-negative error $< 15\%$, and a fixation loss $< 20\%$. All subjects had complete ophthalmic examinations and had to meet the following criteria: best corrected visual acuity $\geq 1.0$, with a spherical error within $\pm 6.0\text{D}$ and a cylinder error within $\pm 3.0\text{D}$. AP-6000 is a fundus oriented perimetry with a picture of the subject’s fundus presented upside-down automatically on the screen and the examiner should arrange the image by pointing to the fovea centralis and the center of the optic disc. A test area was set in the upper and lower hemifields on the fundus image displayed on the monitor. The RNFLD was included in the test area. The arbitrary test point can be added, if needed. The sizes of the targets were Goldmann III. Target color was white and background luminance was 31.5 asb. Exposure duration was 200 ms. The Bracketing method was used as a test strategy. All subjects underwent AP-6000 within 3 months before or after HFA test, and were diagnosed according to the following criteria: Criteria 1: having a cluster of three or more points with 5 dB or more decrease in sensitivity with at least one point with 10 dB or more decrease in RNFLD area; Criteria 2: having a cluster of three or more points with 5 dB or more decrease in sensitivity in RNFLD area; Criteria 3: having a cluster of two or more points with 5dB or more decrease in sensitivity with at least one point with 10 dB or more decrease in RNFLD area.

Results: The sensitivities of each criterion are Criteria 1: 22.7\% (5/22), Criteria 2: 31.8\% (7/22), Criteria 3: 22.7\% (5/22), respectively. There were no decrease in sensitivity fulfilled any of those criterion outside RNFLD area.

Conclusion: The fundus-oriented perimetry may be a useful method to detect visual field abnormalities in pre-perimetric glaucoma.
THE VISUAL FIELD CHANGES FOLLOWING UNILATERAL ACUTE ANGLE CLOSURE ATTACK IN PRIMARY ANGLE CLOSURE GLAUCOMA PATIENTS
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Purpose: To analyze visual field (VF) changes in eyes with unilateral acute angle-closure glaucoma attack (AACG) in primary angle closure glaucoma (PACG) patients and identify risk factors at presentation for VF change after acute attack.

Patients and Methods: In this retrospective case series analysis on data from Taiwan, from January 2000 and October 2009, we evaluated VF change in eyes with AACG and the contralateral eyes without acute attack (CACG). Also, risk factors for VF progression in AACG were analyzed.

Results: Eyes of 88 patients were reviewed. All patients had one eye in the AACG group, the contralateral eye in the CACG group. Mean follow up was 28 months (range, 24-32 months). Mean deviation (MD) and corrected pattern standard deviation (CPSD) showed severity of VF change increased significantly with time (p < 0.001). However, MD value differed significantly at 6 and 9 months after the acute attack (p < 0.05). After resolution of the acute attack in AACG group, higher baseline intraocular pressure (IOP), worse baseline MD and age were statistically significant risk factors for VF progression.

Conclusions: The AACG group had worse VF progression than CACG at 6 and 9 months follow up. Physicians should closely monitor patients with AACG during follow up, especially those with identified risk factors.

Keywords: acute primary angle closure, angle closure, visual field.
FACTORS IN THE VARIATION OF RETINAL NERVE FIBER LAYER BUNDLE ANGLE
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Background: In glaucoma, the correspondence between the functional changes of the visual field and the structural changes of the optic disc is important for the diagnosis of the disease. Polar graph is a visual field representation that can clearly represent this correspondence. Based on an anatomical pattern of the retinal nerve fiber layer (RNFL), polar graph determines the RNFL bundle angles at the optic disc and rearranges the result of each test location of the G2 program around the optic disc. However, the bundle angles can be influenced by many factors. In this study, we measured the RNFL bundle angles and investigated the factors in the variation of the bundle angle.

Methods: Subjects were 36 eyes of 36 subjects (10 males and 26 females; average age, 39.5 ± 14.0 years) including 7 glaucomatous eyes and 29 normal eyes. All the subjects had spherical equivalent (SE) of -10.5 D to +0.25 D. Each subject’s fundus images were taken by the scanning laser ophthalmoscope (SLO, F-10, NIDEK) with a blue laser (490 nm) and the SLO images were averaged using the software tracking method Registax V4.0 to construct a clear 60°RNFL bundle image. We also detected the subject’s blind spot using the custom test of the Octopus 900 with 1° intervals. The G2 test program with the found blind spot was inverted to match the blind spot to the optic disc on the RNFL bundle image for comparison. We traced the trajectories of the RNFL bundle from each test location to the optic disc and subsequently measured the bundle angle at the optic disc for each test point. In this study, four factors were considered relevant to the variation of the bundle angle: SE, axial length (AL), the angle formed by the line passing through the fovea and the optic disc and the horizontal line passing through the fovea (the fovea-optic disc angle), and the angle formed by the central superior and inferior temporal retinal arteries (the temporal retinal artery angle). We investigated their correlations with the bundle angle.

Results: All the test points had a standard deviation of the RNFL bundle angle between 8.7° and 16.9°. Except the AL, the other three factors correlated with the bundle angle. Particularly, the correlations with the bundle angle were observed in the temporal visual field for SE, within the visual field 15° from the fixation point for the fovea-optic disc angle, and in the nasal visual field for the temporal retinal artery angle.

Conclusion: Our results indicated an average individual difference of about 12 degrees in the bundle angle. In addition, the bundle angle could be affected by SE, the fovea-optic disc angle, and the temporal retinal artery angle.
EVALUATION OF THE ALGORITHM TO PREVENT SPIKES-SHAPED ISOPTERS IN FULLY AUTOMATED KINETIC PERIMETRY

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Background: In automated kinetic perimetry, spikes-shaped isopters that indicate deviations from normal kinetic results because of response variability are often observed. To prevent or minimize such events, we developed a new algorithm and evaluated its effect on Program K, our fully automated kinetic perimetry, in virtual patients.

Methods: Goldmann manual kinetic perimetry (MKP) was performed on 100 eyes of 100 patients (average age, 57.1 ± 16.7 years; 63 eyes with glaucoma, 24 eyes with neuro-ophthalmological diseases, and 13 eyes with retinitis pigmentosa). Depending on the characteristic of their visual field changes, the patients were classified into two groups: Group I with flat changes and Group II with steep changes. The obtained isopters were digitized in K-Train (an Octopus kinetic perimetry training software developed by Tübingen University) to be used on 100 virtual patients. Program K was then performed on the 100 virtual patients using target sizes of V/4e, III/4e, I/4e, I/3e, I/2e, and I/1e at a speed of 3 degrees/sec to assess the visual field loss. With K-Train, the virtual patients’ false-positive (FP) rates, false-negative (FN) rates, scatter in the frequency-of-seeing (FOS) curve, and scatter of reaction times were adjustable. By assessing FP and FN rates, the number of vectors, test durations, scatter in the FOS curve and scatter of reaction times, we examined the association between the results of Program K and the Goldmann MKP.

Results: If both the FP and FN rates were less than 20%, the isopters obtained by Program K were comparable to those by the Goldmann MKP. If the FP and FN rates were equal to or higher than 20% and the number of vectors and test durations also increased significantly, spikes were observed in some of isopters obtained by Program K. However, if Group I and II had a scatter in the FOS curve in K-Train respectively less than 0.7 and 0.9 and the scatter of reaction times was less than 0.4, the isopters from Program K were comparable to those by the Goldmann MKP. This indicated the effect of the new algorithm on Program K for eliminating the spikes in the isopters and the effect had resulted in comparable results by both methods.

Conclusion: By simulating the spikes-shaped isopters on the virtual patients, we have shown that the algorithm in Program K could reduce spikes in the isopters and optimize the use of Program K.
Background: Heidelberg Edge Perimeter (HEP) that uses a new stimulus called Flicker-Defined Form (FDF) to selectively stimulate the magnocellular system is developed to detect early glaucoma. The test consists of flickering random dots on a mean luminance background (50 cd/m^2). The 5-degree circular stimulus is created by a phase reversal of the black and white dots that flicker in counterphase to the background dots at a temporal frequency of 15 Hz. The counterphase flickering black and white dots create an illusionary “edge” that the patient perceives as a gray patch or a circle against the mean luminance background. In this study, we evaluated the clinical usefulness of HEP.

Methods: Subjects were 32 eyes of 32 patients with glaucoma (average age, 53.5 ± 10.9 years) and 20 eyes of 20 normal subjects (average age, 42.0 ± 10.0 years). All the subjects underwent Standard Automated Perimetry (SAP) using the Humphrey Field Analyzer (HFA) 24-2 SITA-Standard strategy, Short Wavelength Automated Perimetry (SWAP) on the HFA using 24-2 SITA-SWAP strategy, flicker perimetry on the Octopus 311 (4-zone probability 38S), Frequency Doubling Technology (FDT) on the Humphrey Matrix with 24-2 threshold, and HEP using 24-2 ASTA-Standard strategy. Glaucomatous eyes were graded on the basis of the Hodapp-Anderson-Parrish Criterion: 5 eyes with preperimetric glaucoma, 9 eyes with early stage of glaucoma, 7 eyes with moderate stage of glaucoma, and 11 eyes with advanced stage of glaucoma. The visual field was evaluated using the number of abnormal points. The cutoff criterion for defining a point as abnormal corresponded to a sensitivity equal to or worse than the normal 5% probability level for an age-similar group. The areas under the receiver operating characteristic curves (AUCs) were calculated to assess the detectability of glaucoma.

Results: The AUCs in HEP using the total deviation were 0.70 in preperimetric and early glaucoma, 0.85 in moderate glaucoma, and 0.87 in advanced glaucoma. The AUCs in HEP using the pattern deviation were 0.76, 0.86, and 0.95 in preperimetric and early, moderate, and advanced glaucoma, respectively; which were similar to those in SWAP and FDT. The specificity of HEP was 25% with the total deviation and 55% with the pattern deviation.

Conclusion: HEP appeared to be a useful method for detecting early glaucoma. However, the normal data in HEP might need to be reconsidered because the AUC with the total deviation had a lower value than the AUC with the pattern deviation. In addition, the flickering stimulus and background along with the changing contrast might have increased the difficulty of the test and caused the low specificity of HEP.
RELATIONSHIP OF THE THRESHOLD VALUES BETWEEN THE KINETIC TARGET AND STATIC TARGET
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Background: One of the important objectives of the visual field testing is the evaluation of quality of vision (QOV) of visually disabled people. For the evaluation of severe cases of visual field disorders, kinetic perimetry using the Goldmann perimeter (GP) is as useful as static perimetry with the automated perimeter. However, it is well known that there exists divergence between threshold values of kinetic perimetry and those of static perimetry even under the same conditions. In this study, we investigated the relationship of static perimetric threshold and kinetic threshold with kinetic targets under the corrected reaction time (RT) with a specific constant target speed using the automated perimeter.

Methods: The subjects were 8 eyes of 8 healthy youths (6 males and 2 females; average age: 30.5 years). Each of the 4 quadrants was measured with the automated perimeter, Octopus®900, Goldmann kinetic perimetry (GKP), using the target speed of 3 degrees/sec and the size and luminance of V/4e, III/4e, I/4e, I/3e, I/2e, I/1e. When deciding threshold values, the RT was corrected. Static perimetry was performed using a custom test program with the normal strategy and stimulus size 3 on the meridians where the kinetic perimetry was carried out. The measuring points were arranged with distance of 2 degrees to one another, and threshold values were measured and compared with those of the points which corresponded to the points where response was obtained in GKP.

Results: The threshold value of β/4e obtained with kinetic targets corresponded to the static threshold value of 9.2 ± 5.0 dB. Likewise, the threshold values of I/4e, I/3e, I/2e, and I/1e corresponded to the static threshold values of 15.8 ± 3.2 dB, 19.7 ± 2.5 dB, 26.3 ± 2.6 dB and 28.7 ± 1.9 dB, respectively. The comparison of the kinetic threshold value of δ/4e and static threshold value was not possible. Kinetic perimetry using stimulus size 1 demonstrated divergence from the photometric harmony based on the theoretical spatial summation compared to the static perimetry using stimulus size 3.

Conclusion: The threshold values obtained using kinetic targets were lower than those with static targets, therefore, photometric harmony based on the simple spatial summation cannot be applied when target sizes are different.
DIAGNOSTIC ACCURACY OF VISUAL FIELD STAGING SYSTEMS FOR CLASSIFICATION OF GLAUCOMA SEVERITY
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Background: Evaluation of glaucoma severity is important both for clinical practice and research purposes. The amount of visual field loss detected by standard automated perimetry (SAP) is widely used method to categorise glaucoma severity. Several visual field staging systems (VFSSs) have been proposed for the classification of glaucoma severity but there is no general agreement about which of these staging systems is most accurate. The purpose of this study was to compare the diagnostic accuracy of four VFSSs; Brusini Glaucoma Staging System 2 (GSS2), Advanced Glaucoma Intervention Study (AGIS), Collaborative Initial Glaucoma Treatment Study (CIGTS), and Burr’s MD VFSS for classification of glaucoma severity.

Methods: Sixty-six consecutive adult patients attending glaucoma clinic were eligible. Only eyes with at least two reliable visual field (VF) tests using central 24-2 Humphrey field analyzer within six months of recruitment and no evidence of anterior segment diseases that obstruct the viewing of the optic nerve were included. Each eye was independently graded into stages of glaucoma severity by an experienced glaucoma specialist (AAB, reference standard), based on a clinical guideline, and a researcher using the selected VFSSs (index tests). A random sample of 15% of study population was independently assessed by another ophthalmologist. Sensitivity, specificity, positive predictive values (PPV) and negative predictive values (NPV) were calculated for each VFSS according to level of glaucoma severity.

Results: One hundred and four VFs were compared but four tests were not included in the analysis of CIGTS VFSS due to corrupted files. In total, 16 eyes were diagnosed to be normal, 24 eyes were mild, 32 eyes were moderate and 32 eyes were severe. The agreement between two ophthalmologists was excellent (κ = 0.88 [CI, 0.7 to 1.0]). The sensitivity and specificity of the VFSS in grading the visual field according to level of glaucoma severity was highest in AGIS VFSS (37.5%, 77.3%) for normal stage, Burr’s MD VFSS (70.8%, 60.0%) for mild stage, Brusini GSS2 (65.6%, 75.0%) for moderate stage and Brusini GSS2 (68.8%, 95.8%) for severe stage. While, sensitivity and specificity was lowest in Burr’s MD VFSS (6.3%, 93.2%) for normal stage, AGIS VFSS (16.7%, 57.5%) for mild stage, CIGTS VFSS (20.7%, 73.2%) for moderate stage and CIGTS VFSS (25.0%, 82.4%) for severe stage. Improvement in the performance of VFSS was seen after combining normal and mild visual fields; Burr’s MD VFSS (92.5%, 70.3%), Brusini GSS2 (80.0%, 87.5%), AGIS VFSS (90.0%, 56.3%), and CIGTS VFSS (53.9%, 44.3%), sensitivity and specificity respectively.

Conclusion: Staging systems designed for classifying glaucoma severity have limitations. Burr’s MD VFSS appears to be useful in staging mild disease, while, Brusini GSS2 is useful in staging moderate and severe disease. Overall performance was improved by combining normal and mild disease. Using VFSS as the sole criteria of classifying glaucoma severity is still insufficient in classification of glaucoma severity.
ADJUSTING FOR VISUAL ACUITY TO REMOVE THE POTENTIAL CONFOUND OF CATARACT DEVELOPMENT WHEN ASSESSING VISUAL FIELD CHANGE IN EARLY GLAUCOMA
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Background: Automated perimetry remains the gold standard for functional testing in glaucoma. However, contrast sensitivity (perimetric sensitivity) is affected not just by glaucoma, but also by developing cataract. The Visual Field Index (VFI) aims to provide a global index that is less affected by cataract development. However, it is insensitive to early glaucomatous change, signaling “100% of normal vision” even when generalized loss or very early localized loss are present. This study aims to identify predictors of the rate of sensitivity loss after adjusting for potential cataract development, without excluding early glaucomatous change.

Methods: Data were taken from the ongoing Portland Progression Project, a longitudinal study of participants with early or suspected glaucoma. The rate of change of Mean Deviation (MD) over sequences of six visual fields was predicted based on the initial neuroretinal rim area (from confocal scanning laser ophthalmoscopy), intra-ocular pressure (IOP; the maximum recorded during the series), treatment (the proportion of the six visits at which the patient self-reported taking IOP-lowering medication), and the rate of change of logMAR-equivalent visual acuity during the series. A first-order autoregressive multivariate linear generalized estimating equation model was used, to adjust for multiple series from the same participant.

Results: 1232 series of six visits were included, from both eyes of 145 participants, averaging 4.2 series per eye. At their first visit, 84% of participants had VFI > 98; 31% had VFI = 100. Series began with an average MD of -2.0dB; VFI of 98.3; IOP of 18.1 mmHg; and acuity of -0.01 logMAR equivalent. Only 8% had a rate of change of VFI worse than -1/year, while 29% had MD change worse than -0.33dB/year (both approximately 1% of the available range). Rate of change of MD was predicted by Rim Area (p = 0.003), rate of change of acuity (p = 0.027), Treatment (p < 0.001) and IOP (p = 0.008). Similar models predicted rate of change of MD using optic nerve head cup volume (p = 0.001), and cup-to-disc ratio (p < 0.001).

Conclusion: Adjusting for change in visual acuity allows the rate of glaucomatous progression to be assessed, without discarding information about early glaucomatous change. Clinically, considering the rate of change of MD together with acuity may allow better detection of change than using the trend of VFI in early glaucoma.
PATTERN DEVIATION MAY SOMETIMES BE AN UNRELIABLE INDICATOR OF VISUAL FIELD LOSS DUE TO STATISTICAL ARTIFACTS

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Background: Probability maps are widely used for clinical assessment of the visual field. Total deviation (TD) maps indicate differences from age-corrected mean normal values, and PD maps attempt to highlight localized loss by statistically correcting TD maps for overall loss of sensitivity due to factors such as cataract. The aim of the current study was to look for statistical artifacts in pattern deviation (PD) probability maps. Previous studies have found that it is not uncommon to see, in healthy eyes, clusters of locations flagged as defective in PD probability maps [Heijl & Åsman, Perimetry Update 1988-89]. Here, the number of clustered defective locations is compared for TD and PD probability maps, for visually healthy control subjects and patients with glaucoma, using both standard automated perimetry (SAP) and frequency-doubling perimetry (FDP).

Methods: The most recent pair of reliable SAP and FDP tests was selected for twenty-seven patients and 25 age-similar controls from a longitudinal study. All 52 subjects had good acuity, were experienced with perimetry, and were free from significant cataract or pupillary miosis. Age-corrected TD and PD values were calculated from control data to permit two-tailed analyses and avoid statistical differences between machine norms for the two tests. Cutoff values for suspect-low and abnormal-low sensitive locations were, respectively, the 5th and 1st percentile of the kernel density estimates of distributions for controls. Cutoffs for suspect-high and abnormal-high locations were the 95th and 99th percentile. Suspect and abnormal locations were only included in the analysis if adjoining locations were also suspect or abnormal, i.e. if they were part of an abnormal cluster [Patel et al, Ophthalmology 2007; 114: 480-7].

Results: TD and PD values calculated in reference to study controls were similar to those on machine printouts, typically within ± 1 decibel. Patterns of damage shown in probability maps from TD and PD calculated in reference to control subjects were also similar to patterns in the printouts. TD maps for SAP and FDP showed abnormally low-sensitive clusters for 9 and 6 control subjects, respectively, and abnormally high-sensitive clusters in 5 and 7 subjects. PD maps for SAP and FDP showed abnormally low-sensitive clusters in 11 control subjects and abnormally high-sensitive clusters for 3 and 6 subjects, respectively. These observations lead to the hypothesis that PD has a bias towards abnormally low-sensitive clusters and away from abnormally high-sensitive clusters. Machine printouts for patient data were used to test the prediction that PD increases the number of defective clusters. For both SAP and FDP printouts, 8 patients (30%) had more locations in defective clusters for PD than for TD. The 95% confidence interval for the percentage was from 15% to 48%.

Conclusion: Even though PD was conceived as a means of correcting for diffuse loss, statistical artifacts may occur that introduce bias. Higher number of locations in defective clusters for PD maps than for TD maps seems to occur more frequently than it is commonly thought. In such event, TD may be the more reliable indicator of visual field loss.
EFFECTS OF GLAUCOMA PROGRESSION ANALYSIS IN GLAUCOMA MANAGEMENT
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Background: Visual field tests are important for follow-up of glaucoma. This article was designed to evaluate the effects of Glaucoma Progression Analysis (GPA) and Visual Field Index (VFI) used in Humphrey Field Analyzer perimeter (HFA) in follow-up management of glaucoma patients.

Methods: Retrospective studies of the eyes of glaucoma patients and ocular hypertensive patients were made in at least five reliable central visual field results through 24-2 test of SITA-Fast strategy. Progression of the visual field damage was analyzed by visual field progression scoring criteria of Advanced Glaucoma Intervention Study (AGIS) and analyzing indices of GPA software respectively. Agreement between both methods was quantified by kappa analysis.

Results: There’s a significant relevance between the incidence of the progression of visual field damage evaluated by GPA and the one evaluated by clinical scoring criteria. Furthermore, GPA indicated the test point of abnormal variation with simple triangle symbols, and revealed the possible progressions of visual field with the words of “Likely Progression”, “Possible Progression” or “No Progression Detected” in progression analysis printouts. GPA indicated the velocity of progressive visual field damages within five years through the regression analysis of VFI relative to age, which give a clear clinical guide to patients for the next therapeutic target.

Conclusions: GPA has an excellent efficiency for evaluation of visual field progression, just like clinical scoring criteria of AGIS, and more sensitive, specific and convenient, which has an important guiding effect on the follow-up of either confirmed or suspected glaucoma patients, or ocular hypertension patients.

Keywords: glaucoma, progression of visual field damage, GPA, AGIS, VFI.
COMPARISON OF SITA SWAP, MATRIX FDT PERIMETRY AND SAP FOR DETECTION OF GLAUCOMATOUS VISUAL FIELD DEFECTS
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¹Department of Ophthalmology and Visual Sciences, University Eye Center, Hong Kong - China

Backgrounds: To compare the diagnostic performance of standard automated perimetry (SAP), frequency doubling technology (FDT) perimetry, and short wavelength automated perimetry (SWAP) in detecting glaucomatous visual field abnormality.

Methods: One hundred and thirty-two participants (95 glaucoma patients and 37 normal subjects). Each participant had retinal nerve fiber layer (RNFL) imaging by the Cirrus HD-OCT and visual field testing by SAP, Matrix FDT perimetry, and Swedish interactive thresholding algorithm (SITA) SWAP at the same visit. Any visual field defects were confirmed with at least 2 consecutive examinations by the same types of perimetry. RNFL thickness was used as a reference standard to determine whether glaucoma was present. An RNFL thickness deviation map score ≥ 4 was considered glaucomatous and ≤ 2 was considered normal. The diagnostic sensitivity, specificity and the area under the receiver operating characteristic curve (AUC) of MD (mean deviation) and PSD (pattern standard deviation) for detection of visual field abnormality were compared between perimetries.

Results: Taking all glaucoma patients into consideration, the diagnostic sensitivity was highest for Matrix FDT perimetry (69%), followed by SAP (68%) and then SITA SWAP (59%). When the analysis only included early glaucoma patients, the sensitivity reduced to 52%, 46% and 34%, respectively, with a significant difference detected between Matrix FDT perimetry and SITA SWAP (p = 0.034). The specificity was ≥ 97% for all perimetries. The AUCs of MD and PSD followed a similar order with Matrix FDT perimetry had the greatest AUC (0.91 - 0.95), followed by SAP (0.88 – 0.94), and then SITA SWAP (0.69 - 0.91). There were significant differences in sensitivities at 90% specificity between Matrix FDT perimetry and SITA SWAP (p ≤ 0.001 for MD; p ≤ 0.029 for PSD).

Conclusions: While the diagnostic performance for glaucoma detection was comparable between Matrix FDT perimetry and SAP, Matrix FDT perimetry had a higher sensitivity to detect glaucomatous visual field abnormality than SITA SWAP at a comparable level of specificity.

Table 1: Demographics and visual field measurements of the normal and glaucoma groups

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Glaucoma</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of subjects</td>
<td>37</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>Age (years) (±SD)</td>
<td>53.78 ± 8.99</td>
<td>54.23 ± 14.36</td>
<td>0.83</td>
</tr>
<tr>
<td>Sperical error (D) (±SD)</td>
<td>0.51 ± 1.49</td>
<td>-1.60 ± 3.46</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Cirrus HD-OCT average RNFLT (µm) (±SD)</td>
<td>97.84 ± 7.53</td>
<td>69.69 ± 11.32</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>SAP MD (dB) (±SD)</td>
<td>-0.48 ± 1.08</td>
<td>-8.12 ± 7.65</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>SAP PSD (dB) (±SD)</td>
<td>1.45 ± 0.29</td>
<td>6.15 ± 4.46</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Matrix FDT perimetry MD (dB) (±SD)</td>
<td>0.38 ± 2.14</td>
<td>-9.13 ± 6.66</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Matrix FDT perimetry PSD (dB) (±SD)</td>
<td>2.64 ± 0.44</td>
<td>5.70 ± 2.17</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>SITA SWAP MD (dB) (±SD)</td>
<td>-3.67 ± 3.20</td>
<td>-11.17 ± 7.65</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>SITA SWAP PSD (dB) (±SD)</td>
<td>2.50 ± 0.53</td>
<td>5.56 ± 2.66</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

SD = standard deviation; D = diopter; dB = decibel; RNFLT = retinal nerve fiber layer thickness; MD = mean deviation; PSD = pattern standard deviation; SAP = standard automated perimetry; FDT = frequency doubling technology; SITA SWAP = Swedish interactive thresholding algorithm short wavelength automated perimetry
Table 2: Diagnostic performance of SAP (standard automated perimetry), Matrix FTD (frequency doubling technology) perimetry and SITA SWAP (Swedish interactive thresholding algorithm short wavelength automated perimetry) for detection of glaucoma

<table>
<thead>
<tr>
<th></th>
<th>All glaucoma (n = 95)</th>
<th>Early glaucoma (n = 56)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>SAP</td>
<td>Matrix FDT perimetry</td>
</tr>
<tr>
<td>Sensitivity (%)</td>
<td>68.4 (58.0 - 76.9)</td>
<td>69.4 (59.6 - 77.8)</td>
</tr>
<tr>
<td>(95% CI)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specificity (%)</td>
<td>100.0 (90.6 - 100.0)</td>
<td>97.3 (86.2 - 99.5)</td>
</tr>
<tr>
<td>(95% CI)</td>
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CI = confidence interval.

Table 3: Area under the receiver operating characteristic curve and the sensitivity at 90% specificity of MD (mean deviation) and PSD (pattern standard deviation) for SAP (standard automated perimetry), Matrix FDT (frequency doubling technology) perimetry and SITA SWAP (Swedish interactive thresholding algorithm short wavelength automated perimetry)

<table>
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<tbody>
<tr>
<td></td>
<td>SAP</td>
<td>Matrix FDT perimetry</td>
</tr>
<tr>
<td>AUC MD (95% CI)</td>
<td>0.93 (0.89 - 0.97)</td>
<td>0.94 (0.90 - 0.98)</td>
</tr>
<tr>
<td>Sensitivity (%)</td>
<td>81.1 (66.8 - 91.1)</td>
<td>84.2 (66.3 - 94.7)</td>
</tr>
<tr>
<td>(95% CI at 90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>specificity)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AUC PSD (95% CI)</td>
<td>0.94 (0.88 - 0.97)</td>
<td>0.95 (0.90 - 0.98)</td>
</tr>
<tr>
<td>Sensitivity (%)</td>
<td>81.1 (68.9 - 89.5)</td>
<td>83.1 (75.8 - 94.7)</td>
</tr>
<tr>
<td>(95% CI at 90%</td>
<td></td>
<td></td>
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<tr>
<td>specificity)</td>
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</table>

CI = confidence interval.
COMPARISON OF PROGRESSION ANALYSIS IN OCULAR HYPERTENSION AND GLAUCOMA WITH MD AND NEW VFI INDICES

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**Background:** The Visual Field Index (VFI) is a new indice of evaluation of visual function on standard Humphrey automated périmétrie, less sensitive to changes in clarity of ocular media than mean deviation (MD). The aim of this study was to compare results of the progression analysis evaluated by each indices, in ocular hypertension (OHT) and primary open-angle glaucoma (POAG).

**Methods:** Prospective study of 298 eyes followed 6.6 (±1.7) years (213 OHT and 85 Early POAG). Each subject performed a mean of 10 standard automated perimetry. VFI, MD and their rate of progression were analysed and compared.

**Results:** During follow-up period, in the OHT group, 75% of patients stayed OHT at the end of the study and 25% became POAG. Mean rate of progression in these 2 groups were respectively -0.04%/year and -0.41%/year for VFI, -0.03 dB/year and -0.20 dB/year for MD. Conclusions about progression after statistical trend analysis of the VFI and MD rates of progression were concordant for 84% and 80% of eyes, respectively, in the 2 groups. In the early POAG group, 80% stayed early POAG and 20% progressed to more severe stages of POAG (MD < -6 dB). Mean rate of progression were respectively -0.39%/year and -3.00%/year for VFI, -0.16 dB/year and -1.14 dB/year for MD. Conclusions about progression after statistical trend analysis of the VFI and MD rates of progression were concordant for 78% and 100% of eyes, respectively, in the 2 groups. VFI and MD rates of progression presented a statistically significant Spearman’s rank correlation coefficient (\(p < 0.001\)), with values of 0.678 for the overall population, 0.620 for the OHT group and 0.707 for the POAG group.

**Conclusion:** These 2 indices and their progression analysis, both trend analysis, gives always concordant and complementary evaluation of visual field in OHT and POAG. In glaucomatous subjects presenting a rapid progression profile, indices are strongly concordant. The new VFI indice and his rate of progression seems a good quantification of glaucomatous damages on the visual field and of glaucoma evolution.
COMPARISON OF TOP AND NORMAL STRATEGY IN OCTOPUS PERIMETRY
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Aim: Tendency oriented perimetry (TOP) attempts to assess the visual field by using answers to questions to establish thresholds in the neighboring area. The aim of this study was to compare the results of tendency-oriented perimetry (TOP) and a normal strategy in octopus perimetry as methods in detection of visual field defects in glaucoma patients.

Design: A prospective single centre observational case series was performed.

Participants and Methods: In a glaucoma department of University Eye Clinic 27 patients (47 eyes) with a glaucoma were examined prospectively with TOP and a normal strategy using the program G1 with the Octopus 500E. All patients had previous experience with an automated visual field tests and visual acuity better than 0.7. The following parameters were analyzed for the two strategies studied: examination time, MS (means sensitivity), MD (mean defect), LV (Loss Variance), test reliability (RF).

Results: Mean age of the patient was 55.70 ± 14.53 years. TOP perimetry showed a significant reduction of exploration time: mean 11.09 ± 0.43 minutes with the normal strategy vs. 2.21 ± 0.43 minutes with the TOP strategy (p < 0.01). The average MS was 1 dB higher with normal strategy (25.25 ± 4.57 dB with normal strategy vs. 24.78 ± 4.34 dB with TOP strategy). The average MD with normal strategy was 2.24 ± 4.27 dB and with a TOP strategy was 2.66 ± 3.98 dB. The mean LV tended to be 2 dB higher with normal strategy (16.91 ± 29.19 dB with normal strategy vs. 14.10 ± 25.38 dB with TOP strategy). Correlation coefficient of global indices between both tests was high (for MS r = 0.95, for MD r = 0.98, for LV r = 0.98) and statistically significant (p < 0.01). RF was significantly higher with normal strategy than with TOP strategy (8.23 ± 10.59 vs. 3.58 ± 4.92).

Conclusion: The TOP strategy reduces examination time significantly but seems to be less accurate especially for the calculation of the depth of each scotoma in comparison with the standard Octopus G1 perimetry.
VERIFYING THE ACCURACY OF GLAUCOMA HEMIFIELD TEST (GHT) FOR THE DETECTION OF EARLY GLAUCOMATOUS VISUAL FIELD LOSS: A STUDY

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1Eye & Glaucoma Care, Kolkata - India

Glaucoma Hemifield Test (GHT) is more finely tuned to detect a patch of early glaucomatous visual field loss than other global indices. In the GHT, 5 zones in the upper field are compared with the 5 zones in the mirror images locations in the lower field. The zones being constructed in the approximate patterns of retinal nerve fibres, GHT is directed primarily at the diagnosis of glaucomatous visual field loss, and no other disease.

The present study seeks to verify the accuracy of GHT for the detection of early glaucomatous visual field loss in (1) a group of subjects with ocular hypertension (OHT), converting to glaucoma (at the moment of their glaucomatous conversion) from OHT and in (2) a group of Primary Angle Closure (PAC) subjects at the moment of their conversion from PAC to PACG with early localized defects.

Methods: In a retrospective chart review, 125 cases, (248 eyes) from Rotterdam Eye Hospital, Netherlands and Eye & Glaucoma Care, Kolkata, India were included. 121 patients (242 field charts) with OHT (Intraocular Pressure > 22 and < 32 mmHg and normal visual fields) were included along with 4 PAC subjects (6 field charts, Subacute PAC with pupil block, 360 degree appositional angle closure, IOP > 22 and < 28 mmHg, with patent YAG PI, and normal visual fields). 248 reliable field charts (Humphrey Field Analyzer, 24-2 Program) were analyzed. All participants were tested once half-yearly for a 4 - 7 year period or until the onset of conversion (study end point). The conversion to glaucoma was defined as a reproducible glaucomatous visual defect in Standard Automated Perimetry. Each field was evaluated by Hoddap- Parrish-Anderson’s criteria to detect early localized field defect due to glaucoma. Three criteria for minimal abnormality to determine early glaucomatous defect are: 1) Three or > non – edge adjacent scotomas in pattern deviation probability plot, Two points p < 5% and one point p < 1%; 2) PSD p < 5%; 3) G.H.T. abnormal. Meeting any one of the criteria, seemingly the most accurate among current practices, is accepted as sufficient to make the test result abnormal. The hemifield analysis is probably the most accurate overall.

Result: 1) Out of 121 subjects with ocular hypertension, 18 converted (23 charts); 2) Out of 4 PAC patients 2 converted to PACG based on the criteria mentioned above. The GHT was not “Outside Normal Limits” in 6 charts of those converted patients with OHT and in 2 charts of converted PAC cases. GHT interpreted 8 converted field charts (6 from OHT group + 2 from PAC group), out of 25 (23+2) as “within normal limits” despite the presence of other 2 criteria in all those 8 charts.

Conclusion: Though GHT reportedly the single most effective method of visual field analysis in early glaucoma, visual field evaluation on GHT alone is at significant risk for misinterpretation, under-diagnosis and under-treatment. In OHT and Glaucoma suspects, the defect depth in pattern deviation plot should always be evaluated before any diagnostic/therapeutic decision.
THE CORRELATION BETWEEN VISUAL FIELD INDEX (VFI) VALUE AND MEAN DEVIATION (MD) VALUE OF HUMPHREY FIELD ANALYZER IN GLAUCOMA AND GLAUCOMA SUSPECTS

S. Kimura\(^1\), T. Kimura\(^2\), A. Murakami\(^3\), K. Ono\(^1\)

\(^1\)Department of Ophthalmology, Juntendo Tokyo Geriatric Medical Center, Tokyo - Japan; \(^2\)Ueno Eye Clinic, Tokyo - Japan; \(^3\)Department of Ophthalmology, Juntendo University School of Medicine, Tokyo - Japan

Purpose: We examined the correlation between visual field index (VFI) value and mean deviation (MD) value, also examined VFI plot and MD slope as well in glaucoma and glaucoma suspects.

Participants: Primary open angle glaucoma and ocular hypertension who underwent at least 5 times of SITA standard 30-2 program by Humphrey field analyzer (HFA) U700 model for the certain period. All eyes were analyzed by VFI, VFI plot, MD and MD slope in same visual fields examination.

Methods: The hundred five eyes of sixty cases (male 26 cases 46 eyes – female 34 cases 59 eyes; mean age 57 ± 11.6 y.o.) were enrolled retrospectively. Mean times of HFA examinations were 7.8 ± 1.9. The correlation of that VFI value and MD value, VFI plot and MD slope were analyzed in all eyes and in the classified eyes according to the pattern of visual field defect [central defect, peripheral defect, mixed (central and peripheral) defect and normal type]. Statistical analysis was performed by generalized-estimating-equation (GEE) model.

Results: As to MD values and VFI values, the significant correlation between those was shown in both of analysis by all eyes and by the eyes according to the types of visual field defect. The significant correlation between VFI plot and MD slope was shown by the analysis of all cases. However, these significant correlation were shown in peripheral, mixed and normal type of visual field but in central type (p = 0.509, r = 0.180).

Conclusion: A strong significant correlation was shown in VFI values and MD values and also in VFI plot and MD slope by the analysis of all cases. However, no correlation between VFI plot and MD slope was shown in the eyes with central type of visual field defect. It seems that the evaluation of progression of visual field defect at central area need to be careful attention using these trend analysis.
MICROPERIMETRIC FEATURES IN EARLY GLAUCOMATOUS OPTIC NEUROPATHY
S. Phuljhele¹, R. Sihota¹, L. Aalok¹, S. Parwal¹, R.V. Azad¹
¹Dr Rajendra Prasad Centre for Ophthalmic Sciences, AIIMS, New Delhi - India

Purpose: To evaluate microperimetry, MP1, in early glaucoma vis a vis SAP by mapping the frequency and depth of sensitivity loss at each location in the central 10° around fixation.

Method: Forty eyes with early glaucomatous defect, in form of either nasal step or arcuate scotoma on standard automated perimetry (SAP), and 14 control eyes, underwent microperimetry (MP). Significant loss of retinal sensitivity on microperimetry was mapped for frequency and depth of sensitivity loss at each location in the central 10° around fixation.

Results: Twenty one out of forty eyes had isolated nasal steps and 19 had arcuate defects on SAP examination. The corresponding retinal quadrant/ hemisphere showed significant defects on MP. The average mean sensitivity (MSMP) in the glaucomatous eyes and in the control eyes was 11.8 ± 3.9 dB (6.3-17.4) and 16.6 ± 1.2 dB (15.1-18.9), respectively, p = 0.0004. The average mean defect (MDMP) in glaucomatous and control eyes was -6.5 ± 2.0dB (-12.1 - -2.2) and -3.0 ± 1.2 dB (-4.8 - -0.8) respectively, p = 0.05. In case of eyes with nasal step an absolute scotoma was 14-28% of eyes 8 -10° off the fixation while moderate to mild defects were in seen 10-52% of eyes, with at-least 10% of eyes showing involvement as close as 4° from the fixation. Eyes with an arcuate scotoma showed an absolute scotoma on MP1, in 5-95% of eyes, at locations 6-10 degrees from fixation, with extension up to 2 degrees from fixation in 5-21%. The normal hemisphere on SAP in the glaucomatous showed a mild defect 13-43 % of eyes.

Conclusion: The defects on microperimetry appear to be more extensive and closer to the fixation as compared to standard automated perimetry.
STRUCTURE-FUNCTION RELATIONSHIP BETWEEN SCANNING LASER TOMOGRAPHY, FLICKER DEFINED FORM PERIMETRY AND STANDARD AUTOMATED PERIMETRY IN PATIENTS WITH GLAUCOMA

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Purpose: To investigate the correlation between structure and function using scanning laser tomography, flicker defined form (FDF) perimetry and standard automated perimetry (SAP).

Methods: The sample consisted of 119 participants with early to moderate glaucoma (mean age 63.49 ± 9.22 years, Male/Female ratio = 0.83). One eye of each participant was randomly assigned if both eyes were eligible for the study (60 OD). The study consisted of 3 visits over a 6 week period and included standard automated perimetry (SAP, 24-2 ASTA-Std; visits 2 and 3) and flicker defined form perimetry (FDF 24-2 ASTAStd; all visits) on the Heidelberg Edge Perimeter (HEP; Heidelberg Engineering (HE)). Scanning laser tomography images of the optic nerve were acquired on the first 2 visits. Unreliable HEP visual fields and poor quality images on the HRT were excluded from the study. The SAP/FDF visual fields were divided into sectors corresponding to the six HRT Moorfields regression analysis sectors. The relationship between global and sectoral HRT parameters and the mean deviation (MD) of FDF and SAP were analyzed using correlation coefficients and linear regression. Kappa analysis was used to score the agreement between global and sectoral classifications, i.e WNL, BL and ONL.

Results: The mean MD of FDF and SAP were -7.46 ± 5.39 dB and -2.97 ± 2.34 dB. There was significant correlation between the FDF and SAP MD and HRT rim area, cup shape, rim volume, cup to disc ratio and FSM discriminant function measured by the HRT (p < 0.001), with FDF always giving higher correlations. For example, the correlation between HRT rim area and FDF/SAP MD were (r-value): Global: 0.45/0.26, sup tmp: 0.44/0.32, tmp: 0.31/0.18, inf tmp: 0.56/0.38, sup nsl: 0.37/0.30, nsl: 0.24/0.05, inf nsl: 0.31/0.19). Kappa analysis showed fair agreement between FDF and HRT classifications. The Kappa score was always less for SAP. For example, sup tmp: k = 0.28 (FDF), 0.16 (SAP); inf tmp: k = 0.33(FDF), 0.32(SAP).

Conclusions: FDF perimetry correlated better with scanning laser tomography than SAP in this sample of patients with early to moderate glaucoma.
HEIDELBERG EDGE PERIMETRY IN GLAUCOMA DIAGNOSIS
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Background: Standard automated perimetry has become the clinical standard for diagnosing and monitoring glaucoma patients. The white-on-white Heidelberg Edge perimetry (HEP; Heidelberg Engineering, Heidelberg, Germany) is a new alternative to test visual field in glaucoma patients. The aim of this study was to evaluate and compare the diagnostic ability of HEP and Humphrey perimetry (HFA) to detect retinal nerve fiber layer (RNFL) defects measured with spectral-domain optical coherence tomography (OCT).

Methods: Sixty normal subjects and 53 age-matched glaucoma patients were prospectively selected. Only one eye per subject was randomly included in the statistical analysis. All participants underwent a comprehensive ophthalmologic examination, a reliable HEP (24-2 ASTA Standard strategy), a reliable HFA (Zeiss Humphrey Systems, Dublin, Ca; 24-2 SITA Standard strategy), and imaging with the Spectralis OCT (Heidelberg Engineering). Glaucoma patients had intraocular pressure higher than 21 mmHg and an average RNFL thickness significantly thinned beyond the 5% level. Sensitivity-specificity pairs and the areas under the receiver operating characteristic curves (AUCs) were calculated and compared between HEP and HFA visual field indices: mean deviation (MD) and pattern standard deviation (PSD).

Results: Mean age was 56.9 ± 11.1 years and 60.43 ± 8.9 years (p = 0.068) and RNFL average thickness was 97.2 ± 8.4 µm and 65.3 ± 11.0 µm (p < 0.001) in the normal and glaucoma group, respectively. MD was -0.46 ± 1.1 dB for HFA and -0.31 ± 1.4 dB for HEP in the control group (p = 0.525), while MD was -7.90 ± 7.2 dB for HFA and -7.24 ± 6.4 dB for HEP in the glaucoma group (p = 0.619). PSD of HFA (0.972) and PSD of HEP (0.951) had the largest AUCs. There was no significant difference between both AUCs (p = 0.418). At a fixed specificity of 95%, sensitivity was 91.1% for PSD of HEP (cut-off point: 1.96) and 89.3% for PSD of HFA (cut-off point: 1.92).

Conclusions: HEP and HFA had similar diagnostic ability to discriminate between healthy and glaucoma patients with RNFL defects. PSD yielded the best sensitivity-specificity balance for both systems.
COMPARISON OF SLOPES OF VISUAL FIELD LOSS PROGRESSION BETWEEN PERIDATATM PROGRAM AND GUIDED PROGRESSION ANALYSIS (GPAII) IN GLAUCOMA PATIENTS
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Purpose: To compare the slopes of progression measured by GPAII and PeriData™ in a glaucoma group.

Methods: Retrospective, observational study including 56 eyes of 32 known glaucoma patients with at least 5 reliable visual field examinations in minimum 2 years. Patients who underwent filtering surgery or laser trabeculoplasty during the follow-up period were excluded.

Results: Mean age was 70 ± 18 yrs. Each patient performed a mean number of 13 ± 4.6 (range: 9 to 28) standard automated perimetry visual test (Sita Standard 24-2) per eye and with a mean follow-up of 7.5 ± 1.3 yrs. The mean of progression by PeriData (dB/year) and GPA (%/year) were: -0.2 ± 0.38 and -0.55 ± 0.71 respectively. This difference in progression was significantly different. There was an excellent correlation between Peridata progression analysis and GPA (< 0.001).

Conclusion: Rate of progression with GPA and progression analysis of PeriData are two trend analyses. They represent complementary information and methods for progression of VF. Our data showed a significant difference between the slopes measured by GPAII and PeriData. GPAII showed more negative values which means that it predicts a faster progression.
COLOR AND LUMINANCE VARIANT PUPILLOGRAPHIC PERIMETRY IN GLAUCOMA
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Background: Recent studies utilizing multifocal pupillographic objective perimetry (mfPOP) have reported diagnostic accuracies for glaucoma in the range of those obtained using FDT-Matrix and aHFA perimetry, with average test durations of less than 3 minutes/eye. These studies utilized mfPOP luminance stimuli which likely elicit pupillary contractions mediated by the subcortical pupillary luminance response (PLR). Pupillary responses to color changes between red and green however, appear to be mediated by the cortical pupillary color response (PCR). This study investigated the diagnostic utility of stimuli aimed at eliciting response components from the PLR as well as the PCR, with the aim of sampling responses derived from a more extensive population of retinal ganglion cells.

Methods: Nineteen glaucoma subjects and 24 normal subjects were tested with three 4 minute mfPOP stimulus variants (protocols). The luminance only protocol utilized 67-150 cd/m\(^2\) yellow stimuli on a 10 cd/m\(^2\) yellow background, color and luminance protocols utilized 60-150 cd/m\(^2\) green stimuli on a 10 cd/m\(^2\) red background. The 33 ms duration stimuli were presented at mean intervals of 4 s. Stimulus luminances were balanced in two of the three protocols, yielding more uniform fields in normal subjects.

Results: The balanced color and luminance protocol produced the largest reductions in pupillary contraction amplitudes and the highest accuracy for glaucoma using amplitudes alone (ROC AUC Severe - 100% ± 0.0 SE, \(n = 3\) eyes; Moderate - 88.1% ± 6.2 SE, \(n = 10\) eyes; Mild - 83.2% ± 6.0 SE, \(n = 22\) eyes). Combined amplitude and latency measures produced slightly better results in the non-balanced color and luminance protocol (ROC AUC Severe: 100% ± 0.0 SE, \(n = 3\) eyes; Moderate: 88.8% ± 7.4 SE, \(n = 10\) eyes; Mild: 83.7% ± 6.7% SE, \(n = 22\) eyes). The time-courses of responses were found to be longer or shorter in patients depending on the severity of their mean defect.

Conclusions: Stimuli targeting both cortical PCR and sub-cortical PLR pupillary response components produced higher accuracy than stimuli targeting sub-cortical PLRs alone. Balancing of stimulus luminances resulted in further increases in accuracy.
UNDERSAMPLING AND SAP TEST-RETEST VARIABILITY
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Background: To determine the relative contributions of eye movements and visual field undersampling to test-retest variability (TRV). Undersampling occurs in standard automated perimetry (SAP) if sensitivity varies across a visual field faster than 1/12 cyc/deg (Nq), a very gentle rate of change of sensitivity across the field. Building on previously published work [doi:10.1167/iovs.1110-6014] comparing real and model visual fields the present study sought to quantify the relative contributions of eye movements and undersampling to TRV.

Methods: High resolution model visual fields were spatially smoothed in 9 gradations from nil to < Nq. For each of the 9 levels of smoothing interdecile ranges (IDR = 10th to 90th percentiles) of box plots of TRV were determined for 10 bands of scotoma depth from -28.5 to -1.5 dB. This was repeated for 600 sampled fields for each smoothness. Sampling included eye movements equal to that that of good fixators.

Results: As observed for SAP fields TRV for the unsmoothed fields grew with scD, being larger than smooth fields at the 9 largest scotoma depths (all p < 0.003). By comparison fields smoothed enough to remove the effects of undersampling of showed IDRs that did not differ from 2.5 dB (all p < 0.025) at all scotoma depths even though eye movements remained at normal levels.

Conclusions: Only about 2.5 dB of the IDR of TRV can be attributed to eye movements, the remainder appears to be due to undersampling of the field which is exacerbated by the small Type III stimulus size. Large, blurry, perimeter stimuli should therefore reduce TRV due to undersampling, in agreement with recent findings on the effects of using larger stimuli by Wall et al. [e.g. Arch Ophthalmol 2010; 128: 570-6.].
SPARK: A RAPID STRATEGY FOR AVERAGED, MORE STABLE ESTIMATES OF VISUAL FIELD THRESHOLD
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Background: The purpose of this work is to design a rapid perimetric strategy to provide averaged results.

Methods: We designed a simulation examination model using the distribution frequency of local deviations or defects, based on a retrospective study of 90,335 examinations performed in a glaucoma department.

Results: Based on retrospective analysis, threshold deviation from normal age-adjusted values of several combinations of six points allowed estimating the real mean deviation (MD) with a correlation coefficient $r = 0.995$ (standard error SE = 0.71 dB). The six local deviations obtained with the first phase of the rapid Spark perimetric strategy in the simulation model, showed high correlation with the original MD ($r = 0.984$), and with the remaining local deviations which had SE close to the mean threshold fluctuation (3.06 dB). In patients with early glaucoma (MD < 6 dB) the SE of the estimated MD was < 0.9 dB and the SE in estimating the local point-to-point deviations was 1.8 dB. Using the SE of the previous estimate as a step, we included three additional phases to obtain three additional results. In phase 4 and for the average and median of the four phases, the SE of MD ranged from 0.4 to 0.5 dB for the whole sample and from 0.3 to 0.4 in early glaucoma. Local deviation SE was close to 2 dB in the whole sample and between 1.2 and 1.5 dB in early glaucoma.

Conclusions: Bearing in mind threshold fluctuation, the strategy allows for several possible outcomes, and provides averaged and theoretically more stable results.

Fig. 1.- Both images show the approximate distribution of the six regions selected by the program, with respect to the “24-2” type Garway-Heath morphological map (left) in which the external points (blank) were not analyzed, and with respect to our functional map (right). Fig. 2. - Pearson correlation coefficients ($r$) and standard error (SE), using multiple regression to estimate the value of MD based on deviations from age-adjusted normal threshold values, of points in regions 1, 2, 3, 4, 5 or 6, using the order specified in Fig 1.
WHAT CHANGES ARE REQUIRED TO WHITE-ON-WHITE PERIMETRY TO IMPROVE DETECTION OF PROGRESSION

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Background: Reliably detecting glaucomatous progression using current white-on-white perimetric methods (SAP) often takes upwards of four years of testing. In this study we used computer modeling to quantify the decrease in variability required in current techniques that would lead to detection of progression on average one year earlier than current methods.

Methods: Assuming a true threshold of $t$, we measured the error in the estimate of $t$ produced by SAP as the standard deviation of a Gaussian about $t$, $S(t)$. We derived $S$ by fitting a Gaussian to results from repeated applications of the Full Threshold algorithm simulated on 10000 patients with false response rates of 1%, and a psychometric slope as described in Henson et al (IOVS 2000). As part of this study, we validated this model against published test-retest data, confirming that a Gaussian model based on true thresholds can produce the skewed distributions typical in published test-retest data for SAP. We classified progression in two ways: pointwise linear regression (PLR) on individual locations, and linear regression on Mean Defect (MD). Both techniques used criteria that had 95% specificity at all time periods determined by simulation of 1000 subjects stable at 30dB. Eight types of pointwise progression were simulated for individual locations: all combinations of -1 or -2 dB change per year, 2 or 3 visits per annum, and a beginning threshold of either 20 or 30 dB. Progression of multiple points was also included for whole field analysis with the number of damaged locations increasing from 1 to 10 for different simulation runs. Improved perimetric procedures were simulated by reducing $S$ in steps of 10% from the original.

Results: Table 1 shows the number of years of testing required to achieve 80% sensitivity (at 95% specificity) using PLR on locations beginning at 30 dB. The top row is for current SAP procedures. Table 2 shows the number of years of testing required to achieve 80% sensitivity (at 95% specificity) using linear regression on MD values on whole fields that begin at 30 dB. The columns headed 100% represent current SAP variability, and those headed 60% represent a simulated procedure with 60%*S variability.

Conclusions: If SAP variability is reduced by 20%, to 80%*S, then some progression can be detected earlier using SAP alone, depending on the severity of the progression and frequency of testing. Progression of 1 dB per year can be detected 1 year earlier using a procedure with 40% less variability than current (60%*S). The methods adopted in this paper can be applied to analyse new perimetric techniques prior to lengthy and expensive clinical trials in order to determine their utility for classifying progression.

Table 1: Years until progression is called (PLR)

<table>
<thead>
<tr>
<th>Error</th>
<th>-1 dB/yr</th>
<th>-1 dB/yr</th>
<th>-2 dB/yr</th>
<th>-2 dB/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 visits/yr</td>
<td>3 visits/yr</td>
<td>2 visits/yr</td>
<td>3 visits/yr</td>
</tr>
<tr>
<td>100%*S</td>
<td>4.0</td>
<td>3.7</td>
<td>2.8</td>
<td>2.4</td>
</tr>
<tr>
<td>80%*S</td>
<td>3.6</td>
<td>3.1</td>
<td>2.6</td>
<td>2.2</td>
</tr>
<tr>
<td>60%*S</td>
<td>3.0</td>
<td>2.8</td>
<td>2.3</td>
<td>1.9</td>
</tr>
<tr>
<td>40%*S</td>
<td>2.0</td>
<td>2.0</td>
<td>1.7</td>
<td>1.4</td>
</tr>
</tbody>
</table>
Table 2: Years until progression is called (MD)

<table>
<thead>
<tr>
<th>No. of locations progressing</th>
<th>-1 db/yr 2 visits/yr 100% - 60%</th>
<th>-1 db/yr 3 visits/yr 100% - 60%</th>
<th>-2 db/yr 2 visits/yr 100% - 60%</th>
<th>-2 db/yr 3 visits/yr 100% - 60%</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>4.0 - 2.5</td>
<td>3.3 - 2.3</td>
<td>2.0 - 1.5</td>
<td>2.0 - 1.3</td>
</tr>
<tr>
<td>8</td>
<td>3.0 - 2.5</td>
<td>3.3 - 2.3</td>
<td>2.0 - 1.0</td>
<td>2.0 - 1.0</td>
</tr>
<tr>
<td>9</td>
<td>3.0 - 2.0</td>
<td>3.0 - 2.0</td>
<td>1.5 - 1.0</td>
<td>1.7 - 1.0</td>
</tr>
<tr>
<td>10</td>
<td>3.0 - 1.5</td>
<td>2.7 - 1.7</td>
<td>1.5 - 1.0</td>
<td>1.7 - 1.0</td>
</tr>
</tbody>
</table>
CONTRAST SENSITIVITY IN MEXICAN GLAUCOMA PATIENTS
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Objective: To evaluate changes of contrast sensitivity (CS) in Mexican patients with glaucoma.

Design: Prospective, cross-sectional case series.

Material and Method: We evaluated 120 eyes of 72 subjects from the Glaucoma Service at the Instituto Fundacion Conde de Valenciana in Mexico City. Subjects with a diagnosis of glaucoma, suspected glaucoma, or ocular hypertension were recruited. Visual acuity was measured using the rear-illuminated Lighthouse Visual Acuity Chart at 2 m. Contrast sensitivity was measured using the Mars Contrast Sensitivity Chart with even luminance across the chart. Visual fields of the patients were measured.

Results: Significant correlation was found between the visual field mean deviations and the contrast sensitivity scores for each group of damage.

Conclusions: Reduced contrast sensitivity is significantly correlated with visual field losses in Mexican patients with glaucoma. The study data support the conclusion that, compared with visual acuity, the disease process preferentially affects contrast sensitivity. Contrast sensitivity was shown to be more related than visual acuity to real-world function in patients with glaucomatous changes, reason why it becomes a measure that we should pay attention to in order to assess information or visual rehabilitation to achieve self-independence in glaucoma patients.
CLINICAL EXAMINATION METHODS:
ELECTROPHYSIOLOGY
Clinical Application of Photopic Negative Response to the Flash Electroretinogram in Primary Open Angle Glaucoma

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Backgrounds: Electroretinography (ERG) has been used since the 1940s to evaluate retinal function. This procedure records electrical potentials that originate from cells in the retinal tissue. A typical ERG reveals three individual waves. The a-wave is the first emerging negative potential in the ERG. It originates from and represents the function of the photoreceptor cells. The b-wave is the abrupt positive potential that follows the a-wave, and it indicates the functional activities of Müller cells and bipolar cells. Finally, the photopic negative response (PhNR) is the negative potential that follows the b-wave. The PhNR is an electrical signal that originates in the retinal ganglion cells (RGC) and their axons and may reflect inner retinal function. Previous studies have indicated that the PhNR may be helpful for the detection of early glaucoma. However, there are an insufficient number of clinical studies involving PhNR in China. In this study, we studied the clinical utility of PhNR by comparing the PhNR parameters of normal patients to those with glaucoma.

Methods: 52 normal subjects (52 eyes) and 137 patients with POAG (137 eyes) were included in the study. Flashes were produced by light emitting diodes (LEDs), white stimulus flash on a white background was used. The Humphrey Perimetry C24-2 procedure was used to test the visual field results including Mean Deviation (MD) and Pattern Standard Deviation (PSD). All the patients were divided into three groups according to the visual field results: early stage group, 55 patients (55 eyes); advanced stage group, 40 patients (40 eyes); and late stage group, 42 patients (42 eyes). Spectral domain optical coherence tomography was used to test the mean retinal nerve fiber layer (mRNFL) thickness of POAG.

Results: The amplitudes of a-waves, b-waves, PhNR and the implicit times of PhNR were different among the four groups (p < 0.05). The variation degree of a-waves, b-waves amplitudes and the PhNR implicit times was larger. The MD and mRNFL thickness were positively correlated with the amplitudes for the PhNR (p = 0.000), the correlation coefficient was 0.59 and 0.45 respectively. The PSD was negatively correlated with the amplitudes for PhNR (p = 0.000), the correlation coefficient was -0.37. The area under the ROC curve of the amplitudes of a-waves, b-waves, PhNR was 0.853, 0.830 and 0.918 respectively. Among the three parameters, the diagnostic value of the amplitudes for PhNR is higher. In the case of setting specificity ≥ 95%, the sensitivities of the three parameters were 60.4%, 54.2% and 85.4% respectively.

Conclusions: Compared to normal subjects, the PhNR amplitudes were reduced, and the PhNR implicit times were prolonged in the POAG groups. The decreases in PhNR amplitudes were correlated to the severity of POAG. The PhNR amplitudes had higher sensitivity in POAG early diagnosis, which could serve as a useful evaluation index of visual function of POAG.
CORRELATION BETWEEN MULTIFOCAL VEP RESPONSES AND THINNING OF GANGLION CELL COMPLEX AND RETINAL NERVE FIBER LAYER THICKNESS IN GLAUCOMATOUS EYES

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Background: Agreement and correlation between functional and structural defects have been of a particular interest and importance in diagnosing and monitoring glaucomatous optic neuropathy (GON). Multifocal visual evoked potential (mVEP) and spectral-domain optical coherence tomography (SD-OCT) are considered useful for objectively assessing the macular function and the parapapillary or macular structure, respectively. In addition to the parapapillary retinal nerve fiber layer thickness (RNFLT), ganglion cell complex (GCC) has received increasing attention as a structural measure of GON. The purpose of this study was to evaluate the agreement and correlation among visual field, mVEP, and RNFLT and GCC in eyes with GON at early to moderate stage.

Methods: 56 eyes with GON that had a mean deviation better than -15 dB on the Humphrey Field Analyzer (HFA) SITA-standard 30-2 program (30-2) and 52 age-matched control eyes were enrolled. HFA 30-2, 10-2, mVEP, and SD-OCT were conducted. Visual field was defined as abnormal if clusters of 3 points or more with p < 5%, one of which had p < 1%, were present either on HFA 30-2 or 10-2. Three-channel mVEP with two vertical and one horizontal channel straddling the inion was performed using VERIS Science 5.2 as previously reported (Ishikawa et al. Doc Ophthalmol Epub ahead print). Root-mean-square (RMS) amplitude during 45 and 150 ms from each of 60-local responses was divided by the average of the 60 RMS amplitudes during 325 and 430 ms to yield the signal-to-noise ratio (SNR). Based on receiver operating characteristic analyses regarding the proportion of mVEP responses that exceed a specific SNR criterion, either of two perpendicular channel combinations (one vertical and the other horizontal) that yielded the better area under the curve was determined, from which probability plots were created at the 60 local points. The same cluster definition as in the HFA test was used for the judgment of abnormal. Average RNFLT and GCC were measured using RTVue and were defined as abnormal if their deviation maps were symbolized either by a yellow (p < 5%) or red (p < 1%) code.

Results: Average (± SD) abnormal points of total deviation (TD) 10 and the mVEP were 3.0 ± 5.5 and 2.9 ± 5.4, respectively, in the controls, whereas that was 24.3 ± 14.8 and 11.7 ± 8.6, respectively, in the GON eyes (p < 0.0001, Mann-Whitney U-test). Cohen’s κ was 0.681 between the TD 10 and mVEP judgment. The average RNFLT and GCC were 100.92 ± 12.90 and 91.63 ± 9.66 μm, respectively, in the controls, whereas those were 80.38 ± 8.44 and 77.31 ± 7.44 μm, respectively, in the GON eyes (p < 0.0001, unpaired t-test). The κ value was 0.534 and 0.565 between the mVEP and RNFLT judgments and between the mVEP and GCC judgments, respectively. The correlation coefficient was -0.508 between the mVEP abnormal test points and average RNFLT and -0.449 between those and average GCC, respectively (p < 0.001), whereas it was 0.604 between those and the TD 10 abnormal test points (p < 0.001).

Conclusions: Both two SD-OCT structural measures were fairly correlated with the two functional measures tested.
MULTIFOCAL VEP AND OCT FINDINGS IN PATIENTS WITH PRIMARY OPEN ANGLE GLAUCOMA

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Background: To evaluate objectively the anatomical and functional changes of optic nerve in eyes with primary open angle glaucoma (POAG) by the joint use of optical coherence tomography (OCT) and multifocal visual evoked potentials (mfVEP).

Methods: 29 eyes with open angle glaucoma and visual field defects were tested. OCT examination was performed with Humphrey model 3000. The VERIS system was used for the recording of mfVEP. The results were compared with those of 14 eyes of 7 age-matched control normal subjects.

Results: In glaucomatous eyes the mean retinal response density (RRD) was lower than normal in ring 1, 2 and 3 of mfVEP. Specifically the mean amplitude of mfVEP in POAG eyes was estimated at 34.17 ± 17.62 nV/deg², 6.86 ± 4.82 nV/deg² and 2.62 ± 1.61 nV/deg² in rings 1, 2 and 3 respectively. In contrast the mean latency was similar to the normal control eyes. Also, the mean RNFL thickness in POAG eyes was estimated at 76.83 ± 26.63 µm in the superior area, 52.14 ± 16.25 µm in the temporal area, 75.93 ± 32.49 µm in the inferior area and 58.62 ± 19.39 µm in the nasal area. This means that the RNFL thickness was lower than normal in all the peripapillary areas. Nevertheless the decrease was higher but not statistically significant in the inferior and superior area.

Conclusion: Our study shows that although standard automatic perimetry (SAP) is the gold standard to evaluate glaucomatous neuropathy, the joint use of mfVEP and OCT could be useful in better monitoring glaucoma progression.
AN ODE TO THE OPTIC DISC. A PHOTODOCUMENTATION STUDY
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¹Department of Ophthalmology, Dr Shroff's Charity Eye Hospital, New Delhi - India

Background: Glaucoma diagnosis centres on the evaluation of the optic disc. The morphological changes in the intrapapillary and parapapillary region and the retinal nerve fibre layer are the focus of attention of the clinical examination and the different newer modalities like HRT, GDX and OCT. Variations in optic nerve head often put clinicians under dilemma whether the changes are glaucomatous or not. The diagnostic modalities too can support diagnosis in discs which have almost normal size and shape characteristics. “But what if the optic disc does not follow the rules and tells its own story...”. The aim of this poster is to highlight different type of non glaucomatous entities with discs mimicking glaucomatous disease

Materials and Methods: 423 patients were included in this photodocumentation study. Subjects included were either through direct office visits or referrals as glaucoma suspects. A careful assessment of optic nerve head, disc margin, and cup:disc ratio and neuro-retinal rim was done by slit lamp biomicroscopy and fundus photographs. Diagnosis of glaucoma was established by disc appearance and corresponding visual field changes.

Results: Of the patients referred as glaucoma-suspects, 64% had true glaucomatous optic neuropathy, 8% were suspects with high IOP which on repeat or correlation with CCT were found to be within normal limits. 9% were disc suspects with large sized disc and corresponding large cup, on careful evaluation the NRR was healthy. 12% were high-myopes. There were 12 discs which were torted, 7 were tilted, 3 had situs inversus, 6 had associated medulated nerve fibres, 2 had morning glory syndrome, one with optic disc coloboma and one was macrodisc with disc pit.

Conclusion: Careful evaluation of the optic disc clinically can help differentiate glaucomatous from nonglaucomatous optic nerve head.
RELATIONSHIP BETWEEN CCT AND BETA-ZONE PPA IN GLAUCOMA PATIENTS AND SUSPECTS

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\(^1\)Department of Optometry, University of Alabama, Birmingham, Birmingham - USA

**Background:** To determine whether there is a relationship between CCT and Beta-zone PPA.

**Methods:** Retrospective records review. We selected 40 patients from the clinical files of UAB Eye Care who had photographic evidence of Beta-zone PPA. Included were glaucoma patients and suspects. Excluded were eyes with other causes of PPA such as congenital/structural, refractive and inflammatory. The extent of Beta-zone PPA was assigned based on quadrantal presentation: Inferior temporal (IT), superior temporal (ST), both inferior and superior temporal (IT and ST) and 360 degrees. We then compared the ultrasonically measured CCT in these patients with the extent of Beta-zone PPA. There were 74 eyes with complete data.

**Results:** The mean age of subjects was 64 years (±13.88/38-90). Of the 74 eyes analyzed, 30 eyes had IT only (Group A), 8 eyes had ST only (Group B), 30 eyes had IT and ST (Group C) and 6 eyes had 360-degree presentation (Group D). The mean CCT was 547 microns (±44/462-642) and 531 (±50) for right and left eyes, respectively. The median CCT was 551 and 542 for right and left eyes, respectively. The distribution of CCT (SD / range, microns) among the 4 groups was: Group A 546 (±42/467-623) microns, Group B 565 (±42, 533-624) microns, Group C 552 (±46, 462-642) microns and Group D 506 (±35, 467-540) microns. Additional analyses were not carried out due to the small numbers in Groups B and D. The thinnest mean CCT value, however, was associated with Group D, those with 360-degree PPA.

**Conclusions:** From these data, it appears that among glaucoma patients and suspects a thinner CCT corresponds with circumferential Beta-zone PPA but not quadrantal presentation. Measurement of CCT may represent a surrogate for susceptible lamina cribrosa and choriocapillaris damage that manifests as PPA. The results of this pilot project suggest the need for further study using larger numbers and statistical analyses to determine whether a quantitative relationship between the easily clinically measured CCT and PPA in glaucoma patients exists.
ABSTRACT WITHDRAWN
CLINICAL EXAMINATION METHODS:
IMAGING OF THE ANTERIOR SEGMENT
UBM VERSUS ANTERIOR SEGMENT OCT FOR NARROW ANGLE MEASUREMENT
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Introduction: To evaluate and compare angle opening in case of narrow angle using UBM (VisumaxII, Sonomed) and anterior segment OCT (Visante-OCT, Zeiss).

Methods: One hundred eyes of 50 consecutive patients, with gonioscopic narrow angle, were referred in Explore Vision Center for angle imaging. All patients underwent AS-OCT and UBM (35 MHz) on four meridians (3, 6, 9 12 o’clock meridians) in both eyes, in dark condition. UBM and OCT scans have been performed perpendicularly to the limbus. Angle opening distance at 500μ and 750μ from the scleral spur (AOD 500 and AOD750) were measured and compared.

Results: Angle opening measurement was smaller on superior meridians with both devices. Angle opening measured by anterior segment-OCT were significantly larger (~30%) for both AOD500 and 750 than UBM in each meridians.

Discussion: Gonioscopy remains the reference standard for narrow angle diagnosis. Angle imaging by UBM (Fig. 1) and anterior segment OCT gives objective quantitative measurements. This study shows a significantly larger angle opening measured by anterior segment-OCT versus UBM. This result can be correlated to moderate infrared illumination of fundus by Visante-OCT despite dark condition in the room. On the other hand UBM can be performed in real dark condition. Furthermore, anterior segment reconstruction can be quite different in both techniques: OCT needs a corneal curvature reference that can be distorted by using scans perpendicular to limbus.
LENS VAULT, THICKNESS, AND POSITION IN JAPANESE SUBJECTS WITH ANGLE CLOSURE
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Background: Primary angle closure glaucoma is a leading cause of blindness, particularly in Asian countries¹. The ocular risk factors for developing angle closure glaucoma are shallow anterior chamber, shorter axial length, and increased lens thickness². However, there is little literature investigating the distributions using anterior segment optical coherence tomography (AS-OCT) between primary angle closure suspect (PACS) and primary angle closure (PAC), primary angle closure glaucoma (PACG) in Japanese. The purpose of this study was to investigate the association of lens parameters with angle closure in Japanese and assess the variations of these parameters between PACS and PAC/G using AS-OCT.

Methods: This is the prospective and comparative study. One hundred eighty three of 125 patients with angle closure which were not performed laser peripheral iridotomy [consisting 98 eyes of PACS, 85 eyes of PAC/G and 69 eyes of 55 normal subjects with open angle were recruited. All participants underwent A-scan biometry and AS-OCT. Lens thickness (LT), anterior chamber depth (ACD), lens vault (LV), lens position (defined as ACD+1/2LT) and relative LP (defined as LP/axial length [AL]) were measured and calculated.

Results: Significant differences between angle-closure and normal eyes were found for LV (986 ± 216 µm vs. 491 ± 237; p=0.000), LT (5.07 ± 0.37 m vs. 4.59 ± 0.46; p = 0.000), LP (5.08 ± 0.23 m vs. 5.42 ± 0.33; p = 0.000), and RLP (0.226 ± 0.011 vs. 0.233 ± 0.014; p = 0.000), respectively. After adjusting for age, gender, ACD, LT, and RLP, increased LV and LT was associated significantly with angle-closure (odds ratio [OR], 35.1; 95% confidence interval [CI], 6.34-194.54, comparing lowest to highest quartile, and OR, 17.92; 95% CI, 2.02-158.93, respectively, but no association was found LP (OR, 4.61; 95% CI, 0.64-32.99) and RLP (OR, 1.86; 95% CI, 0.54-6.43). However, no significant differences between PACS and PAC/G were found for LV (999 ± 222 µm vs. 978 ± 208, p = 0.51), LT (5.10 ± 0.33 m vs. 5.02 ± 0.42; p = 0.17), LP (5.06 ± 0.20 m vs. 5.09 ± 0.26; p = 0.30), and RLP (0.225 ± 0.011 vs. 0.227 ± 0.011; p = 0.20).

Conclusion: Eyes with angle closure have thicker lens with greater LV compared with normal eyes in Japanese. The LV, which represents the anterior portion of the lens, is a novel parameter independently associated with angle closure after adjusting for age, gender, ACD, and LT. However, these parameters cannot be used to differentiate PACS from PAC/G in the Japanese.
THE CHANGE OF ANTERIOR CHAMBER ANGLE MEASURED WITH ANTERIOR SEGMENT OCT AFTER ICL IMPLANTATION

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**Purpose:** To compare the change of anterior chamber angle using anterior segment OCT (AS-OCT) before and after ICL implantation in high myopia.

**Design:** Prospective, comparative, interventional, clinical trial.

**Methods:** Total of 40 eyes of 20 patients who underwent ICL implantation were enrolled in the study. Several anterior chamber parameters were measured pre and postoperatively using anterior OCT.

**Main outcome measure:** The angle-opening distance (AOD500, AOD750), the trabecular-iris space area (TISA500, TISA750), and scleral spur angle at the nasal and temporal angles were measured with AS-OCT.

**Results:** There were statistically significant decreases in AOD 500, AOD 750, TISA 500, TISA 750, and scleral spur angle after ICL implantation (p < 0.001).

**Conclusions:** The anterior chamber angle was significantly narrowed after ICL implantation which confirmed by parameters of AS-OCT. We should concern developing PAS or increasing IOP after ICL implantation.

**References**


**ANGLE ASSESSMENT COMPARING TWO SPECTRAL DOMAIN OPTICAL COHERENCE TOMOGRAPHY DEVICES AND GONIOSCOPY**

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**Aim:** To compare the ability of two high resolution, spectral domain optical coherence tomography (SD-OCT) devices to identify angle structures and angle closure, using gonioscopy as the reference standard.

**Methods:** This was a prospective, non-randomized comparative study. Consecutive patients attending the glaucoma clinics at the Singapore National Eye Centre underwent dark-room non-indentational gonioscopy, followed by 4-quadrant anterior segment imaging using iVue (Optovue Corporation, California) and Cirrus (Carl Zeiss Meditec, California) SD-OCT devices by an independent masked examiner. OCT images from both machines were evaluated by another independent masked examiner for the ability to discern Schwalbe’s line (SL), trabecular meshwork (TM), Schlemm’s canal (SC), scleral spur (SS), and if angle closure was present. Angle closure in each quadrant was defined as the presence of contact of the iris with the angle wall anterior to the SS on OCT imaging. For gonioscopy, angle closure was defined if the posterior trabecular meshwork was not visible in that quadrant. Angle closure in an eye was defined as angle closure in 2 or more quadrants on OCT or gonioscopy. The identification of SL, TM, SC, SS and angle closure were compared between iVue and Cirrus OCT machines, and angle closure status compared between each of the machines and gonioscopy using AC1 statistics.

**Results:** 69 eyes of 69 patients (46.4% male, 84.1% Chinese, mean age 64.0 ± 10.5) were included. 58.0% had closed angles on gonioscopy. The most identifiable structures on Cirrus was SS (82.2% of images) and SL (77.2%), while that on iVue were SL (74.5%) and TM (68.2%). SC was the least frequently identified structure in both Cirrus and iVue (10.1% and 13.5% respectively). Angle status was unable to be determined in 14.5% of eyes on Cirrus and 50.7% of eyes on iVue (p < 0.001) mainly due to poor image quality. While there was substantial correlation between Cirrus and iVue for angle closure (19.1% and 17.0% of eyes were closed on Cirrus and iVue respectively, AC1 = 0.67), correlation of angle status of eyes of both machines with gonioscopy was fair to moderate (AC1 = 0.35 and 0.50 for Cirrus and iVue, respectively, when compared to gonioscopy).

**Conclusions:** It was more difficult to determine angle closure status with the iVue SD-OCT compared to Cirrus SD-OCT. Correlation of both machines with gonioscopy was only fair to moderate.
DYNAMIC INTRAOPERATIVE IMAGING OF THE ANTERIOR EYE-SEGMENT BY OCT DURING TRABECULECTOMY
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Background: By connecting the high resolution OCT Visante with the surgical microscope OPMI Visu 200 with a glass fiber the anterior segments of the eye can be shown during intraoperative procedures.

Methods: Case studies of intraoperative dynamic imaging of the anterior segment during trabeculectomy.

Results: Presentation of video recordings of intraoperative dynamic changes of the anterior eye-segment during trabeculectomy.

Conclusion: By connecting a surgical microscope with a high resolution OCT by a glass fiber intraoperative dynamic changes of the anterior eye-segment during trabeculectomy can be shown.
CENTRAL CORNEAL THICKNESS: COMPARATIVE STUDY BETWEEN MEASUREMENTS OBTAINED WITH ULTRASOUND PACHYMETRY AND PENTACAM HR
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Background: Central Corneal Thickness (CCT) has been shown to influence intraocular pressure (IOP) measurements with Goldman applanation tonometry and to be an independent risk factor for the development of primary open-angle glaucoma. The most commonly used technique for measuring corneal thickness is ultrasound pachymetry (UP). However, there are other methods that allow its determination. The Pentacam, which uses a rotating Scheimpflug camera to image the anterior segment of the eye, offers a non-contact way of assessing CCT. This study was performed to compare CCT measurements obtained using the Pentacam HR and ultrasound pachymetry.

Methods: In a prospective study, 3 CCT measurements were taken with the Pentacam HR (Oculus, Inc.) and UP (Humphrey 850) in that sequence from one eye of 33 consecutive patients with normal corneas. The 3 measurements taken with each instrument were averaged and treated as a single number. Paired t test was carried out to assess whether there were any differences between the measurements taken with the 2 instruments.

Results: The mean ± standard deviation of the corneal thickness was 528 ± 39 µm for UP and 544 ± 39 µm for Pentacam. The mean difference between measurements was 16 µm, with a 95% confidence interval ranging from 9 to 22 µm. There was a high correlation between the CCT readings by the 2 methods (correlation coefficient: 0.89). A paired t test showed that the difference between the data sets was statistically significant (p < 0.001), with the Pentacam giving higher readings for CCT compared with the UP.

Conclusions: Our study showed that the CCT measurements obtained by Pentacam HR and UP were well correlated. However, there is a statistically significant difference between the readings with the 2 instruments. Measurements obtained with the Pentacam were systematically higher than those provided by the UP. Therefore, the measurements obtained with the 2 instruments are not interchangeable. Our results are similar to those reported by some authors. The Pentacam also provides additional information about the anterior chamber of the eye, such as corneal topography and curvature, anterior chamber angle, volume and depth. In our opinion these characteristics make this instrument rather promising.
DETERMINANTS AND PREDICTION MODELS OF ANGLE WIDTH FROM ANTERIOR SEGMENT OPTICAL COHERENCE TOMOGRAPHY IMAGES
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Background: To investigate the determinants of angle width; and to derive mathematical models to predict angle width, as measured using anterior segment optical coherence tomography (ASOCT).

Methods: Subjects were recruited from an on-going population based cross-sectional study of Chinese persons aged 40 years and older in Singapore. Participants underwent gonioscopy, A-scan biometry, and imaging by ASOCT (Carl Zeiss Meditec, Dublin, CA). Customized software (Zhongshan Angle Assessment Program, Guangzhou, China) was used to measure the ASOCT parameters and data only from right eye was used for analysis. Linear regression modeling using the R-square, best subsets selection method was performed with trabecular-iris space area at 750 µm (TISA750) and angle opening distance at 750 µm (AOD750) as the dependent angle width variables. Using a combination of ASOCT and A-scan variables, an optimal model that was predictive of angle width was determined by a forward selection regression algorithm.

Results: Complete data were available for 1067 subjects. The mean (standard deviation) age was 56.9 (8.5) years and 50.2% were male. For TISA750, the best determinants among the ASOCT and A-scan independent variables were anterior chamber volume (ACV, r² = 0.51), followed by anterior chamber area (ACA, r² = 0.49) and lens vault (LV, r² = 0.47). The best determinants of AOD750 were LV (r² = 0.56), followed by ACA (r² = 0.55) and ACV (r² = 0.54). The R² value for anterior chamber depth (ACD) and axial length (AL) were 0.39 and 0.27 respectively for TISA750, and 0.46 and 0.30 respectively for AOD750. Results were largely similar when the analyses were performed separately in males and females. An optimal model consisting of 6 variables (ACV, ACA, LV, anterior chamber width, iris thickness at 750 µm, and iris area) explained 81.4% of the variability in TISA750 and 85.5% of the variability in AOD750. The addition of more parameters did not improve the r-square value.

Conclusions: ACA, ACV and LV were the most important determinants of angle width. A predictive model comprising 6 quantitative ASOCT parameters explained more than 80% of the variability of angle width, and may therefore be useful in screening for angle closure.
EVALUATION OF PERIPHERAL ANTERIOR CHAMBER DEPTH OF FELLOW EYES OF ACUTE ANGLE CLOSURE BY SCANNING PERIPHERAL ANTERIOR CHAMBER DEPTH ANALYZER

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Background: We evaluated the grade of peripheral anterior chamber depth (PACD) by scanning peripheral anterior chamber depth analyzer (SPAC) for the fellow eyes of patients who had acute angle closure. Furthermore, SPAC measurements were compared with those of other ocular biometric instruments.

Methods: Twenty-eight consecutive patients (20 female, 8 male, mean ages of 68.6 ± 9.9 years old) who had acute angle closure were examined. Eyes that had been performed prophylactic laser peripheral iridotomy and those treated with pilocarpine were excluded. Ocular biometry by SPAC, A-scan ultrasonography, ultrasound biomicroscopy (UBM) was performed for the un-affected eyes. SPAC measurements were graded into 1 (closed) to 12 (wide open) automatically. UBM images were analyzed using the parameters of AOD500 and TIA.

Results: Eighteen eyes with unilateral APAC were enrolled in the study. Average central anterior chamber depth (CACD) and axial length measured by A-scan was 2.61 ± 0.43 and 22.38 ± 0.87 mm, respectively. SPAC measurement of average CACD was 2.46 ± 0.42 mm and average PACD grade was 4.7 ± 1.2, respectively. SPAC categorical grading of P or S (both symbols were prone to angle closure) was 61.1% (11 subjects). When compared SPAC categorical group S, P and non S, P, significantly shallow anterior chamber depth by SPAC and smaller SPAC grading were demonstrated. All UBM parameters did not show significant difference between S, P group and non S, P group. SPAC grading correlated well with CACD by IOL master and SPAC, but not with UBM parameters.

Conclusion: The fellow eye of acute angle closure was reported to be high risk eye for future angle closure glaucoma. In this study, although the number of patients was small, the relative weak performance to detect anatomic findings of such pre-stage angle closure eyes by SPAC might have some limitations for its daily clinical practice and mass screening.
WAY TO INCREASE THE EFFICIENCY OF PERIPHERAL LASER IRIDECTOMY IN PRIMARY ANGLE-CLOSURE GLAUCOMA PATIENTS

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Background: An increase in the intraocular pressure in PACG patients is connected with pathological anatomical features of the anterior segment of the eye. Peripheral laser iridectomy (PLI) is an effective procedure in case of the presence functional pupillar block and closing of the anterior chamber angle (ACA) due to the iris curvature (IC). However, this laser operation is ineffective in case of plateau iris syndrome when ACA is blocked by the iris root.

Methods: We have analyzed anterior segment tomograms of 24 patients (48 eyes) with PACG before and after laser iridectomy. The age of patients varied from 53 to 81 years (average 69.2 ± 8.0) (M ± σ). 27 persons (54 eyes) at the age from 55 till 80 years formed the control group. The tomography of anterior segment was received in a horizontal meridian (0-180°) at level and longitudinally an anatomic axis. On the received tomograms in temporal and nasal segments were measured: ACA (ACA T, ACA N), stroma’s thickness of the iris in 500 microns distance from scleral spur (IT T, IT N), iris curvature at the level of half of its length (IC T, IC N). The purpose of investigation was to determine the dependence of efficiency of laser iridectomy from index size: iPLI = (IC T+IC N) / (IT T+IT N).

Results: Average ACA values in the control group were 32.3 ± 12.7 and 32.9 ± 12.2 degrees in temporal and nasal segments, accordingly (M ± σ). Average value iPLI in control group was (0.57; 0.40; 0.76) [Me; 25%; 75%]. Average ACA values before and after PLI differed significantly (p < 0.01) and were: 9.6 ± 7.4 and 20.1 ± 9.8 in temporal both 11.9 ± 6.9 and 21.3 ± 8.4 degrees in nasal segments. ACA has summary increased in two segment (EffPLI) on 20.1 ± 14.2 degrees after PLI. All the patients have been divided on two groups depending on EffPLI: PLI1 (EffPLI < 20.1) (n = 25) and PLI2 (EffPLI > 20.1) (n = 23). ACA in temporal and nasal segments significantly did not differ significantly in PLI1 (11.6 ± 7.0 and 12.3 ± 7.4) and PLI2 groups (7.6 ± 7.4 and 11.5 ± 6.4). Average values iPLI for groups PLI1 and PLI2 were (0.89; 0.76; 1.08) and (1.56; 1.02; 2.32) [Me; 25%; 75%], accordingly. Using these data, we have assumed, that criteria EffPLI < 20.1 is iPLI < 0.89. The part of patients with EffPLI > 20.1 in group with iPLI < 0.89 was 20.0% and differed significantly (χ² < 0.05) from the group with iPLI ≥ 0.89 where the part of patients with EffPLI > 20.1 was 60.6 %.

Conclusion: Thus using criterion iPLI ≥ 0.89 efficiency PLI can be increased on the average by 40.6% [CI, 13.8%; 67.4%].
CORRELATION OF RETINAL NERVE FIBRE LAYER THICKNESS ON OCT AND VISUAL FIELD INDICES IN GLAUCOMA PATIENTS AND NORMAL SUBJECTS
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Background: To compare retinal nerve fibre layer thickness and visual field indices in glaucoma patients and normal subjects.

Methods: Prospective, non randomised, cross sectional study of 224 eyes of 125 patients. Five groups including glaucoma suspects (GS), Primary open angle glaucoma (POAG), Ocular hypertensives (OHT), Normal tension glaucoma (NTG) and normal subjects underwent white on white perimetry at baseline, 1 month and 3 months of first visit, and Stratus OCT Scan at first visit and 3 months. Visual field global indices were compared with OCT Retinal Nerve Fibre Layer (RNFL) analysis parameters. RNFL thickness at baseline was compared with thickness at 2nd visit.

Results: OCT parameters did not correlate with VF indices in glaucoma suspects and normal patients, while correlation was statistically highly significant in POAG and significant in OHT and NTG patients.

Conclusion: OCT is an effective tool in monitoring disease progression by measuring RNFL loss in patients of POAG, ocular hypertensives and NTG.
IMAGING OF ANTERIOR CHAMBER ANGLE BY SWEPT-SOURCE AND TIME-DOMAIN ANTERIOR SEGMENT OPTICAL COHERENCE TOMOGRAPHY IN EYES WITH NARROW ANGLE

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Background: To evaluate the usefulness of Swept-source (SS) anterior segment optical coherence tomography (AS-OCT) in scleral spur detection and anterior chamber angle measurements in comparison with time-domain (TD) AS-OCT in eyes with narrow angle.

Methods: Forty two eyes of 22 patients (2 men, 20 women) with narrow angle were enrolled. Of the 42 eyes, 18 eyes were classified as primary angle closure suspect, 15 eyes were classified as primary angle closure, and 9 eyes were classified as primary angle closure glaucoma. All participants underwent gonioscopy, SS-OCT (SS-1000, Tomey, Nagoya, Japan), and TD-OCT (Visante; Carl Zeiss Meditec, Dublin, California). A narrow angle was defined as an angle in which > 270° of the posterior trabecular meshwork cannot be seen. SS-OCT images were obtained in dark conditions using the anterior segment mode, and TD-OCT images were obtained in dark conditions using enhanced anterior single mode. Scleral spur location was assessed in AS-OCT images by masked examiner and was defined as the point where there was an inward protrusion of the sclera with a change in curvature of its inner surface. Angle opening distance (AOD) and the trabecular-iris space area (TISA) were measured semi-automatically from OCT images.

Results: The scleral spur was detectable with TD-OCT in 19 images (23%) in nasal/temporal images while the scleral spur was detectable with SS-OCT in 51 images (61%). The difference was statistically significant (p < 0.001, Fisher exact test). The average AOD and TISA measured by TD-OCT and SS-OCT in 14 images in which scleral spur was detectable with both OCTs, the mean anterior chamber angles measured by TD-OCT and SS-OCT were 0.212/0.202 mm (AOD500, p = 0.77, paired t-test) and 0.077/0.050 mm² (TISA500, p < 0.01, paired t-test), respectively.

Conclusions: SS-OCT was superior to TD-OCT in detecting scleral spur in patients with narrow angles. TISA500 measurement value was lower in SS-OCT analysis.
ANTERIOR SEGMENT BIOMETRY IN EYES WITH NARROW ANGLE USING PENTACAM ROTATING SCHEIMPFLUG IMAGING

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Background: To compare anterior segment parameters in normal open angle eyes and eyes with narrow angle using Pentacam rotating Scheimpflug imaging.

Methods: 46 eyes from 46 consecutive patients with narrow angle were enrolled. Age- and gender-matched 20 eyes from 20 participants with normal open angle formed the control group. A narrow angle was defined as an angle in which > 270° of the posterior trabecular meshwork cannot be seen. When both eyes of the same subject were eligible, right eye was selected. Of the 46 patients with narrow angle, 20 eyes were classified as primary angle closure suspect, 20 eyes were classified as primary angle closure, and 6 eyes were classified as primary angle closure glaucoma. Anterior chamber volume (ACV), central anterior chamber depth (CACD), anterior chamber angle (ACA), corneal volume (CV), central corneal thickness (CCT), mean corneal radius of the front (front Rm) and back (back Rm) surface, corneal shape factor (Q) were measured with Pentacam.

Results: The average ACV, CACD, ACA, CV, CCT, front Rm, back Rm, and Q in narrow angle and open angle were 65.7/132.7 mm\(^3\) (p < 0.0001, t-test), 1.80/2.72 mm (p < 0.0001), 21.7/32.3° (p < 0.0001), 60.6/60.7 mm\(^3\) (p = 0.9104), 536.5/552.1 mm (p = 0.4093), 7.59/7.67 mm (p = 0.2499), 6.17/6.24 mm (p = 0.3465), and -0.51/-0.51 (p = 0.9856), respectively.

Conclusions: Eyes with narrow angle tend to have smaller anterior chamber depth, volume, and angle than those of eyes with open angle. However, there was no significant difference in corneal parameters between both groups. The rotating Scheimpflug imaging is an effective method for screening eyes with narrow angle.
LONGITUDINAL CHANGE IN ANTERIOR CHAMBER DEPTH OF EYES WITH ANGLE CLOSURE AFTER LASER IRIDOTOMY

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Purpose: To investigate longitudinal changes in anterior chamber depth (ACD) of eyes with angle closure after laser iridotomy (LI) and factors related to prognosis.

Patients and methods: Eyes with primary angle closure (PAC), acute PAC, or chronic angle closure glaucoma (CACG) that underwent LI during the period of November 2004 to December 2007 were enrolled (LI group). Eyes that underwent phaco-emulsification and intra-ocular lens insertion in the same period were employed as controls (PEA+IOL group). Longitudinal changes in ACD were evaluated with a scanning peripheral anterior chamber depth analyzer (SPAC) in addition to routine ophthalmic examination after LI or PEA+IOL.

Results: The numbers of eyes of LI group and PEA+IOL group were 48 eyes of 48 subjects (69.8 ± 8.5 years) and 21 eyes of 21 subjects (65.6 ± 12.7 years), respectively. Mean follow-up times of LI group and PEA+IOL group were 43.4 ± 12.7 months and 36.5 ± 2.5 months, respectively. LI significantly increased ACD as indicated by the SPAC grade change from 3.8 ± 1.1 to 4.6 ± 1.2 (p = 0.0002). LI deepened the peripheral ACD but not the central ACD. SPAC grade was gradually reduced during the follow-up period and reached the baseline by the third year of follow up. PEA+IOL significantly increased SPAC grade from 6.7 ± 1.6 to 8.7 ± 2.0 (p < 0.001) but no time-related change was observed. Eyes with PAC and CACG showed similar profiles of LI-induced changes, but eyes with acute PAC showed a smaller change than eyes with PAC and CACG. Twenty-three cases presented with deterioration during the follow-up period. The type of glaucoma, the intra-ocular pressure before LI, the presence of plateau iris configuration, the number of anti-glaucoma eye drops used, and the degree of glaucomatous visual field defects were associated with prognosis.

Conclusions: ACD is temporarily deepened by LI and tended to return to the baseline after some time. Profiles of LI-induced changes differed among the type of angle closure. The type of angle closure and certain factors influenced the prognosis.
IMAGING OF TRABECULECTOMY BLEBS WITH VISANTE ANTERIOR SEGMENT OPTICAL COHERENCE TOMOGRAPHY AFTER DIGITAL OCULAR COMPRESSION
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**Purpose:** To investigate change of intra-bleb morphology of functioning trabeculectomy blebs with anterior segment optical coherence tomography (AS-OCT) after digital ocular compression.

**Design:** Prospective cross-sectional study.

**Methods:** Sixty eight patients who had fornix-based trabeculectomy were recruited from Seoul St. Mary’s hospital. Intraocular pressure (IOP) and AS-OCT images were taken before and after ocular compression. By AS-OCT, bleb height, bleb wall thickness, height and length of the internal cavity were measured. The hyporeflective area and number of microcysts were checked on both vertical and horizontal images. The AS-OCT parameters were compared by IOP change, bleb morphology, and interval between surgery and examination.

**Results:** Significant changes of AS-OCT parameters were observed by ocular compression, except maximum bleb wall thickness. The correlation between IOP change and the parameters of AS-OCT was greatest with the horizontal and vertical length of the internal cavity (Spearman correlation coefficient $r = 0.717; p < 0.0001$ and $r = 0.866; p < 0.0001$, respectively). The response to ocular compression in cystic blebs were mainly by enlargement of the internal cavity and increase in bleb height. However, in diffuse filtering blebs, increase in hyporeflective area and number of microcysts were the main findings. After 6-12 months of surgery, the change in the intra-bleb parameters of AS-OCT significantly reduced, showing no difference after ocular compression.

**Conclusions:** The change of internal bleb morphology after digital ocular compression were significant with AS-OCT in blebs less than 6 months post-operatively. And the response to ocular compression was different by bleb morphology.
LENS VAULT IN ASIAN INDIAN EYES WITH ANGLE CLOSURE

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Background: To measure lens vault (LV) in Asian Indian eyes with angle closure.

Methods: In this prospective observational comparative study, subjects with primary angle closure (including angle closure suspects (PACS), angle closure (PAC) and angle closure glaucoma (PACG)) and normals were enrolled. All subjects underwent gonioscopy and imaging with Fourier-domain source-swept anterior-segment optical coherence tomography (SSOCT; Tomey, Japan). LV was defined as the perpendicular distance between the anterior pole of the crystalline lens and the horizontal line joining the 2 scleral spurs (SS). It was measured manually, after marking the SS, in both horizontal and vertical scans. Imaging was performed prior to laser iridotomy.

Results: Ninety-five eyes (62 subjects) with gradable images (determined by scleral spur detection) were analyzed; 51 eyes (39 subjects) had angle closure and 44 eyes (23 normal subjects) had open angles. LV was found to be significantly greater in angle closure eyes compared to normal eyes for both horizontal (782.1 µ, 95% C.I, 726.4-837.8, vs. 526.9 µ, 95% C.I, 486.2-567.6) (p < 0.0001) and vertical (825.9 µ, 95% C.I, 780.2-871.6 vs. 589.3 µ, 95% C.I, 538.2-640.4) (p < 0.0001) scans. There were no significant differences between PACS (11 eyes), PAC (18 eyes) and PACG (22 eyes) (p > 0.05) for scans from either meridian. After adjusting for age and gender, higher vertical LV (odds ratio, OR 21.6%; 95% C.I, 2.7-172.5% comparing lowest to highest quartile) and horizontal LV (odds ratio, OR 76.3%; 95% C.I, 5.2-1128.9%) was significantly associated with angle closure. Intra-class correlation for intra-observer reliability for measuring LV was 0.87 (95% C.I, 0.74-0.92).

Conclusion: In this cohort of Asian Indians, LV was greater in angle closure eyes when compared to normal eyes. This parameter might be an independent predictor for angle closure disease.
PHYSIOLOGICAL CHANGES IN THE VOLUMES OF IRIS AND ANTERIOR CHAMBER DUE TO DIFFERENT LIGHT CONDITIONS. A QUANTITATIVE STUDY WITH ANTERIOR SEGMENT SWEPT SOURCE OPTICAL COHERENCE TOMOGRAPHY

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Background: A recent report using a time-domain (TD-) optical coherence tomography (OCT) showed that iris volume increased after pharmacologic mydriasis in fellow eyes of acute primary angle closure, whereas it decreased in open angle eyes (Aptel et al. Ophthalmol 2010). The aim of the current study is to quantitatively evaluate the physiological changes in iris volume and anterior chamber (AC) volume due to different light conditions in not only narrow angle eyes but also open angle eyes using an anterior segment swept-source (AS-SS-) OCT, which has much faster scanning speed and higher resolution than the TD-OCT.

Methods: In 19 eyes of 19 subjects with narrow angles (van Herick grade ≤ 2) and 20 eyes of 20 subjects with open angles (van Herick grade > 3), the 360° range of the anterior segments were scanned using an AS-SS-OCT (SS-1000 CASIA, Tomey, Nagoya, Japan) under standardized light (1000 lux) and dark (3 lux) conditions. All subjects had complete images of the anterior segments without the lid coverage. The figures of the iris and AC were manually drawn on B-scan images of the AS-SS-OCT by a single masked examiner (YA) and then the volumes of the iris and AC were automatically calculated.

Results: When the light condition was changed from light to dark, iris volume significantly decreased only in narrow angle eyes (from 38.9 ± 4.12 to 38.3 ± 3.85 mm³, p = 0.01, paired t-test) but not in open angle eyes (from 39.5 ± 5.00 to 39.2 ± 4.81 mm³, p = 0.2). The changes in iris volume was not significantly correlated with age, axial length, and AC depth (Pearson’s correlation coefficient, p > 0.2). The change rate of iris volume was significantly correlated with the pupil diameters under light (R = -0.35, p = 0.03) and under dark (R = -0.45, p = 0.004), and the changes in pupil diameter (R = -0.38, p = 0.02), respectively. AC volume significantly increased with the light condition change from light to dark only in open angle eyes (from 151.5 ± 3.8 to 154.3 ± 39.2 mm³, p = 0.0001), but not in narrow angle eyes (from 83.9 ± 15.1 to 84.8 ± 16.3 mm³, p = 0.1). The change in AC volume was not correlated with the change rate of iris volume (p = 0.8).

Conclusions: When the pupil was physiologically dilated with the light being turned off, the iris volume significantly decreased but the AC volume did not change in narrow angle eyes; while the AC volume increased but the iris volume did not change in open angle eyes.
COMPARISON OF ULTRASOUND BIOMICROSCOPY, TIME-DOMAIN, AND SWEPT-SOURCE ANTERIOR SEGMENTAL OPTICAL COHERENCE TOMOGRAPHY IN EYES WITH NARROW PERIPHERAL ANTERIOR CHAMBER

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Background: The analysis of anterior chamber angle (ACA) configuration is essential for diagnosis and treatment of primary angle closure and its related conditions. Ultrasound biomicroscopy (UBM) has been most commonly used for its non-contact and quantitative evaluation. Recently, in addition to a time-domain anterior segmental optical coherence tomography (AS-OCT) (Visante™, Carl Zeiss Meditec Inc, Dublin, CA), a swept-source AS-OCT, (CASIA™, SS-1000, TOMEY Corporation, Nagoya, Japan) also became available. The objective of our study is to evaluate and quantitatively compare the images of (ACA) structures obtained by UBM, time-domain and swept-source AS-OCT.

Methods: A total of 32 otherwise normal right eyes of 32 consecutive subjects who were seen in the University of Tokyo Hospital and had shallow peripheral anterior chamber (Van Herick grade ≤ 2), but no gonioscopical peripheral anterior synchiae (PAS) were enrolled. UBM examination (UD-1000™, TOMEY), Visante™ and CASIA™ examinations were carried out under standardized light and dark conditions in addition to routine ophthalmologic examinations. ACA configuration parameters, prevalence of appositional closure (APC), the angle opening distance at 500 µm from the scleral spur (AOD500), trabecular iris angle (TIA) and angle recess area (ARA) at 3, 6, 9, and 12 o'clock position were each determined on obtained images by a blinded experienced investigator (NM).

Results: Age, refraction and axial length of the subject eyes averaged 70.0 years, +1.58 diopters and 22.4 mm, respectively. APC under the dark condition was found at least in one quadrant in 32/32, 21/32 and 19/32 eyes with UBM, Visante™ and CASIA™, respectively (p < 0.001). APC was found in 32/32 in the superior, in 11/32 in the temporal, in 15/32 in the inferior, and in 11/32 eyes in the nasal quadrant under the dark condition with UBM. In the same way, APC was found in 20/32, 7/32, 9/32 and 8/32 eyes with Visante™, and in 20/32, 7/32m 9/32, 8/32 eyes with CASIA™ in each quadrant, respectively. The prevalence of APC was significantly different only in the superior quadrant (p < 0.001). Under the dark condition, the average of AOD500 in the superior quadrant was 0.07 (UBM), 0.15 (Visante™) and 0.15mm (CASIA™), that of ARA was 0.04, 0.10, 0.11 mm² and that of TIA was 2.1°, 10.4°, 12.3°, respectively. Only the parameters obtained with UBM in superior quadrant under the dark condition differed from those obtained with other two AS-OCT instruments (p < 0.001). There was no significant difference among the ACA configuration parameters obtained with the 3 instruments in other quadrants under the dark condition, or in all quadrants under the light condition.

Conclusions: Given the eyes with narrow peripheral anterior chamber (Van Herick grade ≤ 2) on slit-lamp biomicroscopy, ACA configuration parameters obtained with
UBM were significantly different from those obtained with the two AS-OCT instruments in the superior quadrant under the dark condition, but not in other quadrants under the dark condition or in the light condition.
CORRELATION OF IOP REDUCTION WITH RETINAL NERVE FIBRE LAYER THICKNESS CHANGES ON OCT AFTER TREATMENT IN GLAUCOMA PATIENTS
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Background: Correlation of intraocular pressure reduction with retinal nerve fibre layer thickness changes on OCT after treatment in glaucoma patients.

Methods: Retrospective observational case series including 128 eyes of 64 glaucoma patients out of which 99 eyes (77.34%) were managed medically and 29 eyes (22.66%) were managed with surgical treatment. All eyes were imaged with OCT pre-treatment and 3 and 6 months post-treatment to measure peripapillary NFL thickness and IOP readings were recorded with Goldmann Applanation tonometry at both visits.

Results: Mean IOP decreased significantly post-treatment from 19.74 ± 4.82 mmHg to 16.8 ± 3.44 mmHg at 3 months and 15.27 ± 3.80 mmHg at 6 months in the medically managed eyes. Mean IOP decreased post-treatment from 22.86 ± 5.02 mmHg to 16.17 ± 2.62 mmHg at 3 months and 14.17 ± 2.74 mmHg at 6 months in the surgically managed eyes. While the increase in the mean RNFL thickness in the inferior quadrant (IAvg) was correlated with IOP reduction in the medically managed eyes at 6 months (r = -.252, p = 0.022), the mean increase in the RNFL thickness in the superior quadrant (SAvg) in the surgically managed eyes was correlated with IOP reduction at 6 months (r = -0.415, p = 0.039).

Conclusion: A significant increase of mean superior and inferior RNFL thickness, which was related to IOP reduction was detected 6 months after Rx. No significant correlation was found between Average RNFL thickness and IOP reduction.
Background: There are certain factors that can make a baby more likely to have vision problems. If a baby is born blind, it is usually because there was a malformation during development, a hereditary condition, an injury at birth or a congenital infection that caused damage.

Methods: Patients at the pediatric age group presenting with congenital glaucoma or different forms of corneal opacities were included in the study. They were evaluated using the Ultrasound BioMicroscopy (UBM) to identify the underlying pathology and undetected malformations in the anterior chamber.

Results: Anatomical micro-structural changes detected previously on histopathological sections were clearly identified in vivo using the UBM.

Conclusion: UBM is a useful tool in pediatric age-group ocular pathology that helps the ophthalmologist in proper decision making for management of each case separately. It protects the surgeon against unpleasant surprises in case of surgical intervention.
APPLICATION OF ANTERIOR SEGMENT OPTICAL COHERENCE TOMOGRAPHY IN EVALUATING THE MORPHOLOGY AND FUNCTION OF FILTERING BLEBS AFTER TRABECULECTOMY
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Objective: To study the application of anterior segment optical coherence tomography (AS-OCT) in evaluating the morphology and function of filtering blebs after trabeculectomy.

Methods: 103 eyes of 79 patients who had previously undergone trabeculectomy followed up for 1-24 months were selected in this study. These filtering blebs were classified into four types as diffuse-like, cystic-like, encapsulating-like and flatten-like by the slit-lamp microscope and AS-OCT. The consistency between the two methods was evaluated by the Chi-Square test. Intraocular pressure after trabeculectomy with four type filtering blebs was also compared by the t-test.

RESULTS: Observation of the slit-lamp microscope showed diffuse-like blebs in 59 eyes (59/103, 57.28%), cystic-like blebs in 22 eyes (21.36%), encapsulating-like blebs in 8 eyes (7.77%) and flatten-like in 14 eyes (13.59%). AS-OCT imaging showed diffuse-like blebs in 55 eyes (53.39%) with the average intraocular pressure of (12.76 ± 3.97)mmHg, cystic-like blebs in 27 eyes (26.22%) with the average intraocular pressure of (15.07 ± 3.43)mmHg, encapsulating-like blebs in 7 eyes (6.80%) with the average intraocular pressure of (28.40 ± 7.42)mmHg, and flatten-like in 14 eyes (13.59%) with the average intraocular pressure of (23.64 ± 6.43) mmHg. This study found that AS-OCT has fine concordance with the slit-lamp microscope in analyzing the morphology of filtering blebs after trabeculectomy. ($X^2 = 82.95$, $p < 0.05$Pearson = 0.6679), for intraocular pressure, it also showed a statistically significant difference between diffuse-like and encapsulating-like blebs ($t = 3.205$, $p < 0.01$), a statistically significant difference between diffuse-like and flatten-like blebs ($t = 2.664$, $p < 0.01$), a statistically significant difference between cystic-like and flatten-like blebs ($t = 2.789$, $p < 0.01$) in the average intraocular pressure, there is no significant difference between cystic-like and flatten-like blebs, there is no significant difference between diffuse-like and cystic-like blebs,either no significant difference between encapsulating-like and flatten-like blebs.

CONCLUSIONS: AS-OCT is a precise tool with non invasive examination and high resolution, which may visualize the internal structure of filtering bleb, and evaluate the postoperative healing process and the function and efficacy of the blebs.
THE DIAGNOSTIC CAPABILITIES OF EYECAM AND GONIOPHOTOGRAPHY COMPARED TO GONIOSCOPY IN ASSESSING FOR ANGLE CLOSURE

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**Purpose:** To compare EyeCam\textsuperscript{TM} (Clarity Medical Systems, Pleasanton, CA) and goniophotography in detecting angle closure, using gonioscopy as the reference standard.

**Methods:** In this prospective, cross sectional study, subjects underwent gonioscopy by a single observer, and EyeCam imaging and goniophotography by different operators. The anterior chamber angle in a quadrant was classified as closed if the posterior trabecular meshwork could not be seen. A masked observer categorised the eyes as per the number of closed quadrants, and an eye was classified as having angle closure if there were 2 or more quadrants of closure. Agreement between the methods was analyzed by kappa statistic and comparison of area under receiver operating characteristic curves (AUC).

**Results:** Eighty-five subjects (85 eyes) were included, the majority of whom were Chinese. Angle closure was detected in 38 eyes (45\%) with gonioscopy, 40 eyes (47\%) using EyeCam and 40 eyes (47\%) with goniophotography (p = 0.69 in both comparisons, McNemar Test). The agreement for angle closure diagnosis (by eye) between gonioscopy and the 2 imaging modalities was high (k = 0.86; 95\% Confidence Interval (CI), 0.75-0.97) while the agreement between EyeCam and goniophotography was not as good (k = 0.72; 95\%CI, 0.57-0.87); largely due to lack of agreement in the nasal and temporal quadrants (k = 0.55–0.67). The AUC for detecting eyes with gonioscopic angle closure was similar for goniophotography and EyeCam (AUC 0.93, sensitivity = 94.7\%, specificity = 91.5\%; p > 0.95).

**Conclusions:** Eyecam and goniophotography have similarly high sensitivity and specificity for the detection of gonioscopic angle closure.
MEASUREMENT OF ANTERIOR CHAMBER CHANGES AFTER LASER IRIDOTOMY WITH THE SCHEIMPFLUG SYSTEM (PENTACAM)
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Purpose: to identify the quantitative changes in the angle and anterior chamber depth after laser iridotomy with the Scheimpflug system (Pentacam)

Material and Methods: Prospective study of 26 eyes of 15 white patients with closed or narrow angle in which a laser iridotomy has been performed to prevent acute angle closure glaucoma. Angle width, anterior chamber depth and anterior chamber volume has been measured before and after the iridotomy.

Results: Mean anterior chamber volume increase was 25.22 mm³. The mean anterior chamber depth in the quadrant of the iridotomy increased 0.226 mm, while it increased 0.306 mm in the inferior part. Mean angle width increased 2.656º. No statistically significant changes in central anterior chamber depth were observed.

Conclusions: Anterior chamber depth increased in all eyes, being the change biggest in the quadrant in which the iridotomy was performed and in the inferior part, with no changes in the central depth. Total anterior chamber volume and angle width also increased in all eyes.
ANTERIOR SEGMENT DYSGENESIS IN YOUNGER PATIENTS WITH ANGLE CLOSURE
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Background: Older Patients with angle closure amongst a Caucasian population are frequently associated with reduced axial length, increased lens thickness, increased iris thickness, and crowded anterior chambers. This study investigates the causes of angle closure in younger patients using UltraBiomicroscopy (UBM)

Methods: 20 Patients with angle closure aged 30-55 years underwent UBM using an Aviso Linear 50 MHz probe. Measurements of AC depth, AC width, lens thickness and axial length were made, together with angle-scleral spur distance, and compared to 20 patients with angle closure aged > 60 years. Statistical analysis was by analysis of variance.

Results: Amongst the younger age group mean AC depth was measured as 2.8 mm (s.d. 0.3mm), AC width at 11.3 mm (s.d. 0.5 mm), Axial length at 23.3 mm (s.d. 1.2 mm), lens thickness at 4.7 mm (s.d. 0.4 mm), and angle to scleral spur distance at 0.2 mm (s.d. 0.03mm). Amongst the older group mean AC depth was measured at 2.4 mm (s.d. 0.14mm), AC width at 10.4 mm (s.d. 0.4 mm), Axial length at 22.5 mm (s.d. 1.1 mm), lens thickness at 4.9 mm (s.d. 0.4 mm), and angle to sclera spur distance of 0.4 mm (s.d. 0.02 mm). AC depth, AC width, and axial length were all significantly greater in the younger group, and angle to sclera spur distance significantly shorter compared to the older group. Anteriorly rotated ciliary bodies were noted in 8 patients in the younger group, and 4 patients in the older group. Thin irides were noted in 9 patients in the younger group, but none in the older group.

Conclusions: Younger individuals with angle closure are characterised by deeper and wider AC, longer axial lengths, more anterior iris insertion, and thinner irides when compared to an older group of angle closure patients. We suggest that anterior chamber dysgenesis and plateau iris are the most common causes of angle closure in younger patients
CLINICAL EXAMINATION METHODS:
IMAGING OF THE POSTERIOR SEGMENT
Background: The purpose of the present study was to compare the intraoperator and interoperator repeatability and within-subject coefficients of variation of measurements of the retinal nerve fiber layer (RNFL) by SD-OCT and stereometric parameters of the optic disk and RNFL by HRT in patients with initial primary open-angle glaucoma (POAG).

Methods: We studied 29 patients (29 eyes) with initial POAG. Each patient was examined by HRT III (Heidelberg Engineering) and Cirrus HD-OCT (Carl Zeiss Meditec) in one session on the same day. Both methods were performed by 2 experienced operators each taking 2 measurements in turn on one and then on another instrument (total of 8 measurements). Mean RNFL thickness and RNFL thickness in 4 quadrants as measured by SD-OCT and 13 stereometric parameters of the optic disk and RNFL measured by HRT were included into analysis. The repeatability was evaluated by J.M.Bland-D.G.Altman analysis. Within-subject coefficients of variation (wsCV) were calculated using J.M.Bland method.

Results: Mean RNFL thickness measured by SD-OCT demonstrated the best intraoperator and interoperator repeatability and the lowest variability. Its intraoperator wsCV (mean for 2 operators: 1.86%) was 3 times lower as compared to the wsCV of the best HRT stereometric parameter - rim area (5.36%), and it was 7 times lower as compared to the wsCV of the mean RNFL thickness measured by HRT III (13.04%).

Conclusions: RNFL study by the method of SD-OCT with Cirrus HD-OCT demonstrates high repeatability and low variability, especially of the mean RNFL thickness. The measurement error of SD-OCT is much lower as compared to HRT and provides for the most stable results of the RNFL examination in patients with initial POAG.
THE COMPARATIVE ANALYSIS RETINOTOMOGRAPHY AND HISTOLOGIC RESEARCH OF A RETINA IN NORM AND AT PRIMARY OPEN ANGLE GLAUCOMA

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Background: The purpose of research - the comparative characteristic of a structural condition of a retina of an eye according to an optical coherent tomography (OCT) and histologic research of a retina in norm and at primary open angle glaucoma.

Methods: 76 person (138 eyes) with primary open angle glaucoma and 22 healthy persons (40 eyes) are surveyed with application of a method spectral OCT on device Cirrus HD-OCT 4000 (Germany). To fourteen patients with a terminal glaucoma it has been executed enucleating the amazed eye with the subsequent histologic research of a retina.

Results: At OCT-research it is noted, that reduction of volume and thickness of the macula in process of progressing glaucoma is connected not only with reduction NFL and GCL, but with reduction of thickness of all layers of a retina. So, INL participates in reduction of thickness macular zones equally with GCL. It is revealed reduction of thickness complex RPE + IS/OS in process of progressing a glaucoma, mainly, due to reduction a hyporeflective layer between membrane Virhove and the most external hyperreflective layer pigmentary epithelium down to its disappearance and merge of two hyperreflective strips in one line. Decrease in shielding ability pigmentary epithelium retinas in the form of expansion of a zone of penetration of light at a level horoidei is revealed. Depth of penetration of coherent light in horoidei accrues in process of development of glaucoma. At an estimation of histologic structure of external layers of a retina in opinion of with a terminal glaucoma, it is revealed reduction of thickness and under pressure of an external and internal nuclear layer, and also atrophy with formation microcists in an external mesh layer and in a layer of external segments of photoreceptors. Migration of individual kernels of bipolar cells in an external mesh layer that can be connected with loss by nervous cells of a support in the form of a network of nervous shoots is noted. Besides it is revealed reduction of thickness a layer pigmentary epithelium retinas with the centers of an atrophy caused by destruction epitheliocits. Migration of individual pigmentary cells in neurosensors a layer is found out.

Conclusion: Thus, retinotomography the picture at a glaucoma practically coincides with structural infringements in a histologic picture of preparations that specifies adequacy of OCT-research of a retina. Are found out retinotomography attributes of involving of external layers of a retina in process of glaucoma, diseases accruing in process of development.
COMPARISON OF GLAUCOMA DIAGNOSIS USING STRATUS AND CIRRUS OPTICAL COHERENCE TOMOGRAPHY IN TAIWAN CHINESE POPULATION
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Background: To compare the glaucoma diagnostic power between Stratus and Cirrus OCT in Taiwan Chinese population.

Methods: One eye each was chosen from 21 ocular hypertension (OH), 27 glaucoma suspect (GS), 35 primary open angle glaucoma (POAG), 26 primary angle closure glaucoma (PACG) and 52 normal subjects. Early glaucoma (EG) was recruited from glaucomatous eyes based on visual field severity (better than -9 dB). All participants were imaged by the same observer at the same visit. The area under the receive operator characteristic (AROC) curve was used to differentiate normal from OH, GS, POAG, PACG and EG eyes; and the sensitivity/specificity of each parameter from internal normative classification was analyzed.

Results: For normal versus OH, the best AROC value was average thickness (Stratus, 0.693; Cirrus, 0.697). For normal versus GS, the best AROC value was average thickness (Stratus, 0.807; Cirrus, 0.776). For normal versus POAG, the best AROC value was average thickness (Stratus, 0.943; Cirrus, 0.930). For normal versus PACG, the best AROC value was 5 o’clock hour (Stratus, 0.830; Cirrus, 0.817). For normal versus EG, the best AROC value was average thickness in Stratus (0.868) and 5 o’clock hour in Cirrus (0.876). However, all sensitivities in 5 groups were fair from the internal normal classification database in both OCTs.

Conclusions: Although Cirrus and Stratus OCTs show promising in early glaucoma detection; and two OCTs show equal glaucoma diagnostic power. The feasibility of internal normative database for Chinese population should be addressed.

Key words: Glaucoma diagnosis, Stratus OCT, Cirrus OCT, Chinese population.
LINEAR CORRELATION OF PERIMETRIC RETINAL SENSITIVITY IN CENTRAL VISUAL FIELD AND PERI-PAPILLARY RETINAL NERVE FIBER LAYER THICKNESS MEASURED BY OCT - OWN OBSERVATION
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Background: Previously, both linear and non linear correlation between retinal sensitivity in central visual field and peri-papillary retinal nerve fiber layer thickness in glaucoma as well as varying level of correlation for each retinal sector were employed, depending on the stage of progression of the disease. Provided that those parameters are of increasing use, a retrospective study was conducted to describe the relationship.

Methods: 32 females and 27 males, of mean age of 63, patients of Glaucoma Clinic of Ophthalmology Department of Wroclaw Medical University were included in the study. The patients of Polish descent, suffering from open angle glaucoma as well as those with suspected glaucoma were chosen. Octopus 101 perimeter and TOP strategy, G2 program were used for visual field evaluation. For measurements of RNFL thickness Stratus OCT and Fast RNFL Thickness scan was engaged.

Results: Statistically significant linear correlation between retinal sensitivity in central visual field and peri-papillary retinal nerve fiber layer thickness was found in all the examined sectors in glaucomatous eyes with confirmed diagnosis as well as in the suspected ones. The strongest correlation was established for inferior retinal nerve fiber layer sector, corresponding with upper sector of visual field. The weakest correlation, but still statistically significant, was found for RNFL thickness in nasal sector and visual field in temporal sectors. The greatest mean RNFL thickness was described for inferior sectors (108 um), the smallest - in temporal sectors (64 um), which is in agreement with ISNT rule.

Conclusion: Optical coherence tomography as well as perimetry are classical tools in glaucoma screening and monitoring. Not to be underestimated is fact of their high linear correlation in describing the peri-papillary retinal nerve fiber layer thickness and retinal sensitivity in central visual field both in open angle glaucoma and glaucoma suspected eyes in all the sectors. Although, the attention must be paid to varying degree of correlation depending on the localization of the visual field errors and RNFLT losses.
INFLUENCE OF OPTIC DISC SIZE ON THE DIAGNOSTIC PERFORMANCE OF MACULAR GANGLION CELL COMPLEX AND PERIPAPILLARY RETINAL NERVE FIBER LAYER ANALYSES IN GLAUCOMA

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**Background:** To evaluate the influence of optic disc size on the diagnostic accuracy of macular ganglion cell complex (GCC) and conventional peripapillary retinal nerve fiber layer (pRNFL) analyses provided by spectral domain optical coherence tomography (SD-OCT) in glaucoma.

**Methods:** A total of 82 glaucoma patients and 30 healthy subjects were included. All patients underwent GCC thickness (a 7x7 mm macular grid, consisting of RNFL, ganglion cell layer and inner plexiform layer) and pRNFL thickness measurement (3.45 mm circular scan) by SD-OCT. Whenever both eyes were eligible, one was randomly selected for analysis. Initially, receiver operating characteristic (ROC) curves were generated for different GCC and pRNFL parameters. The effect of disc area on the diagnostic accuracy of these parameters was evaluated using a ROC regression model. Subsequently, we arbitrarily chose 1.5, 2.0 and 2.5mm² disc sizes (based on the distribution of our data) and compared the predicted areas under the ROC curves (AUCs) and sensitivities at fixed specificities for each of them.

**Results:** Average MD (mean deviation index) for glaucomatous eyes was -5.3 ± 5.2dB. Similar AUCs were found for the best pRFNL (average thickness = 0.872) and GCC parameters (average thickness = 0.824; p = 0.19). The coefficient representing disc area in our ROC regression model was not statistically significant for average pRFNL thickness (-0.176) or average GCC thickness (0.088; p ≥ 0.56). AUCs for fixed disc areas (1.5, 2.0, and 2.5mm²) were 0.904, 0.891, and 0.875 for average pRFNL thickness and 0.834, 0.842 and 0.851 for average GCC thickness, respectively. The highest sensitivities at 80% specificity for average pRNFL (84.5%) and GCC thicknesses (74.5%) were found with disc sizes fixed at 1.5 mm² and 2.5 mm², respectively.

**Conclusions:** Diagnostic accuracy was similar between pRNFL and GCC thickness parameters. Although not statistically significant, there was a trend for a better diagnostic accuracy of pRFNL thickness measurement in cases of smaller discs. For GCC analysis, an inverse effect was observed.

**Table 1: Baseline characteristic of study patients**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Glaucoma patients (n = 82)</th>
<th>Controls (n = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (years)</td>
<td>67.5 ± 10.4</td>
<td>60.5 ± 11.3</td>
</tr>
<tr>
<td>Average visual field mean deviation index (dB)</td>
<td>-5.3 ± 5.2</td>
<td>0.1 ± 1.5</td>
</tr>
<tr>
<td>Average ONH area (mm²; determined by HRT)</td>
<td>2.15 ± 0.64</td>
<td>1.61 ± 0.36</td>
</tr>
<tr>
<td>Average pRNFL thickness (µm)</td>
<td>105.9 ± 18.3</td>
<td>133.1 ± 15.1</td>
</tr>
<tr>
<td>Average superior pRNFL thickness (µm)</td>
<td>103.5 ± 19.4</td>
<td>127.5 ± 16.7</td>
</tr>
<tr>
<td>Average inferior pRNFL thickness (µm)</td>
<td>108.4 ± 21.3</td>
<td>138.7 ± 18.9</td>
</tr>
<tr>
<td>Average GCC thickness (µm)</td>
<td>83.1 ± 11.4</td>
<td>96.3 ± 8.6</td>
</tr>
<tr>
<td>Average superior GCC thickness (µm)</td>
<td>82.5 ± 12.9</td>
<td>96.1 ± 9.4</td>
</tr>
<tr>
<td>Average inferior GCC thickness (µm)</td>
<td>83.8 ± 13.1</td>
<td>96.6 ± 8.1</td>
</tr>
</tbody>
</table>

ONH = optic nerve head; HRT = Heidelberg retina tomography; pRNFL = peripapillary retinal nerve fiber layer; GCC = ganglion complex; * = data are given as mean ± standard deviation whenever indicated.
Table 2: Sensitivities at 80% specificity according to each optic disc size

<table>
<thead>
<tr>
<th>Optic disc area</th>
<th>Average pRNFL thickness</th>
<th>Average GCC thickness</th>
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</thead>
<tbody>
<tr>
<td>1.5 mm²</td>
<td>84.5%</td>
<td>71.8%</td>
</tr>
<tr>
<td>2.0 mm²</td>
<td>82.3%</td>
<td>73.2%</td>
</tr>
<tr>
<td>2.5 mm²</td>
<td>79.9%</td>
<td>74.5%</td>
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</table>
MACHINE-LEARNING CLASSIFIERS ENHANCE THE DIAGNOSIS OF GLAUCOMA USING HIGH DEFINITION OPTICAL COHERENCE TOMOGRAPHY

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Background: Isolated optic nerve head (ONH) and retinal nerve fiber layer (RNFL) parameters from HD-OCT (Cirrus Version 4.5.1.1, Carl Zeiss Meditec, Dublin, CA) have shown good diagnostic performance. Researchers have utilized machine-learning classifiers such as Linear Discriminant Analysis (LDA) and Classification And Regression Tree (CART) to enhance the performance of glaucoma parameters.

Purpose: To evaluate the diagnostic performance of machine-learning classifiers in comparison to the ONH and RNFL parameters for discriminating normal from glaucomatous eyes.

Methods: Consecutive glaucoma patients and normal subjects recruited from an ongoing population based study underwent imaging with the Cirrus HD-OCT spectral-domain optical coherence tomography (Cirrus HD-OCT, V5.0, Carl-Zeiss Meditec, CA, USA) using the Optic Disc Cube 200x200 scan protocol (software v5.0) for measurement of peripapillary ONH and RNFL parameters. Individual values for area under the receiver operator characteristic curves (AUC) for ONH and RNFL parameters were computed and compared with machine learning classifiers (LDA and CART).

Results: 508 normal subjects were compared with 184 glaucoma subjects. Majority of the glaucoma subjects were Chinese (157/184, 85.3%). Average RNFL thickness (0.92), Inferior RNFL thickness (0.92), Vertical Cup-Disc Ratio (0.91) and Rim area/Disc area ratio (0.90) performed better than the other ONH and RNFL parameters. Machine-learning classifiers resulting from LDA (0.96) and CART (0.98) outperformed all the individual parameters for diagnostic accuracy. Misclassification rates in LDA and CART were found to be very low (8% and 5.6% respectively). Discrimination of mild glaucomatous eyes from normal eyes were lower compared to eyes with moderate glaucoma using LDA compared to CART (0.94 vs 0.98).

Conclusion: Machine-learning classifiers resulting from LDA and CART can be utilized in spectral domain Cirrus HD-OCT analysis for glaucoma discrimination.
OBSERVATION AND MORPHOMETRY OF THE GLAUCOMATOUS LAMINA CRIBROSA USING SPECTRAL DOMAIN OPTICAL COHERENCE TOMOGRAPHY (SD-OCT)


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Purpose: To observe and measure the lamina cribrosa in OAG patients using spectral domain optical coherence tomography (SD-OCT).

Methods: This study included 30 OAG patients (17 with POAG and 13 with NTG). All of the patients were examined using SD-OCT (3D-OCT1000 Mark II, Topcon), and the pores of the lamina cribrosa were clearly observed. The average age was 58.1 ± 11.0 years (mean ± standard deviation) and the MD value of the Humphrey visual fields (HVF) was -15.3 ± 7.2 dB. After acquiring the OCT images using the choroidal mode, the images were reconstructed three dimensionally and transverse sections of the lamina cribrosa were examined. Three sections (surface, middle, and depth) were recorded 35 µm each from the surface. Based on the densities of these images, the laminar pores were identified from the beams or vasculature and then the mean pore area and pore ratio against the laminar beams were calculated and compared.

Results: While the mean pore area was 901.6 ± 44.0 µm², the mean pore ratio was 10.3 ± 0.76%. Both the pore area and ratio became statistically smaller as the measurements moved from the surface to depth sections (p = 0.0384 and p = 0.0470, paired t-test). The pore area and ratio were 885.9 ± 44.4 µm² and 10.3 ± 0.87% in POAG patients, and 922.1 ± 35.4 µm² and 10.4 ± 0.61% in NTG patients, respectively. The pore area was larger in NTG patients than POAG patients (p = 0.0161, unpaired t-test), but the pore ratios were similar (p = 0.9167). Neither the pore area nor pore ratio significantly correlated with patient age, VFI or MD of HVF. The measurements in this study are reliable because the reproducibility was 2.82 ± 1.88% and 2.78 ± 1.97% for the pore area and pore ratio, respectively.

Conclusion: The glaucomatous lamina cribrosa can be observed and measured using SD-OCT. This technique should be useful despite some methodological issues and limitations. It may be possible to detect alterations in the lamina cribrosa during the onset and progression of glaucomatous optic neuropathy.
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ABSTRACT WITHDRAWN
THE CONFOCAL SCANNING LASER OPHTHALMOSCOPY SUBSTUDY TO THE EUROPEAN GLAUCOMA PREVENTION STUDY (EGPS): STUDY DESIGN AND BASELINE FACTORS

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Purpose: To describe the study design and baseline factors of the Confocal Scanning Laser Ophthalmoscopy (HRT) ancillary study within the EGPS. This study was designed to examine the relationship between HRT optic disk topographic measurements and baseline demographic and ocular factors.

Methods: Four-hundred eighty-nine eyes of 489 ocular hypertensive participants from 4 centers within the EGPS were investigated in this substudy. Each participant completed HRT imaging at least annually. Mean images for each image series were computed using software version 3.0. Contour line drawing and quality control was performed by two experienced glaucoma specialists at the HRT reading center Mainz, trained by the OHTS HRT reading Center. The association between the results of optic disk topography measurements and intraocular pressure (IOP), central corneal thickness (CCT), baseline photographic estimates vertical cup disk ratio, asymmetry between the two eyes in cup to disk ratio, and baseline visual field indices (pattern standard deviation, PSD) was assessed using regression analysis (univariate and multivariate).

Results: 489 eyes of 489 participants showed good quality images and could be included. Associations between optic disk topography measurements and vertical cup disk ratio were found for almost all stereometric optic disk parameter in both univariate and multivariate analysis. The strongest association was found between vertical cup disk measurements and disk, cup, and rim area, cup and rim volume, cup disk area ratio, linear cup disk area ratio, mean and maximum cup depth (all p < 0.0001). In multivariate analysis furthermore, significant associations were found between PSD, disk area, and HRT optic disk measurements (disk, cup, and rim area, cup and rim volume, cup disk area ratio, linear cup disk area ratio, and mean cup depth, p < 0.05).

Conclusions: The EGPS is the first multicenter, placebo-controlled randomized clinical trial to use HRT for monitoring optic disk changes in participants with ocular hypertension. We found strong associations between vertical cup disk ratio estimates, disk area, PSD, and HRT stereometric parameters.
RELATIONSHIP BETWEEN RTVUE MEASUREMENTS AND HFA 10-2 PARAMETERS
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Background: Recent improvements in retinal imaging with optical coherence tomograph (OCT) make it possible to detect the structural changes in glaucomatous optic neuropathy. Here, we assess the relationship between central visual field sensitivity and retinal structure measured by spectral-domain OCT in primary open-angle glaucoma (POAG) eyes.

Methods: Right eyes of sixty-six POAG patients were enrolled (average age: 57.9 ± 12). As central visual field functional indexes, mean deviation (MD), superior total deviation (sup TD), inferior total deviation (infTD) were derived using Humphrey field analyzer (HFA) central 10-2 SITA standard program. OCT measurements [average RNFL thickness (avgRNFL), superior and inferior avgRNFL (supRNFL, infRNFL), average ganglion cell complex thickness (avgGCC), superior and inferior avgGCC (supGCC, infGCC)] were obtained using RTVue-100. Correlation between each HFA parameter and OCT measurement was calculated. Additionally, correlation between foveal thresholds and OCT parameters (avgRNFL, avgGCC, TU1, TL1) was also calculated. All regression analysis was based on linear regression model.

Results: The correlation coefficients (r) between MD and avgRNFL, avgGCC were 0.484, 0.518, respectively. The association of hemi-field total deviation with sectoral RNFL (supTD, r = 0.385; inf TD, r = 0.579) and sectoral GCC (supTD, r = 0.525; infTD, r = 0.694) was moderate. TL1 have the stronger relationship with foveal threshold (r = 0.703) than avgRNFL (r = 0.415), avgGCC (r = 0.556) and TU1 (r = 0.612).

Conclusion: In POAG eyes, the RNFL and GCC measurements using spectral-domain OCT reflect the central visual field function.
AGREEMENT BETWEEN TIME-DOMAIN OCT (STRATUS OCT), AND SPECTRAL-DOMAIN OCT (CIRRUS HD OCT), FOR MEASURING PERIPAPILARY RETINAL NERVE FIBRE LAYER THICKNESS

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Background: To determine the agreement between peripapillary retinal nerve fibre layer (RNFL) thickness measurements obtained with a time-domain optical coherence tomography (Stratus® OCT Carl Zeiss), and with a spectral-domain OCT (Cirrus HD® OCT Carl Zeiss) in normal subjects and subjects with ocular hypertension and glaucoma.

Methods: A total of sixty four eyes from normal subjects (23), ocular hypertension (22) and glaucoma patients (19) were analysed. Assessment of the peripapillary RNFL thickness were made using the ‘Fast RNFL Thickness (3.4)’ (Stratus OCT) and the ‘Optic Disc Cube 200x200’ (Cirrus HD-OCT) acquisition protocol. The relationship between RNFL thickness measurements of the 2 OCTs were evaluated using a Pearson/Spearman correlation analysis. The RNFL thickness measurements (average, quadrant and clock-hour RNFL Thickness) were then compared (paired t test/Wilcoxon test). p < 0.001 was considered to be statistically significant. Statistical analyses were performed using SPSS software version 16.0.0 (SPSS Inc., Chicago, Illinois, USA)

Results: All RNFL thickness measurements determined by the two OCT machines were highly correlated, with the association being particularly strong for the inferior RNFL Thickness (Pearson r = 0.973; p < 0.001). For Stratus OCT, the average RNFL thickness (mean ± standard deviation) was 102.3 ± 13.94 μm, 95.46 ± 10.45 μm e 68.01 ± 12.91 μm for the normal, ocular hypertensive and glaucoma group. For Cirrus HD OCT, the corresponding measurements were 93.65 ± 11.27 μm, 84.31 ± 7.89 and 67.05 ± 8.97 μm. All Stratus-Cirrus differences were statistically significant by paired t testing / Wilcoxon (p < 0.001) except for the superior, 1, 2, 9, 10 and 11 o’clock group. With those differences (Stratus measurements > Cirrus measurements) been less pronounced in the glaucoma group.

Conclusions: Glaucoma is a progressive disease so longitudinal follow-up for tracking a glaucomatous - functional and/or structural - change is crucial. Assessment of RNFL thickness is of diagnostic significance in glaucoma. Although time-domain OCT (Stratus OCT) has been the prevailing OCT instrument for glaucoma structural assessment, the recent introduction of spectral-domain OCT offers a faster scan speed and a higher image resolution for RNFL imaging. Our study indicates that RNFL thickness measured by the Cirrus HD OCT and Stratus OCT showed considerable discrepancy (Stratus RNFL measurements > Cirrus HD RNFL measurements), although the 2 measurements were strongly correlated. Due to differences in image quality, scan registration technologies, as well as differences in the image segmentation algorithm between the two devices, measured RNFL thickness is not directly compared, and patients should not be scanned back and forth with each instrument, which would introduce too much variability to detect any change over time. A calibration equation needs to be established between the OCT generations.
COMPARISON OF SPECTRAL-DOMAIN OCT AND TIME-DOMAIN OCT ON THE ABILITY TO DETECT LOCALIZED RETINAL NERVE FIBER LAYER DEFECTS IN PATIENTS WITH NORMAL STANDARD AUTOMATED PERIMETRY

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Background: Spectral-domain (SD) optical coherence tomography (OCT) can be expected to have better discriminating ability for glaucoma diagnosis compared with time-domain (TD) OCT based on their advantages include a faster scan and higher-resolution imaging of retinal nerve fiber layer (RNFL). SD-OCT also can determine RNFL thickness by re-sampling the collected data. However, some investigations reported that the discriminating ability between TD-OCT and SD-OCT was comparable for detection of moderately advanced glaucoma. We evaluate and compare the diagnosis ability of direct scanning (RNFL 3.45 mode) and re-sampling from datasets(ONH mode) by SD- OCT and direct scanning by TD- OCT to detect localized RNFL defects in patients with normal standard automated perimetry (preperimetric glaucoma).

Methods: Twenty-five eyes of 25 subjects with preperimetric glaucoma and 33 eyes of 33 normal subjects were studied. The RNFL thickness was measured in ONH and RNFL 3.45 modes by SD-OCT (RTVue-100, Optovue, Inc., Fremont, CA) and in fast RNFL 3.4 mode by TD-OCT (Stratus OCT, Carl Zeiss Meditec Inc., Dublin, CA). Stratus OCT provides RNFL thickness maps including an average, four quadrants and 12 clock hours, whereas RTVue-100 provides 16 regional RNFL thickness maps using either ONH or RNFL 3.45 modes. RNFL thickness data from the four regions of any quadrant were averaged for comparison with Stratus OCT. Based on the internal normative database from each device the sensitivity and specificity for detecting localized RNFL defects were calculated. The areas under receiver operating characteristic curves (AUROC) for discrimination between preperimetric glaucoma and normal were compared between three RNFL measurements.

Results: There were 10 localized RNFL defects in the superotemporal and 17 localized RNFL defects in the inferotemporal and it was 27 RNFL defects in total. The sensitivity of ONH parameters ranged from 36% to 96% and that of RNFL 3.45 parameters ranged from 32% to 100% and that of fast RNFL 3.4 parameters ranged from 4% to 56%. The specificity of ONH parameters ranged from 57.6% to 100% and that of RNFL 3.45 parameters ranged from 57.6% to 100% and that of fast RNFL 3.4 parameters ranged from 75.8% to 100%. The best AUROC of three different RNFL thickness measurements was similar [AUROC = ONH 0.863 (16 regional thickness: IT2), RNFL 3.45 0.865 (average thickness), fast RNFL 3.4 0.872 (7 o’clock sector)].

Conclusions: Based on the internal normative database, SD-OCT (ONH and RNFL 3.45) had generally higher sensitivities than TD-OCT. ONH and RNFL 3.45 modes have similar sensitivities. However, there were no significant differences between the AUROC for three different RNFL thickness measurement methods.
Background: Spectral domain optical coherence tomography (OCT) marks a great advance in ocular imaging, with faster scanning time, higher resolution and reduced motion artifact compared to time domain OCT. In order to distinguish normal from abnormal test findings, as well as for serial follow up of patients and for monitoring progression, it is essential that the test results have a high degree of reproducibility. A change in the results of any test can be considered to be attributable to an ongoing disease process only if the magnitude of the change is in excess of the reported test-retest variability. This study aimed to determine the intrasession as well as inter-session reproducibility of peripapillary retinal nerve fiber layer (RNFL) thickness measurements with the spectral domain Cirrus OCT (Carl Zeiss Meditec, Dublin, CA, USA) in normal and glaucomatous eyes.

Methods: Forty eyes of 40 normal subjects and 40 eyes of 40 glaucomatous patients were included in the study. RNFL measurements were obtained on the Cirrus OCT five times in a single day (for intrasession reproducibility) and on five separate days (for inter-session reproducibility) by a single experienced operator. Intraclass correlation coefficient (ICC), coefficient of variation (COV) and test-retest variability values were calculated for mean RNFL thickness as well as RNFL thickness in four quadrants. A subgroup analysis was done to determine reproducibility parameters in a subset of patients with advanced glaucoma, defined as mean deviation (MD) worse than -12 decibels (dB) on Humphrey visual field testing (Carl Zeiss-Humphrey Systems, Dublin, CA).

Results: Intrasession reproducibility: The ICC, COV and test retest variability values for mean RNFL thickness in normal eyes were 0.993, 1.96% and 4.02 𝜇m respectively. The corresponding values in glaucomatous eyes were 0.996, 2.39% and 3.84 𝜇m. In eyes with advanced glaucoma, these values were 0.996, 2.41% and 3.70 𝜇m respectively. For quadrants, ICC was 0.9 or higher and COV was under 6% in all groups. Test-retest variability was maximum for temporal quadrant measurements in all groups.

Inter-session reproducibility: The ICC, COV and test retest variability values for mean RNFL thickness in normal eyes were 0.992, 2.16% and 4.09 𝜇m respectively, while the corresponding values in glaucomatous eyes were 0.995, 2.62% and 3.98 𝜇m. For eyes with advanced glaucoma, these parameters were 0.990, 2.70% and 4.16 𝜇m. For quadrants, ICC was 0.89 or higher and COV was under 8% in all groups. Test-retest variability was maximum for temporal quadrant measurements in all groups.

Conclusions: Peripapillary RNFL thickness measurements using the spectral domain Cirrus OCT demonstrated excellent reproducibility in normal as well as glaucomatous eyes, including the sub-group of eyes with advanced glaucoma. This may be an advantage over the time domain OCT, in which reproducibility is reportedly lower in advanced glaucoma. In our study, intrasession and inter-session test-retest variability did not exceed 5 𝜇m for mean RNFL thickness.
IN-VIVO, 3D IMAGING OF NORMAL LAMINA CRIBROSA STRUCTURES INCLUDING HORIZONTAL CENTRAL RIDGE AND LAMINA CRIBROSA DEFORMATION IN GLAUCOMA

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Background: Histologic and imaging studies have demonstrated structural changes of the lamina cribrosa (LC) in glaucoma. However, histologic processing of specimens may lead to alterations of the architecture seen in vivo, and conventional optical coherence tomography (OCT) has limited ability to image the entire LC in detail. We evaluated the morphology and position of the normal LC and its structural changes in high-tension glaucoma (HTG) using enhanced depth imaging spectral-domain OCT (EDI SD-OCT).

Methods: We obtained serial horizontal and vertical B-scans of the optic nerve head (ONH) using EDI SD-OCT for one eye of each HTG and normal subject, and reconstructed 3D images of the LC. Horizontal and vertical diameters of the LC and the optic disc were measured in normal subjects. Mean and maximum LC depths were measured in 11 equally spaced horizontal B-scans, and the depth of LC insertion was measured at 32 points along its circumference (reference plane: Bruch’s membrane edges) (Fig A,B). The angle of ONH tilting was also measured in the B-scan along the horizontal midline (Fig B). Depth profiles were compared between the two groups.

Results: A total of 56 HTG (visual field [VF] mean deviation, -16.2 ± 3.1 dB) and 31 normal subjects were included. In normal subjects, horizontal and vertical diameters of the LC were significantly correlated with each other (p = 0.02), and the ratio of horizontal to vertical diameters of the LC had no significant correlation with that of the optic disc or with the angle of ONH tilting (p > 0.3). 3D imaging (Fig C, arrows) and W-shaped depth profiles of the LC and LC insertion in normal subjects (Fig D, E) revealed a previously undescribed horizontal central ridge. The vertical diameter of LC and the angle of optic nerve tilting had a significant negative correlation with LC depth (p < 0.03). Mean and maximum LC depths in the HTG group were significantly greater before and after controlling for those factors (posterior bowing, Fig D). The LC insertion depth in the HTG group was significantly greater in the superior and inferior regions (posterior sliding of LC insertion, Fig E). The depths of LC and LC insertion in the eyes with a VF defect limited to the superior hemifield were significantly greater than those in normal subjects in the inferior region (Fig F, G), where the retinal nerve fiber layer (RNFL) was significantly thinner than normal subjects (p < 0.01).

Conclusions: The shape of the LC has no significant correlation with the shape of the optic disc or with the angle of ONH tilting. Mechanisms of LC deformation in HTG include posterior bowing of the LC and posterior sliding of the LC insertion. Localized LC deformation corresponds to regions of RNFL and VF defects. The horizontal central ridge appears to act as a LC structural support and be less affected by elevated intraocular pressure. This finding explains lower susceptibility of cecocentral and temporal visual fields in glaucoma.
A NOVEL METHOD TO DETECT LOCAL GANGLION CELL LAYER LOSS IN GLAUCOMA BY USING SPECTRAL-DOMAIN OPTICAL COHERENCE TOMOGRAPHY

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Background: Initial glaucomatous damage is thought to occur as a local loss of retinal ganglion cells, particularly in eyes with nerve fiber layer defects. We developed a new method to detect local retinal ganglion cell (RGC) loss by using spectral-domain optical coherence tomography (SD-OCT). This method is based on the 2-dimensionally symmetric structure of ganglion cell layer (GCL). In this paper, we investigated the glaucoma discriminating ability of this method.

Methods: We examined 33 eyes of 21 patients with glaucoma and 36 normal eyes of 22 volunteers. Automated measurement of the thickness of combined GCL and inner plexus layer (termed GCL complex) was developed on a macular cube scan in Cirrus (Carl Zeiss Meditec). We designed an elliptical annulus (inner vertical radius, 0.5 mm; outer vertical radius, 2 mm) that was stretched in the horizontal direction by 20%. We calculated the mean GCL complex thickness for each of the 180 spokes that extend from the inner radius to the outer radius. The spoke with the minimum average value was assumed to indicate the location of the maximum local thinning of the GCL like a compass. The directional angle was assessed in the clockwise direction in the right eye (0-360 degrees) and counterclockwise direction in the left eye. The area under the receiver operating characteristic curve (AROC) was used to compare the glaucoma discriminating ability of the minimum average value and the circumpapillary retinal nerve fiber layer (cpRNFL) thickness.

Results: The average mean deviation in standard automated perimetry was \(-4.74 \pm 4.12\) (mean ± SD). The minimum average value of the GCL complex thickness on spokes was 82.9 \(\mu\)m in normal eyes and 61.5 \(\mu\)m in eyes with glaucoma; the difference between these values was statistically significant \((p < 0.0001)\). The location of the minimum average value was 2–164 degrees \((42.3 \pm 41.0\) degrees) in the superior hemisphere and 215-349 degrees \((325.3 \pm 46.3\) degrees) in the inferior hemisphere. The AROC of the minimum average value of GCL complex thickness was 0.941 and that of cpRNFL was 0.963.

Conclusion: Glaucoma discriminating ability of the minimum average value in our spoke method was comparable to that of cpRNFL thickness. Thus, this method may be useful in the detection of local RGC loss.
CORRELATION BETWEEN STRUCTURAL PARAMETERS OF OPTIC NERVE HEAD AND RETINAL NERVE FIBER LAYER THICKNESS, WITH OPTIC DISC SIZE, IN NORMAL SUBJECTS
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¹Department of Ophthalmology, Miguel Servet University Hospital, Zaragoza - Spain

Background: To assess the correlation between morphological parameters of the optic nerve head and retinal nerve fiber layer (RNFL) thickness measurements, with optic disc size, in a population of normal subjects.

Methods: Prospective observational study. Structural parameters of the optic nerve head were evaluated by means of confocal scanning laser ophthalmoscopy (Heidelberg Retina Tomograph III: HRT-III). The HRT parameter, disc area, was used to determine optic disc size. RNFL measurements were performed by means of optical coherence tomography (OCT) and GDx-VCC scanning laser polarimetry. Pearson correlation coefficients (r) were calculated between RNFL thickness measurements, morphological parameters of the optic nerve head, and optic disc size. A p < 0.05 value was considered with statistical significance.

Results: Ninety-two eyes of 92 normal subjects were included in the study. It was observed a positive and significant correlation between different RNFL parameters assessed by OCT and optic disc size; specifically, global RNFL average thickness (r = 0.269) and thickness of the RNFL segment corresponding to the 11 hour-position (r = 0.343). None of the RNFL parameters assessed by GDx showed any significant correlation. On the other hand, most of the morphological optic disc parameters evaluated by means of HRT-III showed significant correlations with optic disc size, particularly cup area (r = 0.721).

Conclusion: The correlation between RNFL thickness and rim area with optic disc size determines that, optic disc size must be considered in the evaluation of data obtained by means of image devices in clinical practice.
COMPARISON OF RETINAL NERVE FIBER LAYERS MEASUREMENTS USING TIME DOMAIN OPTICAL COHERENCE TOMOGRAPHY AND SPECTRAL DOMAIN OPTICAL COHERENCE TOMOGRAPHY FOR GLAUCOMA SUSPECT AND NORMAL TENSION GLAUCOMA
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¹The Korean ophthalmology society, Sung Mo Eye Hospital, Pusan - Korea Republic

Purpose: To determine the correlation between retinal nerve fiber layer (RNFL) thickness measurements from time domain optical coherence tomography (Stratus OCT™) and spectral domain optical coherence tomography (Cirrus HD-OCT™) for glaucoma suspect and normal tension glaucoma.

Methods: Stratus OCT™ and Cirrus HD-OCT™ were scanned by the same examiner on the same day to measure and compare the retinal nerve fiber layer thickness for 44 eyes of 23 glaucoma suspect and normal tension glaucoma patients from March to August 2010 in Sung Mo Eye Hospital.

Results: When compared the RNFL thickness by disease, normal tension glaucoma has significantly thinner than glaucoma suspect in superior, inferior, temporal quadrant and 5, 6, 7, 8, 11 and 12 microns depending on clock hour by Stratus OCT™ and in superior, inferior, temporal quadrant and 2, 5, 7, 8, 10, 11 and 12 microns depending on clock hour by Cirrus HD-OCT™ (p < 0.05). When compared the RNFL thickness by two machines, Cirrus HD-OCT™ measurements tended to be thinner than Stratus OCT™ from all directions in glaucoma suspect and from all directions except 3 and 7 O’clock directions in normal tension glaucoma (p < 0.05).

Conclusion: RNFL thickness measurements in glaucoma suspect and normal tension glaucoma patients scanned with Cirrus HD-OCT™ correlate well with those from Stratus OCT™. The thickness on the same region are likely to be thinner by Cirrus HD-OCT™ than Stratus OCT™. However, more comparative studies are needed to evaluate measurement values from various diseases and measurement values from spectral domain optical coherence tomography.

Table 1: Result - Stratus OCT

<table>
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IMAGING AND DETECTION OF LOCALIZED PREPERIMETRIC RETINAL NERVE FIBER LAYER DEFECTS IN GLAUCOMA USING SPECKLE-NOISE-REDUCED SPECTRAL-DOMAIN OPTICAL COHERENCE TOMOGRAPHY


1Department of Ophthalmology, University of Kyoto, Kyoto City - Japan; 2Department of Ophthalmology, University of Kyoto, Okayama - Japan

Background: Nerve fiber layer defects (NFLDs) precede the development of visual field defects in eyes with glaucoma. Automated detection of narrow NFLDs is useful for preperimetric glaucoma diagnosis. Although circumpapillary retinal nerve fiber layer (cpRNFL) thickness measured using optical coherence tomography (OCT) has the greatest ability to discriminate glaucoma, its sensitivity for detecting localized NFLDs in patients with preperimetric glaucoma is reportedly poor. Speckle-noise-reduction using spectral-domain OCT (SD-OCT) improves visualization and enables measurement of NFLDs. This study aimed to determine whether improved visualization of NFLDs by this method improves automated detection of NFLDs in patients with preperimetric glaucoma.

Methods: Twenty-eight eyes of 28 patients with NFLDs and preperimetric glaucoma, detected on color fundus photographs, were examined using Spectralis™ HRA+OCT (Heidelberg Engineering), single-scan time domain OCT (TD-OCT; Stratus OCT), and SD-OCT (RTVue-100). To reduce speckle noise in cpRNFL images, we averaged 16 cpRNFL B-scans. The presence of NFLDs was defined as abnormal thinning of the cpRNFL (p < 1%) at least in a part of a sector map. Alternatively, NFLDs were judged to be present when the mean cpRNFL thickness curve crossed the red zone (p < 1%) in the cpRNFL thickness map. NFLD detection based on these 2 definitions was compared among single-scan TD-OCT, single-scan SD-OCT, and images with reduced speckle noise.

Results: A total of 35 NFLDs were detected in the 28 eyes examined. Spectralis significantly improved sensitivity for detecting NFLDs according to the sector abnormality (p < 1%), as compared to Stratus OCT (17.1% versus 48.6%; p = 0.001); however, the sensitivities achieved using Spectralis and Optovue were similar (45.7% versus 48.6% p = 1.000). Spectralis significantly improved sensitivity for detecting NFLDs according to the cpRNFL thickness map, as compared to Stratus OCT (31.4% versus 88.6%; p = 0.001) and RTvue-100 (62.9% versus 88.6%; p = 0.021).

Conclusions: These results suggest that speckle-noise reduction enhances the detection of localized RNFL defects in patients with preperimetric glaucoma. Failure to detect the average of cpRNFL thickness within each sector may be a limitation for detecting preperimetric NFLDs.
QUANTITATIVE ANALYSIS OF REINAL NERVE FIBER LAYER THICKNESS IN HEALTHY KOREAN BY SPECTRALIS SD-OCT
B.J. Cho

1Department of Ophthalmology, Konkuk College of Medicine, Seoul - Korea Republic

**Background**: To determine the normal range of retinal nerve fiber layer (RNFL) thickness in healthy Korean by SD-OCT and to discover the relationship of RNFL with age, gender, and variations of ocular parameters.

**Methods**: The peripapillary RNFL of randomly selected 218 eyes of 125 normal Korean (96 males and 122 females, age 20 to 76 years) was imaged with SD-OCT(Spectralis SD OCT, Heidelberg Engineering). RNFL thickness was measured around the optic nerve head and divided into 4 segments. Refraction, axial length also measured using auto-refractive keratometer, ultrasonography.

**Results**: The mean RNFL thickness of the normal Korean was 101.38 ± 9.89 µm. Considering RNFL thickness in 4 segments, the superior, inferior, nasal and temporal segment average thickness are 124.20 ± 11.65 µm, 129.5 ± 10.18 µm, 81.75 ± 9.96 µm, and 78.82 ± 14.13 µm. As age increased, mean RNFL thickness decreased significantly (r = -0.169, p = 0.012), Also RNFL thickness was observed to decrease with age in 3 quadrants except nasal area. : superior (r = -0.332, p < 0.01), inferior (r = -0.371, p < 0.01), temporal (r = -0.251, p < 0.01), nasal (r = 0.008, p = 0.908). Age-related RNFL values revealed significant negative correlation with axial length (r = -0.569, p = 0.006), refractive error (r = 0.278, p < 0.01). Disc cupping size had no significant influence in correlation analysis.

**Conclusions**: This study determined RNFL thickness, as determined by Spectralis SD-OCT, for normal healthy Korean and age-related differences. The findings could be used as clinical parameters for early diagnosis of glaucoma.
RETINAL NERVE FIBER LAYER IMAGING WITH SPECTRAL-DOMAIN OPTICAL COHERENCE TOMOGRAPHY. AGREEMENT WITH OPTIC DISC PHOTOGRAPHY FOR MEASUREMENT OF RNFL DEFECTS
E. To¹, C. Ye¹, M.C.-Y. Yu¹, C.P. Pang¹, D.S.-C. Lam¹, C.K.-S. Leung¹
¹Department of Ophthalmology and Visual Sciences, The Chinese University of Hong Kong, Hong Kong SAR - China

Background: To compare the agreement of the area and the angular width of localized retinal nerve fiber layer (RNFL) defects measured with optic disc photography and optical coherence tomography (OCT).

Methods: 39 localized RNFL defects from 30 eyes of 22 glaucoma patients were identified from a database of 259 color optic disc stereophotographs. These patients had RNFL imaging performed with an SD-OCT. RNFL thickness deviation maps generated by the OCT with abnormal pixels denoted in red (RNFLT below the lower 99% normal distribution) or yellow (RNFLT below the lower 95% normal distribution) was aligned and overlaid with the corresponding optic disc photographs. The area and the angular width were measured and compared between optic disc photographs and the OCT RNFL thickness deviation maps. Their agreement was analyzed with the Bland-Altman plots.

Results: The area and the angular width of RNFL defects measured with the optic disc photographs were 2.45 ± 1.04 mm² and 28.14 ± 12.75°, respectively, which were significantly smaller than those measured by the OCT RNFL thickness deviation map when the RNFL defects were defined in yellow and red (4.03 ± 2.01 mm² and 75.91 ± 45.57°, respectively, both with p < 0.001). When the RNFL defects were defined in red, a significant difference in angular width (48.93 ± 28.98°, p = 0.004), but not in area (2.40 ± 1.49 mm², p = 0.443) was found between the 2 imaging modalities. The agreement between OCT and optic disc photograph measurements of RNFL defects was poor. Larger RNFL defects were associated with greater differences between OCT and optic disc photograph measurements.

Conclusions: Analysis of the OCT RNFL thickness deviation map could reveal additional RNFL abnormalities not detectable in optic disc photographs.

Figure 1. Polar plots showing the frequency distribution of the angular width of RNFL defects measured with optic disc photographs (A) and the Cirrus HD-OCT RNFL thickness deviation map (B, RNFL defects defined in red pixels; C, RNFL defects defined in red and yellow pixels).
STRUCTURE-FUNCTION RELATIONSHIP OF MACULAR GANGLION CELL COMPLEX AND RETINAL NERVE FIBER LAYER MEASUREMENTS USING SPECTRAL-DOMAIN OPTICAL COHERENCE TOMOGRAPHY IN GLAUCOMA
S. Miura\textsuperscript{1}, A. Miki\textsuperscript{1}, K. Matsushita\textsuperscript{1}, K. Nishida\textsuperscript{1}
\textsuperscript{1}Department of Ophthalmology, Osaka University Graduate School of Medicine, Osaka - Japan

Background: To measure macular ganglion cell complex (GCC) and retinal nerve fiber layer (RNFL) thickness with spectral-domain OCT (SD-OCT) in patients with glaucoma, and to evaluate and compare the correlation between visual field parameters and OCT measurements.

Methods: SD-OCT (RS3000, Nidek, Japan) was used to measure GCC, and circumpapillary RNFL thicknesses in 32 eyes from 16 glaucoma patients. All subjects underwent a full ophthalmic examination, including visual acuity, refraction, intraocular pressure measurement with Goldmann applanation tonometry, standard automated perimetry, and fundus examination. The diagnostic performance of the software-provided classification in both GCC and RNFL was evaluated on the correlation with visual field results in each hemi field. The associations between visual field mean deviation and OCT measurements were evaluated with regression analysis and Pearson correlation coefficients. A field defect was defined as having $\geq 3$ significant ($p < 0.05$), non edge, contiguous points with $\geq 1$ at the $p < 0.01$ level on the same side of horizontal meridian in the pattern deviation plot.

Results: In 64 hemi fields tested, 41 (64.1 \%) was classified as abnormal in both GCC and SAP, 6 (9.38 \%) was classified as abnormal in GCC and was classified as normal in SAP, 2 (3.13 \%) was classified as normal in GCC and was classified as abnormal in SAP, and 15 (23.4 \%) was classified as normal in GCC and was classified as normal in SAP, and 1 (1.56 \%) was classified as abnormal in both RNFL and SAP, 3 (4.7 \%) was classified as abnormal in RNFL and was classified as normal in SAP, 2 (3.13 \%) was classified as normal in RNFL and was classified as abnormal in SAP, and 1 (1.56 \%) was classified as normal in both RNFL and SAP. Mean GCC thickness was $73.22 \pm 11.13 \textmu m$, and mean RNFL thickness was $74.94 \pm 9.82 \textmu m$. The correlation ($R^2$) between visual field mean deviation and GCC thickness was 0.30 ($p = 0.0012$). In contrast, the correlation between visual field mean deviation and RNFL thickness was 0.25 ($p = 0.0038$).

Conclusions: Both macular GCC thickness and RNFL thickness showed significant correlation to the corresponding visual field sensitivity. The structure-function relationship was similar between GCC and RNFL measurements.
HOW TO ASSESS SUPPOSED PERIMETRY RESULTS FROM SOCT READINGS IN
GLAUCOMA PATIENTS
M. Rzendkowski¹, A. Burian²
¹Pryzmat-Okulistyka, Gliwice - Poland, ²A. Chelkowski Institute of Physics, University of
Silesia, Katowice - Poland

When diagnosing or analyzing glaucoma advancement, we usually rely on both methods:
objective analysis of the optic disc and retinal nerve fiber layer (RNFL) morphology, and
subjective analysis of visual function (by means of perimetry). Unfortunately, in many cases we
are not able to achieve reliable perimetry results. It happens in patients who have motorial or
mental obstacle, as well as in those who have coexisting chorioretinal diseases. Diagnosing and
assessing glaucoma advancement in such patients is of high difficulty. Aim of this study is to
develop a method, which would allow to assess supposed perimeter results from SOCT readings,
dedicated especially for this group of patients. There was a group of 47 patients (83 eyes)
involved in this study. All of them were with diagnosed glaucoma (in various stages of
advancement), no other eye diseases and reliable perimeter results. The perimeter was performed
with Octopus 311, dynamic test G1. Optic disc and RNFL were analyzed with Spectral OCT
Copernicus HR ver. 4.2 rev. 5. From the vast set of SOCT parameters, four well correlated with
MD of static perimeter were taken for the further analysis. These were: a. Cup/Disc area ratio (r
= 0.71) - b. Cup/Disc vertical diameter (r = 0.67) - c. RNFL mean thickness (r = 0.67) - d. Rim
absence (r = 0.88) where the linear Pearson correlation coefficient is denoted by r. On the basis
of these four parameters, a new one called PCGA (Perimetry Correlated Glaucoma
Advancement) was calculated, which was achieved by a linear scaling of the variability range for
all four parameters to the variability range of the MD parameter. Then a weighted sum of scaled
parameters was calculated with the weights given by the four individual correlation coefficients
with MD. The resulting correlation coefficient of this new parameter with that of MD is
approximately 0.78. In this way, we may obtain PCGA value, being supposed to be MD result in
patients, where static perimeter is of no reliability. Sensitivity of this method is not perfect, but
further study on a larger group of patients, seems be necessary in order to improve results, i.e. to
increase the correlation coefficient.
GLAUCOMA DIAGNOSTIC CAPABILITIES OF OPTIC NERVE HEAD PARAMETERS AS DETERMINED BY CIRRUS™ HD OPTICAL COHERENCE TOMOGRAPHY
Y.R. Lee¹, K.R. Sung¹, J.H. Na¹
¹Department of Ophthalmology, College of Medicine, University of Ulsan, Asan Medical Center, Seoul - Korea Republic

Background (Purpose): To compare the glaucoma diagnostic capabilities of optic nerve head (ONH) parameters with retinal nerve fiber layer thickness (RNFLT) using Cirrus spectral-domain optical coherence tomography (OCT, Carl Zeiss Meditec Inc, Dublin, CA; version 5.0.0.326).

Methods: Two hundred and twenty nine glaucomatous, 405 glaucoma suspect, and 109 healthy subjects were imaged by Cirrus OCT optic disc cube mode. Correlations were sought between RNFLT and ONH parameters (disc and rim area, average and vertical cup to disc (C/D) ratio, and cup volume). Areas under receiver operating characteristic curves (AUCs) of average RNFLT were compared with those of ONH parameters with respect to discrimination between glaucomatous and healthy subjects. Subgroup analysis was performed in early (EG), moderate-to-advanced (AG) glaucomatous groups, glaucoma patients with a small disc area (SG) and a large disc area (LG).

Results: Rim area showed the strongest correlation with average RNFLT (r = 0.663) and the highest AUC (0.871). The overall AUC for discrimination between healthy and glaucomatous subjects was higher for average RNFLT than for rim area (0.957 vs 0.871, p < 0.001). In the EG and SG subgroup, the AUC of average RNFLT was significantly greater than those of all ONH parameters. In AG patients, the AUCs of average RNFLT and rim area, in LG patients, the AUC of average RNFLT and vertical C/D ratio, did not differ significantly.

Conclusions: RNFLT was better than any tested ONH parameter when used for glaucoma discrimination, especially in patients with early-stage glaucoma and in glaucomatous patients with small optic discs.
COMPARISON OF SENSITIVITIES FOR DETECTING DIFFUSE AND LOCALIZED RETINAL NERVE FIBER LAYER DEFECTS WITH TIME-DOMAIN OPTICAL COHERENCE TOMOGRAPHY IN PATIENTS WITH GLAUCOMA

Y.C. Yoo¹, S.H. Kang², K.H. Park³
¹Department of Ophthalmology, Kangdong Sacred Heart Hospital, Hallym University College of Medicine, Seoul - Korea Republic; ²Department of Ophthalmology, Chuncheon Sacred Heart Hospital, Hallym University College of Medicine, Chuncheon - Korea Republic; ³Department of Ophthalmology, Seoul National University College of Medicine, Seoul - Korea Republic

Background: The thickness of retinal nerve fiber layer (RNFL) is decreased in a diffuse and/or a localized manner with glaucoma. The purpose of the present study was to compare the ability of time-domain optical coherence tomography (OCT) for detecting diffuse and localized RNFL defects using inbuilt normative database in patients with early to moderate open angle glaucoma.

Methods: This cross-sectional institutional study included 43 eyes of 43 subjects with diffuse RNFL defects and 89 eyes of 89 subjects with localized RNFL defects, both having localized visual field defects confined to one hemifield. Among 89 eyes with localized RNFL defects, 43 eyes of which mean deviation (MD) matched to that of 43 eyes with diffuse RNFL defects were selected for statistical analysis. The fast RNFL thickness protocol of the Stratus OCT (Carl Zeiss Meditec, Dubin, CA, USA) was used. The clock-hour sector and quadrant parameters corresponding to the hemifield with visual field defect were evaluated at $P < 0.05$ with regard to the integral normative database of Stratus OCT. The sensitivities of these parameters were compared between diffuse and localized RNFL defects.

Results: The average MD of glaucomatous eyes with diffuse RNFL defects (-2.63 ± 1.92 dB) was not significantly different compared with those with localized RNFL defects (-2.55 ± 2.05 dB) ($p = 0.86$). The sensitivity of clock-hour sector parameter in diffuse RNFL defects (83.7%) was not significantly different compared with that in localized RNFL defects (81.4%) ($p = 1.00$). The sensitivity of quadrant parameter in diffuse RNFL defects (74.4%) was significantly higher than in localized RNFL defects (51.2 %) ($p = 0.04$).

Conclusions: The clock-hour parameter of time-domain OCT detected RNFL defects without significant difference of sensitivities between diffuse and localized pattern of RNFL loss in glaucomatous eyes. However, the quadrant parameter of Stratus OCT showed better sensitivity in diffuse defect than in localized RNFL defects.
GDX-VCC VS GDX-ECC IN GLAUCOMA DIAGNOSIS

G. Milano¹, S. Lombardo¹, L. Bossolesi¹, M. Bordin¹, M. Raimondi¹, S. Lanteri¹, G.C.M. Rossi¹
¹University Eye Clinic, Pavia - Italy

Background: To compare results provided by scanning laser polarimetry variable corneal compensation (VCC) vs enhanced corneal compensation (ECC) and evaluate correlation of visual field results in glaucoma patients.

Methods: Study included 339 eyes of 182 patients screened by the glaucoma unit of the University Eye Clinic of Pavia (Italy). Patients were submitted to complete ophthalmic examination, standard automated perimetry (SAP), scanning laser polarimetry with GDx-VCC and Gdx-ECC. We evaluated for each exam quality image Q, typical scan score (TSS), nerve fibers index (NFI), nerve fibers layer average thickness (TSNIT average), upper sector (TSNIT sup) and lower sector (TSNIT inf). Q, TSS and morphometric parameters VCC and ECC were compared using Wilcoxon signed-rank test and Lin correlation coefficient. Correlation between GDx and perimetric indexes MD and PSD were evaluated with Pearson correlation index “r”.

Results: With VCC only 204 images on 339 images (60%) were good quality (Q > 7) meanwhile with ECC 325 on 339 (96%). With VCC 140 scannings on 339 (41%) had TSS < 80 meanwhile with ECC were atypical 20 scannings on 339 (6%). ECC vs VCC displays constantly lower TSNIT thickness and higher NFI. All comparison between ECC and VCC showed statistically significant differences. GDx parameters and perimetric indexes were compared with statistic significance.

The correlation was better for ECC parameters and first of all NFI.

Conclusion: ECC provides better quality images vs VCC. High quality exam is the first condition to reproduce the real RNFL structure (more reliably). ECC notes nerve fibers layers significantly lower vs VCC and reveal a better correlation with perimetric indexes, is plausible GDx-ECC could improve early glaucoma diagnosis.
RATE OF CHANGE OF RETINAL NERVE FIBER LAYER, NEURORETINAL RIM AND VISUAL FIELD PROGRESSION IN GLAUCOMA

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Background: Examination of serial stereo optic disc photographs is an important strategy to determine optic disc and RNFL progression in managing glaucoma. The agreement for assessment of progressive optic disc changes is poor even among glaucoma specialists. Major clinical trials evaluating glaucoma progression were essentially focused on visual field testing. There are relatively few published data on optic disc progression, and RNFL progression. The advent of digital imaging technologies has substantially enhanced objective and quantitative monitoring of RNFL changes. The RNFL is largely composed of axons of retinal ganglion cells whereas the neuroretinal rim also contains non-neural structures. Having a different structural composition, the longitudinal profile of progressive neuroretinal rim and RNFL damage is likely to be different. It is germane to know if the rate of progression is different between the two structural markers and to what extent they agree for detection of progression with visual field assessment. This study aims at evaluating the performance of progression detection and the rate of change of retinal nerve fiber layer (RNFL), neuroretinal rim and visual field measurements in glaucoma.

Methods: One hundred and eight eyes from 70 glaucoma patients were followed 4 monthly for at least 2.9 years (median 3.2 years) for measurement of RNFL thickness with the Stratus optical coherence tomography (OCT) (Carl Zeiss Meditec, Dublin, CA), neuroretinal rim area with the Heidelberg Retinal Tomograph (HRT 3, Heidelberg Engineering, Dossenheim, Germany), and visual field with the Humphrey field analyzer II (Carl Zeiss Meditec). Linear regression analyses were performed between VFI (visual field index), RNFL, and neuroretinal rim measurements and age with progression defined when a significant negative trend was detected. The agreement among structural and functional measurements was evaluated with kappa statistics. The mean rate of change was estimated with linear mixed modeling.

Results: A total of 1105 OCT, 1062 HRT and 1099 visual field measurements were analyzed. The agreement of progression detection among the 3 investigations was poor (kappa ≤ 0.09). Ten eyes (9.3%)(9 patients) showed progression by average RNFL thickness, 16 (14.8%)(14 patients) by global neuroretinal rim area, and 35 (32.4%)(31 patients) by VFI. Only 1 (0.9%) eye had progression detected by all 3 methods (Figure1, 2 and 3). There were large variations in the rate of change of VFI, average RNFL thickness and global neuroretinal rim area with a range between -0.63% and -4.97% per year, -2.32 and -10.12% per year, and -0.61% and -8.48% per year, respectively (Table 1). The respective mean rate estimates were -1.15% per year (95% confidence interval: -1.56 to -0.73%), -0.70% per year (-1.19% to -0.21%), and -1.06% per year (-1.56% to -0.55%).

Conclusion(s): The agreement of progression detection among RNFL, neuroretinal rim and visual field measurements was poor and the rate of RNFL, neuroretinal rim and visual field progression varied considerably within- and between-subject. Given this variability, interpretation of RNFL, neuroretinal rim and VFI progression always should be evaluated on individual basis.
Table 1: Rate of change (with 95% confidence intervals) of visual field index, average retinal nerve fiber layer thickness, and global neuroretinal rim area of 10 eyes from 5 patients showing progression in both structure (retinal nerve fiber layer thickness and / or neuroretinal rim area) and function (visual field index) with trend analysis.

| Patient code | Rate of change of 
| Rate of change of VFI (%) | Rate of change of average RNFL thickness (%) | Rate of change of global neuroretinal rim area (%) |
|--------------|---------------------------------|---------------------------------|---------------------------------|
| 1L           | -0.97 (95% CI: -1.10 to -0.85) | -0.85 (95% CI: -1.20 to -0.50) | -0.63 (95% CI: -1.03 to -0.23) |
| 2R           | -2.47 (95% CI: -3.20 to -1.74) | -4.71 (95% CI: -6.49 to -2.93) | -5.95 (95% CI: -8.13 to -3.77) |
| 3R           | -3.10 (95% CI: -3.80 to -2.40) | -3.10 (95% CI: -4.10 to -2.10) | -3.10 (95% CI: -4.10 to -2.10) |
| 4L           | -4.02 (95% CI: -5.53 to -2.51) | -4.02 (95% CI: -5.53 to -2.51) | -4.02 (95% CI: -5.53 to -2.51) |
| 5R           | -2.17 (95% CI: -3.00 to -1.34) | -2.17 (95% CI: -3.00 to -1.34) | -2.17 (95% CI: -3.00 to -1.34) |
| 6L           | -3.30 (95% CI: -4.50 to -2.10) | -3.30 (95% CI: -4.50 to -2.10) | -3.30 (95% CI: -4.50 to -2.10) |
| 7R           | -2.56 (95% CI: -3.50 to -1.62) | -2.56 (95% CI: -3.50 to -1.62) | -2.56 (95% CI: -3.50 to -1.62) |
| 8R           | -3.00 (95% CI: -4.00 to -2.00) | -3.00 (95% CI: -4.00 to -2.00) | -3.00 (95% CI: -4.00 to -2.00) |
| 9L           | -0.93 (95% CI: -1.12 to -0.74) | -0.93 (95% CI: -1.12 to -0.74) | -0.93 (95% CI: -1.12 to -0.74) |
| 10R          | -1.66 (95% CI: -2.22 to -1.10) | -1.66 (95% CI: -2.22 to -1.10) | -1.66 (95% CI: -2.22 to -1.10) |

*Patient code is arbitrary defined (L=left and R=right).

RNFL = retinal nerve fiber layer, VFI = visual field index, CI = confidence Interval.

Figure 1. A Venn diagram comparing the number of progressing eyes detected by trend analysis of visual field index (VFI), global neuroretinal rim area and average retinal nerve fiber (RNFL) thickness measured by the Cirrus HD-OCT (high density optical coherence tomography) and the Stratus OCT. Figure 2. A Venn diagram comparing the number of progressing eyes detected by trend analysis of inferior visual sensitivy, superior neuroretinal rim area and superior RNFL thicknes. Figure 3. A Venn diagram comparing the number of progressing eyes detected by trend analysis of superior visual sensitivity, inferior neuroretinal rim area and inferior RNFL thickness.
COMPARISON OF RETINAL NERVE FIBER LAYER PROGRESSION BETWEEN SPECTRAL-DOMAIN OCT AND TIME-DOMAIN OCT
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Background: Based on the principle of low-coherence interferometry, both time domain and spectral domain optical coherence tomography (OCT) provide cross sectional visualization of the retina layers. Measurement of retinal nerve fiber layer (RNFL) thickness with OCT has been shown reliable to discriminate normal from glaucomatous eyes and detection of glaucoma progression. Spectral domain OCT allows more repeatable and reproducible than the time domain OCT. With a lower measurement variability, it is expected that the spectral domain OCT would be more sensitive to detect RNFL changes in glaucoma progression. The purpose of this study is to compare the performance of a spectral-domain OCT and a time-domain OCT to detect RNFL progression in glaucoma patients.

Methods: One hundred twenty-eight eyes from 81 glaucoma patients were followed at 4 month intervals for at least 24 months for RNFL imaging and visual field examination. Both eyes were imaged by the Cirrus HD-OCT (Carl Zeiss Meditec Inc., Dublin, CA) and the Stratus OCT (Carl Zeiss Meditec Inc.) and had visual field testing at the same visits. Linear regression analyses between circumpapillary RNFL measurements (average, superior and inferior RNFL thicknesses), visual field index (VFI) and follow-up time were performed. RNFL progression and RNFL improvement were identified when a significant negative or positive trend was detected, respectively. The agreement between the OCT instruments for progression detection was analyzed with kappa statistics.

Results: Twenty-two (19 patients) and 4 eyes (4 patients) had progression, and 0 and 5 eyes (5 patients) had improvement detected by the Cirrus HD-OCT and the Stratus OCT average RNFL measurements, respectively (Fig.1). The agreement for detection of RNFL progression was poor between the 2 OCT instruments (κ = 0.188, 0.027 and 0.267 for average, superior and inferior RNFL thicknesses, respectively). The respective agreement between VFI and average RNFL thickness progression determined by the Cirrus HD-OCT and the Stratus OCT was 0.125 and 0.047. The rate of average RNFL thickness progression ranged between -1.52µm/year and -5.03µm/year for the Cirrus HD-OCT and between -2.22µm/year and -7.60µm/year for the Stratus OCT (Fig. 2).

Conclusion: The Cirrus HD-OCT outperformed the Stratus OCT in detecting more eyes with RNFL progression and fewer eyes with RNFL improvement. Due to reduced measurement variability, the Cirrus HD-OCT could detect changes in RNFL thickness sooner than the Stratus OCT.
Figure 1. A Venn diagram comparing the number of eyes with progression by average retinal nerve fiber layer (RNFL) thickness obtained with the Cirrus HD-OCT (high density optical coherence tomography), the Stratus OCT, and the VHI (visual field index). Progression was defined when a significant negative trend was detected between average RNFL thickness and VHI value.

Figure 2. A cumulative frequency plot of minimum duration required (years) to detect Cirrus HD-OCT (high density optical coherence tomography) and Stratus OCT average retinal nerve fiber layer (RNFL) thinning progression.
CORRELATION BETWEEN STRUCTURAL AND FUNCTIONAL LOSS IN GLAUCOMA: GANGLION CELL LOSS VS FREQUENCY DOUBLING TECHNOLOGY
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Background: Glaucoma assessments have traditionally relied on visual field and optic disc measurements. Histological and theoretical considerations suggest that measuring ganglion cell structure and/or function might provide valuable adjuncts. Spectral Domain Optical Coherence Tomography (SD-OCT) enables measurement of ganglion cell density. Visual field testing by Frequency Doubling Technology (FDT) is believed to assess ganglion cell function. The aim of this study was to measure correlations between these two modalities.

Methods: We reviewed the case notes of 63 eyes of 31 patients. Ganglion cell indices by SD-OCT included average ganglion cell volume (GCC-av), generalised loss of volume (GCC-GLV), focal loss of volume (GCC-FLV) and difference in superior-inferior volume (GCC-SI). FDT indices included mean and pattern standard deviation (FDT-MD and FDT-PSD).

Results: All data were normally distributed (Kolmogorov-Smirnov Goodness to Fit: all tests p > 0.05). Correlations were tested by Linear Regression with Pearson Product Moment statistics. All ganglion cell indices correlated significantly with FDT-MD (GCC-GCC-av R = 0.430, $R^2 = 0.185$, p < 0.001; GCC-SI R = -0.279, $R^2 = 0.078$, p < 0.02; GCC-FLV R = -0.508, $R^2 = 0.258$, p < 0.001; GCC-GLV R = -0.606, $R^2 = 0.367$, p < 0.001) and with FDT-PSD (GCC-av R = -0.381, $R^2 = 0.145$, p < 0.001; GCC-SI R = 0.420, $R^2 = 0.176$, p < 0.001; GCC-FLV R = 0.536, $R^2 = 0.287$, p < 0.001; GCC-GLV R = 0.465, $R^2 = 0.216$, p < 0.001). The global ganglion cell loss index, GCC-GLV, was the strongest predictor of the index of total functional loss, FDT-MD, explaining 37% of the variance. Conversely, the focal ganglion cell loss index GCC-FLV proved to be the strongest predictor of focal functional loss, FDT-PSD, explaining 29% of the variance.

Conclusions: This preliminary study demonstrates significant correlations between structural and functional measures of ganglion cell loss. The strongest predictors, however, failed to explain levels of variance of functional loss that would suggest a role in current clinical practice. Histological evidence demonstrates that structural damage, especially ganglion cell loss, precedes functional changes. This might explain why Ganglion Cell indices, despite significant correlations, explain only a limited amount of the variance of FDT performance. Ganglion cell measurements may well prove useful in the early diagnosis of glaucoma and especially pre-perimetric diagnosis. They may also have a useful role as an objective measure of glaucoma progression. We are currently investigating these roles.
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ABSTRACT WITHDRAWN
CAN RETINAL NERVE FIBER LAYER THICKNESS PREDICT THE VISUAL OUTCOME AFTER DECOMPRESSION IN PATIENTS WITH PITUITARY ADENOMA?
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Purpose: To define the prognostic criteria for visual field recovery in patients with compressive optic neuropathy and consecutive visual field defect before decompression surgery by objective evaluation of retinal nerve fiber layer thickness (RNFLT) measured by optical coherence tomography (StratusOCT) and assessment of functional defect by standard automated perimetry (SAP).

Methods: Prospective cohort study including 46 eyes of 23 pituitary adenoma patients who underwent surgical intervention due to compressive macroadenoma. For comparison the study included 24 eyes of 12 patients with microadenoma, defined as negative controls for the disease. Any other optic neuropathy and retinal disease were excluded. In cases of surgical intervention RNFLT measurements and SAP were done one week before and one week, one month and three months after the surgery. One-way ANOVA with Tukey or Games-Howell post hoc tests, Pearson correlation and positive predictive value at various RNFLT thresholds were determined. SPSS 16.0 statistical software, accepting values of $p < 0.05$ as statistically significant were used for analysis.

Results: Based on post-surgical VF recovery of 46 eyes of 23 patients the baseline average (AVG0) RNFLT were 90.4 ± 13.3 µm in those with total VF recovery ($n = 22$), but 75.8 ± 13.3 µm when permanent visual loss was present ($n = 19$) and 96.5 ± 8.2 µm in controls. AVG0 and the follow-up (AVG3) RNFL were in good correlation with the final visual field parameters in the visually impaired (AVG0 vs MD = 0.947 and PSD = -0.969; AVG3 vs MD = 0.800 and PSD = -0.690). The positive predictive value of RNFLT at 70.0 µm was 1.0, while at 80.0 µm it was 0.92.

Conclusions: RNFLT imaging by means of OCT at baseline of patients with pituitary adenoma provides valuable information about the extent of the optic nerve damage. The possible nerve fiber loss detectable at the level of the retina in cases with successive visual field damage is a sensitive surrogate to forecast postoperative visual recovery.
AGREEMENT BETWEEN VISUAL FIELD GLOBAL INDICES AND RETINAL NERVE FIBER LAYER THICKNESS AS MEASURED BY SCANNING LASER POLARIMETRY WITH ENHANCE CORNEAL COMPENSATION AND OPTICAL COHERENCE TOMOGRAPHY

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Objective: To assess the strength of the association between retinal nerve fiber layer (RNFL) thickness measured with scanning laser polarimetry (GDx ECC) and optical coherence tomography (OCT), and visual field (VF) global indices (MD, PSD, and VFI) in patients with glaucoma and healthy subjects.

Methods: One hundred eleven subjects, 64 normal 36 with early to moderate open-angle glaucoma (OAG) who met the eligibility criteria were enrolled in this prospective, cross-sectional, and observational study. Subjects underwent complete ophthalmologic examination, automated perimetry, GDx-ECC and HD-OCT. GDx-ECC parameters were recalculated in 90 degrees segments (quadrants) in the calculation circle to be compared. The relationship between RNFL thickness and VF, expressed as MD, PSD, and VFI, were evaluated with Pearson correlation coefficients and Lin's concordance coefficients. P-values less than 0.05 were considered statistically significant.

Results: Correlation of RNFL and the VF parameters MD, PSD, and VFI in normal eyes was not significant. Correlation coefficients (r) between RNFL and VF parameters in glaucoma eyes were moderate and statistically significant: ranged from 0.51 (VFI) to -0.53 (PSD) for AvgThick OCT, from -0.57 (PSD) to 0.66 (MD) for TSNIT ECC; and from -0.60 (MD) to -0.63 (VFI) for NFI ECC. Concordance (rc) of RNFL and the VF parameters were low in normal and glaucoma eyes.

Conclusion: The results of our study suggested that structure-function relationship in glaucoma evaluated with a correlation test, as an index of the precision of the data, is statistically significant but moderate. However, agreement between structure and function evaluated by a concordance test, as a measurement of the accuracy of the data, is poor.
FAST VS. EXTENDED SCANNING LASER POLARIMETRY PROGRESSION ANALYSIS

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Purpose: Ocular imaging devices provide quantitative structural assessment that might improve glaucoma progression detection. The best way of using this information to detect progression remains unknown. Scanning laser polarimetry (SLP) offers progression analysis based on population-derived cut-off criteria (Fast) and analysis based on individual-derived criteria (Extended). The purpose of this study was to compare the performance of SLP Fast and Extended progression analysis.

Methods: Healthy, glaucoma suspect, and glaucomatous eyes (76 eyes of 48 subjects) with at least 4 reliable visual fields (VF) and good quality scanning laser polarimetry (GDx-ECC) acquired at the same visits were enrolled. VF progression was defined by the guided progression analysis (GPA) and by the visual field index (VFI). GDx measurements were analyzed by the fast mode (FM) using a single measurement from each visit that was compared to the population rate of progression, and the extended mode (EM) using 3 sequential measurements from each visit that were compared to individual variability.

Results: Average baseline VF mean deviation was -1.34 (range: -10.85 to 2.07) dB and average follow-up duration was 3.3 (1.6-5.1) years. Using the GDx summary plot report, 12 eyes progressed with EM, 11 with FM, with 6 of the eyes progressing by both methods. Seven eyes progressed by VF but only 2 of them were defined as progressors with EM with one of these eyes progressing also by FM. Using TSNIT average report, 6 eyes progressed by EM and 10 by FM. None of the TSNIT EM progressors showed progression with VF. Two FM progressors were also progressing by EM and 2 other eyes progressed by VF.

Discussion: There is poor agreement between VF and GDx progression regardless of the use of population derived or individual variability criteria. Further investigation is needed to determine the best method to assess glaucoma progression.
PECULIARITY OF OPTIC NERVE HEAD MORPHOMETRY IN GLAUCOMA AND AGE RELATED MACULAR DEGENERATION
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Background: To study peculiarities of changes of optic nerve head measurements in patients with normal tension glaucoma and age related glaucoma.

Material and methods: 23 patients (40 eyes) with late atrophic AMD and 22 patients (38 eyes) with normal tension glaucoma in developed and advanced stages were examined. Morphometry of optic disc head was performed using optical coherent tomography on Stratus OCT 3000.

Results: Tendency to increased area of optic disc head was noted in late AMD group. Disc area of 2.5 - 3.0 mm² was found in 11 eyes (27.5%), shape of optic nerve head was regular. In patients with normal tension glaucoma at developed and advanced stages the same tendency to increased optic disc head area was noted. Disc area of 2.5-3.0 mm² was found in 20 eyes (52.6%). Cup/disc ratio in patients with AMD in 50% of cases (20 eyes) was 0.791 ± 0.06, moderate in deepness; in patients with normal tension glaucoma 0.864 ± 0.07, moderate in deepness.

In group with AMD there was moderate decrease of volume (0.337 ± 0.01) and area of neural rim (1.46 ± 0.06). In group with normal tension glaucoma there was significant decrease of volume (0.141 ± 0.02) and area of neural rim (1.076 ± 0.06). RNFL in AMD patients was moderately diminished in all segments (96.2 ± 2.8 μm), in normal tension glaucoma patients it diminished in temporal segment (79 ± 3.5 μm).

Conclusion: Peculiarity of optic disk head morphometry in patients with AMD in moderate diminished volume and area of neural rim and evenly moderately decreased RNFL in all segments. In patients with normal tension glaucoma volume and area of neural rim was significantly decreased and specific thinning of RNFL in temporal segment of optic disc was noted.
ASSESSMENT OF MACULAR ANATOMICAL AND FUNCTIONAL CHANGES IN GLAUCOMA PATIENTS
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Background: Glaucoma is recognized to have its major detrimental effect upon the eye by killing retinal ganglion cells. The process of cell death appears to be initiated at the optic nerve head, though other sites of injury are possible but unconfirmed. There is a greater loss of ganglion cells from some areas of the eye, and this feature of glaucoma seems related to the regional structure of the supporting connective tissues of the optic nerve head. To detect the correlation between micro-structural changes in the Ganglion Cell Complex (GCC) thickness and macular functional damage detected in glaucoma patients.

Methods: A prospective study on patients with primary open angle glaucoma (POAG). The patients were divided into groups according to the generalized glaucoma functional damage detected. Evaluation of micro-structural changes of the Ganglion Cell Complex (GCC) at the macular area using spectral domain optical coherence tomography (OCT) was performed. Deviation map together with the average, superior and inferior GCC thicknesses obtained from the thickness map were used. Humphrey Automated Perimetry (HAP) using 10-2 Threshold strategy for detection of functional damage at the macular area was also performed to all eyes.

Results: Significant correlation between anatomical and functional changes in glaucomatous maculae with significant deviation from normal values was detected in eyes with severe affection. An Average thickness of the GCC in eyes showing no visual field defect was ± 102.1 µ. In eyes with early glaucomatous functional damage the average GCC thickness was ± 96.5 µ, while eyes showing advanced field defects had an average GCC thickness of ± 65.2 µ. These changes indicated a significant reduction of the GCC thickness (deviations exceeding the lower 95th percentile), compared to age-matched normative database, in patients with advanced glaucomatous functional damage. A statistically significant correlation between the GCC thickness and the existing macular field defects was detected in the inter-group analysis.

Conclusion: The combination of evaluating the macular area both anatomically (using spectral domain OCT) and functionally (using the HAP, 10-2 strategy) has an important role in defining the impact of GCC thickness on the integrity of the visual function in glaucoma patients.
Background: HRT III can measure automatically three dimensional topography images of optic disc and surrounding retina using five parameters of glaucoma probability score (GPS). We analysis the difference of optic nerve head topography between normal tension glaucoma and primary open angle glaucoma with HRT III.

Methods: Seventy-five normal tension glaucoma patients and 80 primary open angle glaucoma patients were included. Five parameters of GPS, rim steepness, cup size, cup depth, horizontal RNFL curvature and vertical RNFL curvature were compared between two groups.

Results: Among five parameters, rim steepness has statistical significant difference (p < 0.05) between two groups, and cup size and vertical RNFL curvature has the difference but no statistical significance. Rim steepness also has significant difference after correcting the difference of MD and PSD in visual field between two groups.

Conclusion: There are controversy whether optic nerve head topography is different between normal tension glaucoma and primary open angle glaucoma or not. In this study, with the measurement of HRT III, rim steepness has statistical significant difference between normal tension glaucoma and primary open angle glaucoma.
EFFECT OF MACULAR NERVE FIBER LAYER MEASUREMENTS SUPERIOR AND INFERIOR SEPARATELY ON DETECTING GLAUCOMATOUS VISUAL FIELD DEFECTS

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Background: Our purpose is to evaluate the effectiveness of ganglion cell (GCC) parameters (GCC average, GCC superior, GCC inferior, FLV, GLV,) obtained by GCC measurement using Fourier-domain OCT (RTVue-100) to find out the glaucomatous visual field changes.

Methods: Compare the discrimination power of GCC average, GCC superior, GCC inferior, FLV and GLV to detect glaucoma at early, moderate and severe stage. Participant underwent reliable standard automated perimetry testing and OCT imaging with GCC scan. The area under the receiver operating characteristic curve (AUC) was used to discriminate the power of GCC average, GCC superior, GCC inferior, FLV and GLV to detect glaucoma at early, moderate and severe stage.

Results: One hundred fifty glaucoma patients and 73 normal subjects were included in this study. The AUC for GCC average were 0.758, 0.815, 0.921; GCC superior were 0.977, 0.976, 0.987; GCC inferior were 0.93, 0.971, 0.976; FLV were 0.775, 0.887, 0.973 and GLV were 0.768, 0.836, and 0.952 for early, moderate and severe glaucoma respectively. Among those parameters, GCC superior had the highest AUC for detecting each stage of glaucoma.

Conclusion: Ganglion cell complex parameter divided into superior and inferior can detect the corresponding visual field loss caused by glaucoma with high discrimination power. The AUC was higher with the severity of glaucoma stage.
INVESTIGATION OF FLOOR EFFECT FOR RETINAL NERVE FIBER LAYER MEASUREMENT WITH OPTICAL COHERENCE TOMOGRAPHY
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Background: Optical coherence tomography (OCT) average retinal nerve fiber layer (RNFL) thickness does not get below 30\textmu m even in eyes with optic neuropathy with no light perception. However, it is unknown what factors contribute to this “floor effect”. We examined the effect of retinal blood vessels (BV) and the frequency of segmentation failure on RNFL measurement obtained with a spectral-domain OCT.

Methods: One hundred and thirty glaucoma patients, forty suspects and forty normal subjects were enrolled for this study. One eye was selected at random from each subject for circumpapillary RNFL scan by the Spectralis OCT (Heidelberg Engineering, GmbH, Dossenheim, Germany). The OCT images were exported to a customized computer program written in MATLAB R2010a (The MathWorks Inc., Natick, Massachusetts, USA) to remove BVs and refine the boundaries of RNFL. The effect of BVs removal and RNFL segmentation refinement to RNFL measurement were evaluated.

Results: The mean proportion of BVs relative to the average RNFL thickness was 4.2 $\pm$ 0.9\%, 4.7 $\pm$ 1.5\% and 7.8 $\pm$ 4.7\%, respectively for the normal, suspect and glaucoma groups. When the average RNFL thickness was above approximately 70\textmu m, the proportion remained at 4.5\% (95\% CI: 4.2 - 4.8). When it is below 70\textmu m, the proportion increased with decreasing RNFL thickness. Taking the refined RNFL thickness as the reference standard, 7.50\% had an underestimate (average RNFL thickness (post-refinement) – average RNFL thickness (pre-refinement) $>$ 3.5 \textmu m) in the suspect group, 6.15\% had an overestimate (average RNFL thickness (pre-refinement) - average RNFL thickness (post-refinement) $>$ 3.5 \textmu m), and 4.62\% had an underestimate in the glaucoma group. For eyes with an overestimate, the algorithm misidentified the outer boundary of the ganglion cell layer as that of the RNFL (Fig. 1A). For eyes with an underestimate, the algorithm failed to detect the segment with thin RNFL (Fig. 1B).

Conclusions: Both the inclusion of BVs and segmentation failure could contribute to floor effect of OCT RNFL measurement. The impact of BVs on RNFL measurement is more substantive in advanced glaucoma when the RNFL is thin. Enhancement of RNFL segmentation algorithm with removal of BVs may improve the detection of progressive RNFL changes.
Figure 1. Examples showing overestimation (A) and underestimation (B) of RNFL thickness measured with the Spectralis OCT.
EFFECT OF GLAUCOMA SURGERY ON RETINAL NERVE FIBRE LAYER THICKNESS AND OPTIC NERVE HEAD PARAMETERS USING STRATUS OCT
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Background: Retinal nerve fiber layer (RNFL) thickness measurement by optical coherence tomography (OCT) is a useful adjunct in glaucoma management especially for monitoring progression. However, it may alter after lowering intraocular pressure (IOP) with drugs or surgery. It is uncertain whether the change in RNFL thickness is transitory or persistent with mixed results from different studies. There have also been reports of changes in optic nerve head (ONH) parameters measured by confocal scanning laser ophthalmoscopy (CSLO) following lowering of IOP but these changes using the OCT have not been studied. This study was done to evaluate changes in RNFL thickness and ONH parameters measured by Stratus OCT before and after trabeculectomy.

Methods: This prospective interventional case series included seventeen patients scheduled for trabeculectomy. Thirteen patients were male and four were females with a mean age of 51.23 ±7.15 years. There were 8 Primary open angle glaucoma, 6 Primary angle closure glaucoma and 3 secondary open angle glaucoma patients. RNFL and ONH parameters were measured using Stratus OCT version 3 (Carl Zeiss Meditec, Dublin, CA) 1 week preoperatively and at 1 week, 1 month and 3 months post trabeculectomy. The change in best corrected visual acuity (BCVA), IOP, average and quadrant RNFL thickness vertical integrated rim area, horizontal integrated rim width, disc area, cup area and rim area following trabeculectomy were noted.

Results: The BCVA was >20/40 in 11 patients preoperatively and in 7, 11 and 14 patients at 1 week, 1 month and 3 months respectively after surgery. The mean IOP was 30.23 ±9.02 mmHg preoperatively. It reduced by 68.5% at 1 week (9.52 ±2.42 mmHg), 59.1% at 1 month (12.35 ±4.59 mmHg) and 53.9% at 3 months (13.6 ±2.31 mmHg) postoperatively. The mean average RNFL thickness preoperatively was 54.05 ±14.02 µm, which changed to 59.39 ±19.52 µm, 54.50 ±10.17 µm and 51.95 ±11.94 µm at 1 week, 1 month and 3 months postoperatively. The average RNFL thickness increased significantly by 5.33 ±8.44 µm at 1 week (p = 0.019) but the change at 1 month (0.44 ±6.37 µm) and 3 months (2.10 ±7.49 µm) was not statistically significant. Amongst the ONH parameters, the optic disc cup area showed a statistically significant decrease from 2.39 ±0.52 mm² preoperatively to 2.14 ±0.52 mm² at 1 week (p = 0.022) and 2.22 ±0.53 mm² at 1 month (p = 0.038). However, the cup area measurement of 2.25 ±0.59 mm² at 3 months was not significantly lesser than the preoperative value (p = 0.214). No significant change was found in other ONH parameters. There was no correlation between change in average RNFL thickness parameters and IOP change at 1 week (p = 0.73), 1 month (p = 0.93) and 3 months (p = 0.11). The cup area and IOP change at 1 week (r = -0.26, p = 0.31), 1 month (r = -0.027, p = 0.27) and 3 months (r = -0.55, p = 0.20) also showed no correlation.

Conclusions: Short term fluctuations were noted in RNFL thickness and ONH parameters postoperatively following trabeculectomy but the values reverted back to normal within 3 months. This may be an artifactual change due to post-operative edema. Our study showed that this transient increase should not be considered and preoperative measurements should be taken as baseline for follow up.
ANALYSIS OF RETINAL NERVE FIBER LAYER (RNFL) DEFECTS IN GLAUCOMA PROGRESSION
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Background: Progressive RNFL thinning is commonly evaluated with trend or event analysis on global or sectorial RNFL thicknesses derived from a circumpapillary scan. With the advent of spectral-domain optical coherence tomography, evaluation of RNFL defects can be examined in an RNFL thickness map. The purpose of this study was to develop an algorithm to identify the longitudinal changes of RNFL defects based on the RNFL thickness deviation map derived from the Cirrus HD-OCT.

Methods: The RNFL thickness deviation map was composed of 50x50 pixels. RNFL measurement below the 95% normal distribution range in each pixel was highlighted in the RNFL thickness deviation map and color-coded based on the probability of normality. RNFL defects were defined as RNFL measurements fell outside the lower 99% of the centile ranges and coded in red. A software program written in MATLAB 2010a was developed to identify new changes in the RNFL thickness deviation map. Three baseline and 2 follow-up images for each eye were examined. The baseline images were overlaid by matching the branch points of retinal blood vessels. Repeatable RNFL abnormalities coded in red in the baseline images were compared with the 2 follow-up images to look for development of new RNFL defects. Serial OCT images from 10 eyes of 10 glaucoma patients followed every 4 months for 30 months were evaluated.

Results: Two patterns of progressive changes of RNFL defects were identified: (1) new islands of RNFL defects (14%) and (2) expansion of a pre-existing defect (86%). RNFL defects expansion was more commonly found over the temporal edge (74%) than the nasal edge (26%) of the defects. Progressive RNFL defects developed in a range between 0.41 mm² and 1.54 mm² and were largely found over the superotemporal, followed by the inferotemporal sectors of the optic disc.

Conclusion: This study illustrated the methodology of evaluating longitudinal changes of RNFL defects using the RNFL thickness deviation map. Prospective studies with a larger sample size are needed to investigate the patterns and risk factors of RNFL defects expansion in glaucoma patients.
Figure 1 Detection of enlargement of RNFL defects. Areas outlined in black represent repeatable RNFL abnormalities observed in the baseline images. Areas outlined in red represent the regions of RNFL defects enlargement.
ANALYSIS OF RETINAL NERVE FIBER LAYER THICKNESS IN ALCOHOL INDUCED OPTIC NEUROPATHY
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Purposes: To evaluate the retinal nerve fiber layer (RNFL) thickness using Optical Coherence Tomography (OCT) in chronic alcohol users.

Methods: We studied seventeen chronic alcohol users. In a control group, sixteen volunteers without use of alcohol. Subjects had similar characteristics ages 35-45, and normal vision. Both eyes were tested for analysis of the retinal nerve fiber layer thickness with Stratus OCT.

Results: There was alteration in the Deviation from normal graph with a loss of nerve fibers in 39.4% of patients in the study group. In the control group this alteration was observed in 14 eyes (18.7%). As regards the parameters that allow comparison between the study and control groups Stratus OCT was able to detect RNFL loss in the papillomacular bundle of patients with alcohol induced optic neuropathy.

Conclusions: The chronic use of alcohol was associated with alteration of the nerve fiber layer. Stratus OCT is capable of identifying RNFL loss in the papillomacular bundle of patients with late stage alcohol induced optic neuropathy. Thus, these results can contribute to the early diagnosis of nerve fiber layer loss in optic neuropathy.
SPECTRAL DOMAIN OCT ANALYSIS OF NERVE FIBER AND GANGLION CELL COMPLEX THICKNESS IN PREPERIMETRIC GLAUCOMA
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Introduction: Preperimetric glaucoma (PPG) may be defined as the presence on clinical examination of typical glaucomatous disk changes, focal or generalized rim thinning, and abnormal excavation, with a normal computerized visual field.

Methods and Materials: 147 consecutive patients with glaucoma or suspicion of glaucoma were examined by the Optovue SD OCT. After complete ophthalmic examination including Humphrey 24-2 visual field testing, 30 patients (19 female, 11 male; mean age 63.7 years) were identified with perimetric glaucoma (PG) in one eye and PPG in the fellow eye. The 30 eyes with PPG were compared to 47 randomly chosen eyes of 47 normal patients (28 female, 19 male; mean age 60 years). The following OCT parameters were studied: total, superior, and inferior retinal nerve fiber layer (RNFL) thickness; total, superior, and inferior ganglion cell complex (GCC) thickness; focal loss volume (FLV) and global loss volume (GLV). In addition, mean deviation (MD) and pattern standard deviation (PSD) visual field indices were compared.

Results: Significant differences in average, superior, and inferior RNFL were found (mean ± SEM): PPG: 91 ± 2.3 µ. 91 ± 2.5 µ, 92 ± 2.5 µ - Normals: 101 ± 1.8 µ, 100 ± 1.9 µ, 102 ± 1.8 µ p = 0.001, 0.002, 0.001 by t-test. The FLV index was also significantly different (Median, first-third quartiles): PPG: 1.52 (0.6 - 3.72) - Normals: 0.50 (0.26 - 1.06) p < 0.001 (Mann-Whitney U test). Areas under the ROC all showed relatively low sensitivity and specificity: Av RNFL 0.713, sup RNFL 0.710, inf RNFL 0.699, total GCC 0.635, sup GCC 0.629, inf GCC 0.626, FLV 0.746, GLV 0.670, MD 0.657, PSD 0.682.

Conclusion: RNFL thinning and focal thinning of the GCC given by the FLV index relative to normals are characteristic of PPG, consistent with the idea that ganglion cell complex and nerve fiber pathology precede visual field defects. The AROC for FLV is the highest of the parameters studied, but judged only fair at best. RNFL thickness and FLV of the GCC are neither specific nor sensitive enough to be of isolated diagnostic value.
COMPARISON OF RETINAL NERVE FIBER LAYER THICKNESS MEASUREMENTS USING STRATUS AND SPECTRALIS OPTICAL COHERENCE TOMOGRAPHY IN VARIOUS STAGES OF GLAUCOMA

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Background: To determine the agreement between the retinal nerve fiber layer (RNFL) thickness measurements from the Stratus Time domain Optical Coherence Tomography (OCT) and the Spectralis Spectral Domain OCT.

Methods: A total of 218 eyes from 171 normal subjects and subjects with glaucoma were analyzed. The subjects were divided into groups by visual field criteria: normal (n = 77), early glaucoma (n = 75), moderate glaucoma (n = 41) and severe glaucoma (n = 25). Peripapillary RNFL thickness were measured with the Stratus OCT and the Spectralis OCT on the same day in one eye of each subject to determine agreement. Two operators used the same instruments for all scans. Main outcome measures: Mann-Whitney U test and Bland-Altman analysis of the RNFL thickness measurements.

Results: The average age of glaucoma subjects was significantly higher than normal subjects: 61.34 ± 43.8 years versus 43.8 ± 17.03 years, respectively. For Stratus OCT the average RNFL values (Mean ± Standard deviation) was 104.7 ± 24.38 µ, 84.8 ± 10.6 µ, 72.8 ± 10.7 µ, 54.8 ± 12.4 µ in the normal, early, moderate and severe glaucoma groups, respectively. The corresponding values for the Spectralis were 100.6 ± 18.8 µ, 82.7 ± 9.2 µ, 72.3 ± 8.9 µ and 53.5 ± 14.5 µ. The Stratus – Spectralis differences were not significant except in the normal group p = 0.02 (by Mann-Whitney test). Quadrant wise Bland-Altman plot analysis showed a systematic difference in measuring RNFL thickness between the 2 devices. Spectralis underestimates thinner RNFL and overestimates thicker RNFL compared to Stratus OCT.

Conclusion: Spectralis and Stratus RNFL thickness measurements cannot be used interchangeably. Spectralis measurements appear to be smaller at thinner RNFL and should be interpreted with caution in severe disease.
Background: There is no specific criteria for drawing the contour outline of the optic disc in the HRT III analyzer. The contour line either can be placed on the topography or on the reflectance image with or without the aid of a conventional optic disc photograph. Our goal is to determine whether statistically and clinically significant differences can be detected in the measured HRT III parameters between standard and photography-guided contour line drawing.

Methods: We analyzed twice, 51 HRT III images (v 3.0) for 51 eyes of patients with ocular hypertension and early glaucoma. The first results were obtained drawing the contour line based on topographic and reflectance maps. The contours are deleted at the end of the session. The second measures were done a week later by the same observer at the same images, and the contour line was determined based on monoscopic digital photographs from a non-mydriatic retinal camera. We apply the intraclass correlation coefficient (ICC) test to assess the relationship between the two measurements, and record the change of clinical significance of MRA analysis of 306 papillary sectors studied and the 51 global analysis identified.

Results: The ICCs values were above 0.8 in all measured parameters except disc area (0.622), rim area (0.548) and FSM (0.596). Thirty-one of the fifty-one images analyzed, showed differences between both methods: 24 images showed worse results in the standard measurements and 7 showed worse results in photograph based measurements. 48 of the 305 papillary sector registered have a worse outcome in the analysis of the standard images and 10 papillary sectors are worse after using photographs to determine the contour line. A definitive diagnosis of MRA is worst in 10 images analyzed using HRT III maps, and one eye worsened his overall analysis on the photograph-based contour images.

Conclusions: HRT stereometric data do not differ significantly by drawing the outline with or without the aid of photography in patients with ocular hypertension or early glaucoma. However, there are significant changes in the MRA in 60% of eyes evaluated.
COMPARISON OF DIAGNOSTIC CAPABILITY OF STRATUS AND SPECTRALIS OPTICAL COHERENCE TOMOGRAPHY IN PATIENTS WITH GLAUCOMA

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Background: To compare the diagnostic agreement and performance for glaucoma detection between a time-domain (Stratus) and a spectral-domain (Spectralis) optical coherence tomograph (OCT).

Patients and Methods: 60 primary open angle glaucoma, 60 ocular hypertension and 60 normal subjects were included in this study. One eye from each individual was selected randomly for retinal nerve fiber layer (RNFL) imaging by the Stratus (Carl Zeiss Meditec Inc., Dublin, CA,) and the Spectralis OCT (Heidelberg Engineering), respectively. Glaucoma was defined based on the presence of visual field defects with the Humphrey visual field analyzer (Carl Zeiss Meditec, Dublin, CA). Measurements were performed in two different sessions on the same day with each of the systems. The measurements of retinal nerve fiber layer (RNFL) thickness were compared among the groups. Areas under the receiver operating characteristics curves (AUCs), including the average thickness, thickness in each of the 4 quadrants, were compared.

Results: RNFL thicknesses of the two OCTs showed a good correlation. The mean the average thickness, and thickness in each of the 4 quadrants in glaucomatous eyes significantly less than in normal and OHT eyes determined by the 2 OCT devices. The AUCs for the RNFL thickness parameters of Stratus OCT were similar to that of Spectralis OCT.

Conclusions: Both OCT technologies did well in the diagnosis of glaucoma. RNFL thickness parameters are able to discriminate between normal, ocular hypertensive patients and glaucoma.
Relationship of Glaucomatous Change in Peripapillary RNFL and Macular Thickness Observed by Spectral Domain Optical Coherence Tomography

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Purpose: To determine the difference between peripapillary retinal nerve fiber layer (RNFL) thickness and macular thickness measurements by Spectralis domain optical coherence tomography (SD-OCT) in normal subjects and glaucoma patients.

Design: Evaluation of diagnostic test for better screening or early diagnosis. Participants: A total of 81 eyes from 50 subjects (male = 53%, female = 38%, average age of 56.01 yrs old) were included. The subjects consist of three groups: normal (n = 35), mild to moderate glaucoma (n = 20), and severe glaucoma (n = 26).

Methods: Peripapillary RNFL and macular thickness was measured with SD-OCT. Two operators used the same instruments for all scans on the same day for each subject.

Main Outcome Measures: Student paired t testing, kolmogorov, reduction ratios, and ROC curve analysis of RNFL and macular fiber thickness measurements was used.

Results: The average age of the glaucoma groups were slightly more than that of the normal group: 53.49 versus 57.93 years, respectively. The average RNFL thickness (mean ± standard deviation) was 95.14 ± 8.6 μm, 71.70 ± 12.9 μm and 45.38 ± 8.7 μm for the normal, mild to moderate, and severe groups, respectively. For average macular thickness the corresponding measurements were 313.0 ± 9.9 μm, 303 ± 16.7 μm, and 280.07 ± 16.2 μm. All differences were statistically significant by t testing (p < 0.001). There was also a highly significant direct linear relationship between macular fiber thickness and RNFL thickness (p < 0.001). ROC curve plots showed larger values in nasal outer area (.833), inferior outer (.832) and superior outer (.818). However, the same measurement for RNFL revealed bigger numbers in superior (.972) and inferior (.946) regions, according to findings these areas are more sensitive to pressure change and can be better representatives of disease progression.

Conclusion: correlation among peripapillary RNFL and macular thickness measurements demonstrate a parallel changes in both regions while higher correlation is observed in outer ring of macula thickness with more sensitivity in nasal, inferior and superior regions, respectively.

Key words: Optical coherence tomography, glaucoma, macula fiber thickness, retinal nerve fiber thickness.
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ABSTRACT WITHDRAWN
NORMATIVE VALUES WITH SPECTRAL-DOMAIN OPTICAL COHERENCY TOMOGRAPHY (CIRRUS OCT) FOR EVALUATED RETINAL NERVE FIBER LAYER (RNFL) THICKNESS IN COLOMBIAN POPULATION

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Objectives: To describe the global values, by quadrant and segment of retinal nerve fiber layer (RNFL) measurement with Spectral-Domain optical coherence tomography (Cirrus OCT) in Colombian population.

Design: Transversal descriptive-prospective.

Patients and Methods: 211 eyes out of 120 healthy patients were examined. Thorough ophthalmological examination was conducted by a glaucoma specialist, Humphrey computerized visual campimetry and Spectral-Domain optical coherence tomography (Cirrus OCT, Carl Zeiss Meditec, Optic Disk Cube protocol 200 x 200).

Results: The average age of the participants was 40.35 ± 13.2 years (range between 18 and 69 years of age), with a female participation of 59%. The average CFNR global peripapilar thickness was 98.5 ± 9.28 µm with a range between 74 and 124 µm. Quadrant value results were the following: upper 123.2 ± 16.82 µm, nasal 71.4 ± 11.5 µm, lower 131.5 ± 15.95 µm and temporal 67.2 ± 9.42 µm. There was evidence of less thickness in patients above 60 years of age and slightly thicker in females. The thinner segments are numbers 3 and 9; the thicker segments are number 6 and 7.

Conclusions: The global average of thickness of CFNR was slightly higher than the one reported by other studies conducted on races other than Hispanic using the same technology, and lower than the ones conducted on populations with similar OCT Time-domain.

Key Words: Optical coherency tomography, Retinal nervous fiber layer, Time-domain, Spectral-domain.
TEST RETEST VARIABILITY OF SPECTRAL-DOMAIN OCT IN ASSESSMENT OF RETINAL NERVE FIBER LAYER FOR PATIENTS HAVING GLAUCOMA

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Background: Spectral-Domain OCT is an objective test to assess RNFL thickness in Patients having Glaucoma. Interpretation of results is based on measured thickness of RNFL by machine; however measured RNFL thickness may varies between the test and influence results. To assess inter test or test retest measurement variability with the Spectral-Domain optical coherence tomography (OCT) in diagnosing retinal nerve fiber layer defects in patients having Glaucoma.

Methods: In a prospective analysis of consecutive Three hundred twenty eyes of patients having Glaucoma underwent spectral-Domain OCT (Cirrus, Carl Zees Mediate Inc Dublin, CA). For every patient at least three RNFL images were taken, 6×6-mm square parapapillary region scans were done fifteen minutes apart, and best of two scans were selected for comparison. All test reports included in study pass the signal strength (more than six), artifacts free good images only considered for evaluation. In all patients RNFL thickness compared on average RNFL thickness, thickness in each quadrants and at each clock hours. Intertest variability is considered significant if RNFL thickness deviation map showing deviation of probability from 95% to 10%, or 5% to 1% (color code map shows green to yellow or green/yellow to red) in at least one clock hour angular location. In all these patients who showed deviation in at least one clock hour position RNFL thickness also compared in each quadrant. At each clock hour where RNFL thickness variation was noted on color coded map, mean of RNFL thickness variation was calculated and compared with mean of RNFL thickness of each patients at one of the clock hour position where no deviation was seen.

Results: Twenty one eyes (6.56%) shows deviation of of RNFL thickness as green to yellow or green/yellow to red at least in one of the clock hour position, however on analysis of four quadrants only seven eyes (2.18%) shows similar kind of deviation between two test results. In all the patients average RNFL color coding remained unchanged. There was no correlation in test retest variability with age, refractive error, or severity of Glaucoma. Angular or clock hour position did not show any specific correlation. Mean of normal RNFL thickness at one of the clock hour position was 1.066 ± 0.73 micron and mean of RNFL thickness in affected clock hour position was 10.3 ± 4.9 micron (p < 0.0000)

Conclusions: Spectral-Domain OCT does show intertest or test retest variability of RNFL thickness at some location in 6x6mm square parapapillary region, however that is not observed in significant number of patients however RNFL thickness deviation is significant in these patients. Test retest variability is free of age, refractive error and severity of Glaucoma. One must take in to account this while interpreting the results. Intertest variability was seen at angular or clock hour position more often, than to four quadrant however mean RNFL thickness remained same.
RELATIONSHIP BETWEEN SHORT-WAVELENGTH AUTOMATIC PERIMETRY (SWAP) AND HEIDELBERG RETINA TOMOGRAPH (HRT) IN EYES WITH OCULAR HYPERTENSION (OHT)

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Aims: To compare and correlate optic nerve head parameters obtained by HRT with defects detected by short-wavelength automatic perimetry (SWAP) in eyes with ocular hypertension (OHT).

Methods: The study included 1 eye of 130 ocular hypertensive patients with a mean age of 47 ± 12 years. All subjects had reliable visual fields and HRT measurements performed within a 2-week period. The eyes were classified as normal/abnormal according to visual field criteria and Moorfields regression analysis (MRA). Correlations between visual field indices (mean deviation, pattern standard deviation (PSD) and corrected PSD) and HRT parameters were analyzed using Spearman correlation coefficient (r) and the agreement between the tests in classifying eyes was defined with k value.

Results: The mean central corneal thickness (CCT) was 559 ± 37 µm. Twenty-five eyes (19.2%) had SWAP visual field defects. Twenty-eight eyes (21.5%) had abnormal HRT evaluation. Six eyes (4.6%) had abnormal HRT evaluation and SWAP visual field defects. Another nine eyes had “suspicious” HRT evaluation and SWAP visual field defects. The k values was 0.12 for SWAP and MRA (p = 0.12). Eyes with pathological MRA had significantly reduced CCT (p = 0.029) whereas eyes with SWAP visual field defects did not defer in CCT. No statistical significant correlation between HRT and SWAP parameters was detected.

Conclusions: SWAP visual field defects may coexist with abnormalities of optic disk detected by HRT in eyes with OHT. In most eyes, however, the two methods detect different glaucoma properties.
Background: Enhanced Depth Imaging (EDI) is a recent spectral domain OCT acquisition method. This technique allows choroidal thickness (CT) measurement. The authors report results from a preliminary study comparing CT in normal and glaucomatous eyes.

Methods: The aim of this study was to measure subfoveal CT in normal and glaucomatous eyes and to evaluate the EDI technique. 17 eyes of 9 healthy subjects were compared with 23 eyes of 14 glaucomatous patients. CT has been evaluated with a Spectralis OCT. A section was obtained within a 30 degree scan centered on the fovea, with 100 scans averaged for each section. 2 acquisitions were performed for each eye by the same operator in order to use an average CT measurement (Fig 1). Results were compared with clinical examination data (refractive error, peripapillary atrophy and age).

Results: The two CT measurements were strongly correlated $r = 0.99$ ($p < 0.001$). In the healthy group, mean age was 72.76 ± 7.71 years, mean refractive errors was 0.71 ± 0.74 D and peripapillary atrophy was present in 29% of the eyes. Mean subfoveal CT was 224.38 µm. In the glaucomatous group, mean age was 71.39 ± 11.37, mean refractive error was -1.37 ± 2.74 D and peripapillary atrophy was present in 70% of the eyes. Mean subfoveal CT was 219.98 µm. No significant difference between the two groups was demonstrated for the subfoveal CT or refractive errors. In both groups, there was a negative correlation between CT and peripapillary atrophy. In healthy eyes, peripapillary atrophy was correlated with age ($p < 0.001$), whereas it wasn’t in the glaucomatous population ($p = 0.795$).

Conclusion: This is the first study, in our knowledge, evaluating EDI OCT in glaucomatous eyes. Reproductibility is excellent. CT and peripapillary atrophy were always negatively correlated. No CT difference in the normal or glaucomatous group was found but the studied population’s effective was limited. Further studies are required to evaluate a relationship between CT and peripapillary atrophy and the link with the evolutive stage of the glaucomatous neuropathy.
STRUCTURE-FUNCTION RELATIONSHIPS USING ENHANCED AND VARIABLE CORNEAL COMPENSATION SCANNING LASER POLARIMETRY: COMPARISON WITH SPECTRAL-DOMAIN OPTICAL COHERENCE TOMOGRAPHY

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Background: To evaluate and compare the regional relationships between visual field sensitivity and retinal nerve fiber layer (RNFL) thickness as measured by spectral-domain optical coherence tomography (OCT), scanning laser polarimetry with variable (GDx VCC) and enhanced (GDx ECC) corneal compensation. To evaluate and compare the discriminating abilities of each of these RNFL imaging devices among healthy eyes, suspected glaucoma and glaucoma.

Methods: Prospective cross-sectional study. One hundred and fifty eyes of 150 patients (50 with healthy eyes, 50 with suspected glaucoma, and 50 with glaucoma) were tested on Cirrus-OCT, GDx VCC, GDx ECC, and standard automated perimetry. Data on RNFL thickness were extracted for 256 peripapillary sectors of 1.40625 degrees each for the OCT measurement ellipse and 64 peripapillary sectors of 5.625 degrees each for the GDx VCC and GDx ECC measurement ellipse. Correlations between peripapillary RNFL thickness in 6 sectors and visual field sensitivity in the 6 corresponding areas were evaluated using linear and logarithmic regression analysis. Receiver operating curve areas were calculated for each instrument.

Results: With spectral-domain OCT, the correlations (r(2)) between RNFL thickness and visual field sensitivity ranged from 0.123 (nasal RNFL and corresponding visual field area, linear regression) to 0.876 (supratemporal RNFL and corresponding visual field area, logarithmic regression). By comparison, with GDx-VCC and GDx ECC, the correlations respectively ranged from 0.079 and 0.122 (nasal RNFL and temporal RNFL, with the corresponding visual field area, linear regression) to 0.403 and 0.642 (supratemporal RNFL and inferotemporal RNFL with the corresponding visual field area, logarithmic regression). The structure-function correlations were generally stronger with spectral-domain OCT than with GDx ECC, with GDx ECC than with GDx VCC, and with logarithmic regression than with linear regression. The largest areas under the receiver operating curve were seen for GDx ECC nerve fiber indicator (NFI) (0.981 ± .096 - p < .001) in eyes with glaucoma and for GDx ECC NFI (0.924 ± .102 - p < .001) in eyes with suspected glaucoma.

Conclusions: The structure-function relationship was significantly stronger with spectral-domain OCT than with scanning laser polarimetry GDx ECC, and with GDx ECC than with GDx VCC. This relationship was better expressed logarithmically than linearly. Measurements with these different instruments should not be considered to be interchangeable.
NORMATIVE DATA OF ONH, RNFL AND GCC ON FOURIER DOMAIN OCT. IS IT APPLICABLE IN BLACK SOUTH AFRICAN EYES?
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Objectives: 1) To study the Optic Nerve Head (ONH), Retinal Nerve Fiber Layer (RNFL) and Ganglion Cell Complex (GCC) parameters in a group of normal eyes in black South Africans. 2) To compare the normative data in the study group with other ethnic group studies (Hispanic, Afro-American, Caucasian and Asian)

Design: Prospective, observational study of randomly selected normal eyes from Eye clinic patients.

Material and Method: 30 eyes were studied in adult patients with no ocular disease or disorder. All subjects underwent a complete ophthalmologic examination to confirm normal anterior segment and fundus. All OCT scans were performed on RTVue Fourier-Domain OCT (FD-OCT) with recommended provider protocols. Statistical analysis of the data was done with T test, mean and standard deviation and Confidence Interval (95%).

Results: Mean and Standard deviation for Optic Nerve Head (ONH) was 2.07 and 0.59. For Retinal Nerve Fibre Layer (RNFL) was 114.6 and 12.9 and for Ganglion Cell Complex (GCC) was 99.10 and 1.50. This data was found to be closer to the Hispanic ethnic group rather than Afro American group. Caucasian and Asian values were significantly different from our cohort.

Conclusions: Although our sample size is small, we have established that the normative data of black South Africans is closer to Hispanic ethnic group. At this point of time we are not in position to recommend change in clinical evaluation of data using this ethnic normative data. Further larger group analysis is underway to make such recommendations.
CLINICAL EXAMINATION METHODS: BLOOD FLOW AND PERFUSION
CHANGES IN OPTIC NERVE HEAD BLOOD FLOW FOLLOWING APPLICATION OF TAFLUPROST IN NORMAL SUBJECTS

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Background: Tafluprost is a new prostaglandin F2α analogue in clinical use for the treatment of ocular hypertension and glaucoma. We evaluated changes in optic nerve head blood flow following application of tafluprost in normal subjects using laser speckle flowgraphy (LSFG), a non-invasive technique that can measure real-time, two-dimensional relative blood flow velocity of ocular microcirculation using the laser speckle phenomenon.

Methods: This prospective study included 9 eyes of 9 normal Japanese subjects [average (± standard deviation) age = 36.3 ± 8.0 years]. Each eye had a best corrected visual acuity of 20/25 or better, a spherical equivalent refractive error between -5 and +5 diopters, a normal intraocular pressure (IOP) below 21 mmHg, and no significant ocular disease upon routine ophthalmological examination. Each subject had no history of systemic disease such as diabetes mellitus, hypertension, or heart disease. Before application of tafluprost, we measured IOP, brachial artery blood pressure, and pulse rate. After mydriasis, we measured the mean blur rate (MBR), a quantitative index of relative blood flow velocity, in the overall, superior, temporal, inferior, and nasal regions of the optic nerve head using the LSFG Analyzer (Softcare, Ltd., Ilzuka, Japan; version 3.0.20.0). After 7 days of application of 0.0015% tafluprost once daily, the same examinations were performed again, and the IOPs, mean systemic blood pressures [diastolic blood pressure + 1/3 (systolic minus diastolic blood pressure)], perfusion pressures (2/3 mean systemic blood pressure minus IOP), pulse rates, and MBRs before and after application of tafluprost were compared.

Results: The average IOPs, mean systemic blood pressures, perfusion pressures, and pulse rates before and after application of tafluprost were 14.9 ± 2.2 and 11.6 ± 3.1 mmHg, 97.8 ± 14.5 and 97.3 ± 9.2 mmHg, 50.3 ± 10.6 and 53.3 ± 7.1 mmHg, and 83.1 ± 20.7 and 84.7 ± 21.9, respectively. The average MBRs in the overall, superior, temporal, inferior, and nasal regions of the optic nerve head before and after application of tafluprost were 12.2 ± 1.7 and 12.7 ± 1.9, 13.2 ± 2.8 and 13.7 ± 2.8, 8.5 ± 2.0 and 8.9 ± 2.2, 13.4 ± 1.7 and 13.9 ± 2.1, and 13.7 ± 1.3 and 14.1 ± 1.6 arbitrary units, respectively. The average IOP after application was significantly lower than that before application (p = 0.030). The average mean systemic blood pressure, perfusion pressure, and pulse rate after application were not significantly different from those before application (p ≥ 0.139). The average MBRs after application were significantly higher than those before application in the overall (p = 0.008), superior (p = 0.044), and temporal (P = 0.044) regions of the optic nerve head. The average MBRs after application were not significantly different from those before application in the inferior and nasal regions of the optic nerve head (p ≥ 0.066).

Conclusion: Application of tafluprost for 7 days may increase optic nerve head blood flow in normal subjects.
OCULAR PERFUSION PRESSURE AND RETROBULBAR HAEMODYNAMICS IN DIFFERENT TYPES OF GLAUCOMA
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\textsuperscript{1}Eye Clinic, University of Florence, Florence - Italy

\textbf{Background:} Previous investigations have shown that altered perfusion of the optic nerve may be pathogenetically relevant in different types of glaucoma. This study aimed at comparing ocular perfusion pressure (OPP) and color Doppler Imaging (CDI) measurements in ophthalmic artery (OA) and to describe the correlation between CDI and OPP in normal tension (NTG), pseudoexfoliative (XFG), primary open angle (POAG) glaucoma patients and healthy controls.

\textbf{Methods:} Forty-four NTG, 47 PXG, 41 POAG patients and 40 healthy controls were evaluated (Tab. 1). One eye per subject was considered. Intraocular pressure and systolic and diastolic blood pressure were measured by Goldmann applanation tonometry and Riva-Rocci sphygmanometer. Mean and diastolic OPP (mOPP and dOPP) were calculated. Retrobulbar haemodynamic measurements were recorded by CDI. Differences in OPP and CDI parameters between groups were assessed by ANOVA for repeated measures and Student’s t-test. The correlations between resistivity index of ophthalmic artery (RI-OA) and OPPs were evaluated by Pearson's correlation analysis.

\textbf{Results:} mOPP and dOPP were reduced in NTG compared to PXG, POAG and controls (p < 0.001) (Tab. 2). Comparisons between glaucoma subgroups revealed that mOPP was lower in NTGs than in XFGs and POAGs (p < 0.001) and in XFG than in POAGs (p = 0.032). Similarly, dOPP was lower in NTGs than in XFGs (p = 0.020) and POAGs (p < 0.001) and in XFGs compared to POAGs (p < 0.001). Resistivity index of ophthalmic artery was higher in XFGs than in NTGs, POAGs and controls (p < 0.001) (Tab. 3). Subgroups analysis showed that RI-OA was more elevated in XFGs than in NTGs and POAGs (p < 0.001) and in NTGs than in POAGs (p = 0.022). Resistivity index of ophthalmic artery negatively correlated with mOPP and dOPP in NTGs (r = -0.342, p = 0.023; r = -0.371, p = 0.013) and XFGs (r = -0.603, p < 0.001; r = -0.539, p < 0.001).

\textbf{Conclusion:} This study, by showing reduced ocular perfusion pressures and elevated resistivity index of ophthalmic artery, demonstrated a reduced perfusion of the optic nerve in normal tension and pseudoexfoliative glaucoma. A state of vascular dysregulation of the optic nerve is suggested in these two types of the disease, more evident in pseudoexfoliative glaucoma.
Table 1: Demographic and clinical features of the study population

<table>
<thead>
<tr>
<th></th>
<th>NTGs</th>
<th>XFGs</th>
<th>POAGs</th>
<th>Controls</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>44</td>
<td>47</td>
<td>40</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>69.6 ± 0.6</td>
<td>69.7 ± 0.7</td>
<td>69.2 ± 1.0</td>
<td>67.6 ± 0.9</td>
<td>0.249</td>
</tr>
<tr>
<td>Gender</td>
<td>23 men</td>
<td>21 women</td>
<td>21 men</td>
<td>21 men</td>
<td>1.000</td>
</tr>
<tr>
<td>Topical treatments</td>
<td>29 PGs</td>
<td>31 PGs</td>
<td>27 PGs</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>CCT (µ)</td>
<td>539.8 ± 5.3</td>
<td>526.9 ± 4.0</td>
<td>534.1 ± 5.6</td>
<td>535.1 ± 4.1</td>
<td>0.270</td>
</tr>
<tr>
<td>IOP (mmHg)</td>
<td>13.7 ± 0.3</td>
<td>14.3 ± 0.3</td>
<td>14.4 ± 0.3</td>
<td>14.3 ± 0.3</td>
<td>0.441</td>
</tr>
<tr>
<td>Mean SEP</td>
<td>129.10 ± 1.04</td>
<td>133.70 ± 0.87</td>
<td>133.30 ± 0.87</td>
<td>135.20 ± 0.95</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Mean DEP</td>
<td>75.68 ± 0.62</td>
<td>78.72 ± 0.81</td>
<td>81.71 ± 0.97</td>
<td>84.38 ± 1.00</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

NTG = normal tension; XGF = pseudoexfoliative glaucoma; POAG = primary open-angle glaucoma; CCT = central corneal thickness; IOP = intraocular pressure; SBP = systolic blood pressure; DBP = diastolic pressure.

Table 2: Ocular perfusion pressure in the study population

<table>
<thead>
<tr>
<th></th>
<th>NTGs</th>
<th>XFGs</th>
<th>POAGs</th>
<th>Controls</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>mOPP (mmHg)</td>
<td>76.09 ± 0.57</td>
<td>79.78 ± 0.72</td>
<td>82.02 ± 0.73</td>
<td>83.32 ± 1.13</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>dOPP (mmHg)</td>
<td>58.30 ± 0.63</td>
<td>60.96 ± 0.91</td>
<td>64.79 ± 0.92</td>
<td>67.07 ± 1.02</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

mOOP = mean ocular perfusion pressure; dOPP = diastolic ocular perfusion

Table 3: Retrobulbar haemodynamic parameters in the study population

<table>
<thead>
<tr>
<th></th>
<th>NTGs</th>
<th>XFGs</th>
<th>POAGs</th>
<th>Controls</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSV-OA (cm/sec)</td>
<td>29.35 ± 1.06</td>
<td>30.01 ± 0.94</td>
<td>26.78 ± 1.01</td>
<td>32.90 ± 0.97</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>EDV-OA (cm/sec)</td>
<td>5.69 ± 0.15</td>
<td>6.54 ± 0.17</td>
<td>7.45 ± 0.31</td>
<td>11.44 ± 0.36</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>RI-OA</td>
<td>0.80 ± 0.01</td>
<td>0.71 ± 0.01</td>
<td>0.64 ± 0.01</td>
<td>0.64 ± 0.01</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>PSV-SPCA (cm/sec)</td>
<td>11.39 ± 0.30</td>
<td>13.36 ± 0.36</td>
<td>12.99 ± 0.37</td>
<td>13.22 ± 0.31</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>EDV-SPCA (cm/sec)</td>
<td>3.57 ± 0.08</td>
<td>5.45 ± 0.15</td>
<td>6.06 ± 0.20</td>
<td>6.09 ± 0.13</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>RI-SPCA</td>
<td>0.68 ± 0.01</td>
<td>0.58 ± 0.01</td>
<td>0.53 ± 0.01</td>
<td>0.53 ± 0.01</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>PSV-CRA (cm/sec)</td>
<td>11.41 ± 0.30</td>
<td>9.73 ± 0.32</td>
<td>9.88 ± 0.30</td>
<td>11.51 ± 0.36</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>EDV-CRA (cm/sec)</td>
<td>3.72 ± 0.12</td>
<td>4.64 ± 0.14</td>
<td>5.22 ± 0.17</td>
<td>5.94 ± 0.17</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>RI-CRA</td>
<td>0.66 ± 0.02</td>
<td>0.51 ± 0.01</td>
<td>0.46 ± 0.01</td>
<td>0.47 ± 0.01</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

NTG = normal tension; XGF = pseudoexfoliative glaucoma; POAG = primary open-angle glaucoma; PSV = peak-systolic velocity; EDV = end-diastolic velocity; RI = resistivity index; OA = ophthalmic artery; SPCA = short posterior ciliary artery; CRA = central retinal artery.
ASSOCIATION OF OPTIC NERVE HEAD BLOOD FLOW AND OPTIC DISC STRUCTURE IN THE NORMAL AND GLAUCOMA PATIENTS

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Background: To investigate whether the microcirculation of optic nerve head was correlated to the optic disc structure in the patients with open-angle glaucoma (OAG).

Methods: One hundred fifteen eyes (34 control, 40 large cup disc (LCD), and 41 glaucoma) were included in this study. LCD was defined as (1) within normal limits in Glaucoma Hemifield test of Humphrey Field Analyzer (HFA, SITA standard), (2) Cup to Disc area (C/D) ratio of HRTII was more than 0.47. Optic disc structure was evaluated by HRTII and average thickness of retinal nerve fiber layer thickness (avg RNFLT) was measured by OCT3. The microcirculation of optic nerve head was examined with a laser speckle flowgraphy (LSFG-NAVI, Softcare Ltd, Fukuoka, Japan) and the mean blur rate (MBR) of all mean (AM), vessel mean (VM), and tissue mean (TM) was calculated. The correlation was evaluated with a Spearman rank correlation coefficient. Logistic analysis of MBR values to differentiate the patients with LCD and GE, Area Under the Curve (AUC) for MBR was calculated by receiver operating characteristics (ROC).

Results: The correlation coefficients to AM were significant in Mean Deviation of HFA (r = 0.46, p < 0.01) and avgRNFLT (r = 0.61, p < 0.01), and C/D ratio (r = -0.57, p < 0.01). Compared to control group (53.4 ± 6.5), VM in LCD (48.7 ± 5.8, p = 0.03) and glaucoma group (45.0 ± 7.1, p < 0.01) was significantly smaller. While TM of glaucoma groups (11.3 ± 2.2) was significantly smaller in than that in LCD (13.0 ± 2.2, p < 0.01) and control groups (13.4 ± 2.0, p < 0.01). ROC curve analysis revealed that cut-off values was 19.3 in AM (AUC, sensitivity, specificity: 0.71, 0.45, 0.94, respectively), 39.6 in VM (0.61, 0.30, 0.96), and 11.3 in TM (0.71, 0.64, 0.80).

Conclusion: These results suggested that the decreased optic nerve head blood flow both in vessel and tissue was significantly affect the status of optic nerve head structures in the patients with glaucoma.
RETINAL NERVE FIBER LAYER THICKNESS CORRELATES WITH DT-MRI MEASURE “RADIAL DIFFUSIVITY” REFLECTING MYELIN DAMAGE IN THE OPTIC RADIATION IN GLAUCOMA

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Purpose: In glaucoma damage of retinal ganglion cells may continue to the linked optic radiations (OR). This damage may concern the axonal integrity as well as demyelination or glia cell impairment. This study investigated measures of axonal demyelination, i.e. radial diffusivity (RD), in the optic radiation of glaucoma patients. The results were correlated with the homonymous retinal nerve fiber layer thickness (RNFL).

Methods: Fourteen control subjects (mean age, 52.0 ± 11.7 years) were age-adjusted to 12 patients with normal tension glaucoma (NTG, mean age, 58.3 ± 9.5 years; p = 0.157) and 18 patients with primary open angle glaucoma (POAG, mean age, 55.7 ± 7.3 years; p = 0.296). The control subjects had eye diseases without neuronal participation. All subjects underwent magnetic resonance (MR) tomography-based diffusion tensor imaging (DTI) of the optic radiation and eye examination by the Spectralis optical coherence tomography. MR images did not show cerebral space occupying lesions along the visual pathway. The optic radiations in the DTI were outlined semi-automatically and the mean values of FA and RD of both OR’s were measured. The homonymous RNFL thickness corresponding to the respective OR was calculated.

Results: If corrected for age, gender, and diagnosis groups (control, NTG, POAG) partial correlation analysis disclosed a correlation between RD and the RNFL thickness (right OR: r = -0.350, p = 0.025; left OR: r = -0.478, p = 0.002).

Conclusion: In glaucoma DTI-derived parameters of axonal integrity and demyelination of the optic radiation (4th neuron) are suggested to change with decreasing retinal nerve fiber layer thickness (3rd neuron), i.e. with increasing glaucoma severity.
Partial correlation analysis corrected for age, gender, and diagnosis groups. "control", 1x NTG, 16 POAG"
OCULAR PERFUSION PRESSURES AND RETINAL AND NEURORETINAL RIM BLOOD FLOW IN PRIMARY OPEN ANGLE GLAUCOMA PATIENTS

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Background: To evaluate a possible association between systemic vascular factors and blood flow perfusion in the peripapillary retina and in the optic nerve head, in patients with primary open angle glaucoma (POAG) and to identify the best indicator of the ocular perfusion pressure. In particular, we tried to verify the existence of a correlation between the ocular mean, ocular systolic and ocular diastolic perfusion pressure vs the peripapillary retinal and neuroretinal rim blood flow.

Methods: Thirty-eight patients with primary open angle glaucoma (15/23 male/female, mean age 60.71 ± 6.56 ys; range 45-70 ys) under medical antiglaucomatous therapy were studied. IOP, systemic arterial pressure were measured. We calculated the ocular mean (OMPP = mean blood pressure – IOP), systolic (OSPP = systolic blood pressure – IOP) and diastolic perfusion pressure (ODPP = diastolic blood pressure - IOP). Visual Field through Humphrey Field Analyzer were also performed. Peripapillary retinal and neuroretinal rim blood flow were measured with the Heidelberg Retina Flowmeter (HRF). The HRF regions of interest were superior and inferior peripapillary retina (temporal and nasal) and neuroretinal rim at the temporal side. The analysis of the flow has been made on every image through the AFFPIA - SLDF (3.3 version). Finally we gathered the flow values of the temporal peripapillary retina (mean between superior and inferior), nasal peripapillary retina (mean between superior and inferior) and neuroretinal rim. Statistical analysis was conducted using the Pearson’s test; significance was set at p < 0.05.

Results: Mean IOP values 15.7 ± 3.5 mmHg; mean systemic arterial pressure values:SBP 121.0 ± 11.2 mmHg, DBP 75.1 ± 10.0 mmHg and MBP 90.6 ± 9.6 mmHg. Mean VF values PSD 5.74 ± 4.4 dB and MD -6.32 ± 6.2dB. Mean HRF values: temporal flow: 238.71 ± 50.9 AU; nasal flow: 219.25 ± 61.3 AU, neuroretinal rim flow 172.50 ± 98.35AU. The correlations were the follows: OMPP - Temporal peripapillary retinal blood flow (r = 0.41; p = 0.01); OMPP – Nasal peripapillary retinal blood flow (r = 0.36; p = 0.02); OMPP - Neuroretinal rim blood flow (r = 0.02; p = 0.9); OSPP - Temporal peripapillary retinal blood flow (r = 0.37; p = 0.02); OSPP - Nasal peripapillary retinal blood flow (r = 0.38; p = 0.02); OSPP - Neuroretinal rim blood flow (r = -0.06; p = 0.7); ODPP - Temporal peripapillary retinal blood flow (r = 0.28; p = 0.09); ODPP – Nasal peripapillary retinal blood flow (r = 0.20; p = 0.2); ODPP - Neuroretinal rim blood flow (r = 0.07; p = 0.7).

Conclusions: Our findings show that OMPP and OSPP are statistically correlated to peripapillary retinal blood flow, more than ODPP. Neuroretinal rim blood flow was not related to ocular perfusion pressure, probably because of the high variability of results.
CORRELATION BETWEEN GLAUCOMA DAMAGE AND OCULAR PULSE AMPLITUDE MEASURED WITH A DYNAMIC CONTOUR TONOMETER
D. Musetti¹, M. Iester¹, A. Bagnis¹, C.E. Traverso¹
¹Clinica Oculistica, Dinog, University of Genoa, Italy, Genova - Italy

Purpose: The difference between mean minimum and mean maximum of pulse curve is called ocular pulse amplitude (OPA). Pascal Dynamic Contour Tonometer (DCT) calculated automatically during each IOP measurement. In this study we evaluated whether OPA was correlated to the glaucoma damage in healthy subjects and in primary open angle glaucomatous patients.

Methods: This is a prospective cross-sectional study. 90 normal and 72 glaucomatous eyes were selected for this study. Glaucomatous patients had to be under treatment with either a prostaglandin or a β-blocker in a monotherapy regimen. Normal subjects had to have normal visual field and optic nerve head, untreated intraocular pressure below 21 mmHg, no family history of glaucoma. Glaucmatous patients had typical glaucomatous visual field defects, abnormal ONH assessed using stereoview with a volk 90° lens, open angle by gonioscopy. Pearson ‘r’ correlation and Student’s t-test was used for the statistical analysis of the results.

Results: The mean age was 61.71 ± 16.22 (mean ± SD) years and 69.62 ± 13.33 years, respectively, and no significant difference was found. A statistically significant (p < 0.001) difference was found for OPA between healthy (9.77 ± 1.14 mmHg) and glaucomatous (2.96 ± 1.06 mmHg) eyes. A mild correlation (r = -0.16) was found between cup/disc ratio and OPA.

Conclusion: The OPA was significantly higher in normal eyes whereas it was lower in glaucomatous patients, however a mild correlation with the structural damage was found.
ASSOCIATED FACTORS WITH THE OPTIC NERVE DISC PARAMETER OF LSFG-NAVI IN THE NORMAL SUBJECT
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Department of Ophthalmology, Tohoku University Graduate School of Medicine, Sendai City - Japan

Background: Laser speckle flowgraphy (LSFG-NAVI) is a noninvasive technique that can measure relative optic nerve head (ONH) blood flow using the laser speckle phenomenon. In this study, we investigated the factors associated with the disc parameters of LSFG-NAVI in the normal subject statistically.

Methods: Eighty one eyes of 46 healthy volunteers (male/female: 27/19) who had the regular medical checkups were included in this study. The persons with ocular diseases, history of the intraocular surgery, and systemic disease affecting the ocular blood flow like hypertension, hyperglycemia, hyperlipidemia, and smoking history were excluded in this study. Age, spherical equivalent (SE), averaged retinal nerve fiber layer thickness (avgRNFLT) were recorded. Averaged RNFLT was measured by 3D-OCT 1000 (TOPCON). As the optic disc parameters of LSFG-NAVI, mean blur rate (MBR), skew, and blowout score (BOS) were assessed by equipped software (LSFG Analyzer) at vessel mean (VM), tissue mean (TM), or all mean (AM), separately. After the slit lamp examination, the pupil was dilated and fundus check with the indirect ophthalmoscopy, digital fundus photograph, OCT, and LSFG were performed. Each parameter was analyzed using Spearman's rank correlation coefficient and P < 0.05 was considered significant.

Result: The average of each parameter was as follows; 60.0 ± 10.2 years in age, -1.9 ± 2.6 D in SE, 121.8 ± 10.3 \(\mu\)m in avgRNFLT, 49.2 ± 6.4 in VM-MBR, 14.0 ± 1.6 in TM-MBR, 29.0 ± 4.2 in AM-MBR, 11.9 ± 1.3 in VM-skew, 13.2 ± 1.5 in TM-skew, 12.3 ± 1.3 in AM-skew, 77.5 ± 5.4 in VM-BOS, 73.7 ± 5.5 in TM-BOS, and 76.5 ± 5.4 in AM-BOS. Age was significantly correlated with VM-MBR (\(r = -0.50, p < 0.001\)), AM-MBR (\(r = -0.37, p < 0.001\)), VM-skew (\(r = 0.42, p < 0.001\)), TM-skew (\(r = 0.45, p < 0.001\)), AM-skew (\(r = 0.48, p < 0.001\)), and TM-BOS (\(r = -0.27, p = 0.015\)). SE was significantly correlated with TM-MBR (\(r = -0.27, p = 0.018\)), TM-skew (\(r = -0.29, p = 0.010\)), and AM-skew (\(r = -0.24, p = 0.029\)). AvgRNFLT was significantly correlated with VM-MBR (\(r = 0.28, p = 0.011\)), AM-MBR (\(r = 0.28, p = 0.011\)), VM-skew (\(r = -0.30, p = 0.007\)), TM-skew (\(r = -0.23, p = 0.036\)), and AM-skew (\(r = -0.30, p = 0.006\)).

Conclusion: In normal subject, the some specific disc parameters of LSFG-NAVI were significantly correlated with aging, myopia, and thickness of nerve fiber layer. Age was correlated with LSFG parameters, especially with VM-MBR and skew. These data suggest that VM-MBR and skew are suitable for the aging research and also age-matched comparison is better when the parameters of LSFG are used for analysis.
OCULAR BLOOD FLOW IN YOUNG PATIENTS WITH OPTIC DISC SUSPICIOUS OF GLAUCOMA

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Normal-tension glaucoma (NTG) refers to glaucomatous optic nerve head changes and corresponding glaucomatous visual field defects in the absence of elevated IOP. An elevated prevalence of vasospastic diseases (primarily migraine and Raynaud's disease), ischemic vascular diseases, and hypotension are common.

**Purpose:** To evaluate the retro-ocular blood flow in the young age patients with suspicious glaucomatous optic nerve head

**Patients and Methods:** Twenty two young patients with mean age 20years 10 of them with normal optic discs as control and 12 with bilateral variable degrees of optic nerve head glaucoma like changes were enrolled in the study. All patients underwent complete ophthalmic examination & diurnal measurement of IOP, Visual field assessment & OCT (5 of them) and retro-ocular Doppler have been done.

**Results:** Compared to the control group, no significant difference has been observed in the PSV, EDV and RI of the retro-ocular ophthalmic and central retinal arteries between the two groups.

**Conclusion:** Young patients have to be followed up closely before considering them low tension glaucoma

**Key words:** Low tension glaucoma, retro-ocular Doppler, ocular hemodynamic.
SYMPATHETIC HYPERACTIVITY AND ENDOTHELIAL PERIPHERAL DYSFUNCTION IN NORMAL TENSION GLAUCOMA PATIENTS

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Background: Defective cardiovascular neuroregulation has been advocated as a possible main contributing factor in the etiology of normal tension glaucoma (NTG). The purpose of the study was to define parameters of autonomic nervous system activity and peripheral vascular reactive hyperemia in NTG patients.

Methods: Ambulatory automated 24-hour electrocardiogram and blood pressure (BP) monitoring by using Lifecard CF and SpaceLab 90207-30 combined with occlusion provocation test were carried out in 54 NTG patients (44 women, mean age 59.7) and 43 control subjects (34 women, mean age 57.0), who were matched for age, gender and medication. Heart rate variability (HRV) time and frequency domain parameters [low-frequency (LF), high-frequency (HR) and LF/HF ratio], and blood pressure variability (BPV), calculated with the value of standard deviation in 24-hour BP measurement were calculated and analyzed for both study groups. Postocclusive hyperemia response parameters (\(TM\) - time to peak flow, \(TH\) – half-time hyperaemia, \(TR\) – time to rest flow, \(BZ\) - biological zero and \(MAX\) – maximum hyperemic response) were compared for patients with a nocturnal fall in mean blood pressure (MPB) of less than 10% (non-dippers), of 10-20% (dippers) and of more than 20% (over-dippers).

Results: NTG patients demonstrated higher LF and LF/HF values for 24-hour period, day-time and night time than control subjects. There was no difference in BPV between study groups (10.4 ± 1.9 vs. 10.5 ± 2.1, \(p = 0.790\)). In NTG patients, \(TH\) was significantly higher (79.0 ± 80.9 s vs. 51.5 ± 35.3 s, \(p = 0.028\)) and \(BZ\) was significantly lower (2.3 ± 1.0 vs. 3.1 ± 2.0, \(p = 0.009\)) as compared to the control group. There was statistically significant difference between non-dippers, dippers and over–dippers in the \(BZ\) parameter (2.3 ± 0.9 vs. 2.7 ± 1.3 vs. 1.4 ± 0.4 \(p = 0.024\)).

Conclusions: NTG patients exhibit sympathetic hyperactivity and an abnormal peripheral hyperemia response as compared to healthy subjects.
RETINAL BLOOD FLOW MEASUREMENTS USING DOPPLER FOURIER-DOMAIN OPTICAL COHERENCE TOMOGRAPHY IN GLAUCOMATOUS EYES WITH SINGLE-HEMIFIELD DAMAGE

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Background: Vascular factors have been suggested to impact the risk for development and progression of glaucomatous optic neuropathy and visual field loss. This study was conducted to examine the hypotheses that retinal blood flow (RBF) measurements are significantly reduced in the abnormal visual hemifield of glaucomatous eyes with single-hemifield damage; and examine the association between RBF, retinal sensitivity and retinal nerve fiber layer thickness (RNFL) in the normal and abnormal hemifields.

Methods: Glaucomatous eyes with visual field loss confined to a single hemifield underwent Fourier-domain optical coherence tomography (FDOCT, RTvue, Optovue Inc, Fremont, CA), Doppler FDOCT, and standard automated perimetry (SAP). Mean retinal sensitivity values were calculated in the normal and abnormal SAP hemifields using the average of 26 of the 52 test locations. Using Doppler FDOCT a double-circle scanning pattern was used to measure the RBF around the optic nerve head, transecting all retinal branch arteries and veins. The identification of veins was based on disc photograph registered with Doppler image. The flow was derived from the recorded Doppler frequency shift and the calculated angle between the probe beam and blood vessel. Total retinal blood flow was obtained by adding flow from all veins. Flow values from an eye were deemed acceptable only if greater than 63% of the venous cross-sectional area met criteria for acceptable Doppler angle and angle variability. Mean RBF was also calculated for each corresponding retinal hemifield. RBF parameters included in the analyses consisted of total, superior and inferior hemispheric blood flow, and total venous area and venous velocity. Structural parameters included were average, superior and inferior RNFL thickness.

Results: Forty-one glaucomatous eyes were screened, and 9 eyes of 9 patients (mean age 64 ± 11 yrs) meeting eligibility criteria were included. Thirty-two eyes were excluded due to weak signal strength index, improper position of inner limiting membrane or low valid venous area percentage. Mean RBF was significantly (p = 0.006) reduced in the retinal hemisphere associated with abnormal SAP hemifield (16.9 ± 7.2 µL/min) compared with the normal retinal hemisphere (22.8 ± 8.4 µL/min). Mean retinal sensitivity was significantly (p = 0.046) reduced in the abnormal hemifield (20.5...
± 9.0 dB) compared with the normal hemifield (27.9 ± 1.3 dB). RBF in the abnormal hemifield was significantly associated with RNFL thickness (r = 0.83, p = 0.01) in corresponding hemisphere. Total RNFL thickness (96.0 ± 13.1 µm) was associated (r = 0.79, p = 0.02) with total venous velocity (12.7 ± 8.8 mm/sec).

**Conclusion:** In glaucomatous eyes with single-hemifield damage, retinal blood flow measure was significantly reduced in the hemisphere with abnormal SAP compared with the normal hemisphere suggesting that glaucoma is associated with vascular changes in the retina.
COMPARISON OF SITTING AND SUPINE DIASTOLIC BLOOD PRESSURE (BP) AND MEAN OCULAR PERFUSION PRESSURE (OPP) IN PATIENTS UNDERGOING DIURNAL INTRAOCULAR PRESSURE MONITORING

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Purpose: To compare the diastolic blood pressure (BP) and mean ocular perfusion pressure (OPP) in sitting and supine position in patients undergoing diurnal intraocular pressure (IOP) monitoring.

Methods: 100 consecutive patients undergoing diurnal IOP monitoring were included in the study. Patients had normal tension glaucoma (NTG) and primary open angle glaucoma (POAG) showing progression or were NTG suspects. Sitting BP was measured at 8.30, 12.30 and 16.30. Supine BP was measured at 12.30 after placing the patient supine for 30 minutes. Ocular perfusion pressure (OPP) was measured with the following formula: OPP = (1/3 systolic pressure + 2/3 diastolic pressure)*2/3-IOP.

Results: 28 POAG, 34 NTG, and 38 NTG suspects were included. 46 were Caucasians, 31 African-Caribbeans and 23 Asians. Mean supine diastolic BP (71.2 mmHg) was significantly lower (p < 0.001) than mean sitting diastolic BP at 12.30 (78.8 mmHg) and was also significantly lower compared to any mean diastolic BP during the monitoring period (p < 0.001). OPP was significantly lower at the supine position (39.6 mmHg RE, 39.8 LE mmHg) than the mean sitting OPP (45.9 mmHg RE, 42.3 mmHg LE) at 12.30 for both eyes (p < 0.001). Mean supine OPP was the lowest of the whole monitoring period for both eyes (p < 0.001). A trend for more pronounced decrease in the BP and OPP at the supine position was observed in the group of Caucasians and also in the group of POAG.

Conclusion: BP and OPP appear to be significantly lower in the supine rather than the sitting position in POAG, NTG and NTG suspects undergoing diurnal pressure monitoring. Measuring BP and OPP at normal working hours may allow the detection of at least a part of the BP and OPP decreases expected during the night.
IMPAIRED AUTOREGULATION OF RETROBULBAR BLOOD FLOW IN PATIENTS WITH PRIMARY OPEN ANGLE GLAUCOMA

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Background: There is evidence from a variety of studies that blood velocities in retrobulbar arteries are reduced in primary open angle glaucoma (POAG). The present study seeks to investigate whether autoregulation of retrobulbar blood flow is impaired in patients with POAG. For this purpose, the association between retrobulbar blood flow velocities and systemic blood pressure is measured in a group of patients with POAG and healthy subjects and used as an indicator of a possible vascular dysregulation.

Methods: The study comprised 252 patients with POAG and 198 healthy age-matched control subjects. Systemic blood pressure was measured noninvasively using automated oscillometry. Retrobulbar mean flow velocity (MFV) in the ophthalmic artery (OA), the posterior ciliary arteries (PCA), and central retinal artery (CRA) were measured using color Doppler imaging (CDI).

Results: No difference in mean arterial pressure was observed between the two groups. As expected, intraocular pressure was higher in POAG patients compared with healthy controls. All retrobulbar blood flow velocities were significantly reduced in POAG patients compared with healthy control subjects (p < 0.01 each). In addition, the correlation between MFV and mean arterial blood pressure in the CRA was more pronounced in patients with POAG than in healthy control subjects.

Conclusions: Our results confirm that retrobulbar blood flow velocities are reduced in POAG patients. In addition, an abnormal correlation between blood velocities and mean arterial blood pressure was found in POAG. This indicates that autoregulation is compromised in patients with POAG.
CLINICAL EXAMINATION METHODS:
ULTRASONOGRAPHY AND ULTRASOUND
BIOMICROSCOPY
HIGH FREQUENCY ULTRASOUND IMAGING IN VISCOCANALOSTOMY
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Purpose: To evaluate by high frequency ultrasound imaging the anatomical characteristics of viscocanalostomy and their relationship with the intraocular pressure (IOP) lowering.

Methods: A transversal study which included 9 eyes (7 patients) undergoing viscocanalostomy and examined by high frequency ultrasound (80 MHz). Several variables were evaluated, including the presence of the intrascleral space, the maximum length and height of the intrascleral space and the minimum thickness of residual trabeculo-Descemet membrane (TDM). Surgical success was considered to be achieved when IOP was < 22 mmHg or the IOP was lowered by more than 20% without the use of any medication. The possible association between ultrasound variables and the surgical outcome was determined.

Results: The mean time between surgery and the ultrasound examination was 15.5 ± 8.8 months (range 6-29). The mean IOP decreased from a preoperative value of 23.5 ± 6.9 mmHg (range 13.7-32.0) to 14.5 ± 2.4 mmHg (range 10.7-17.3) postoperative (p < 0.05). The presence of an intrascleral space was a common finding. The mean length of the intrascleral space was 1.83 ± 0.51 mm, the mean height was 0.36 ± 0.17 mm; and the mean TDM thickness was 0.14 ± 0.07 mm. There were a poor correlation between the level of IOP at the time of ultrasound imaging and the length of the intrascleral space ($r^2 = 0.359$), the height of the intrascleral space ($r^2 = 0.017$) or the thickness of the remaining TDM ($r^2 = 0.003$).

Conclusions: In patients undergoing viscocanalostomy, ultrasound examination after a minimum of 6-month follow-up period showed the presence of an intrascleral space in all patients. There was no statistically significant relationship between the level of IOP and the anatomical characteristics of the intrascleral space.
Background: To identify the impact of the presence of peripheral anterior synechia on the depth of anterior segment in patients with a shallow anterior chamber after peripheral laser iridotomy by analyzing changes in the anterior segment biometry using ultrasound biomicroscopy (UBM).

Methods: Twenty eyes of twenty patients with peripheral anterior synechia and shallow anterior chamber, and another twenty eyes of twenty patients with shallow anterior chamber without peripheral anterior synechia were studied. The changes in the anterior segment biometry for each group of patients depending on the presence of peripheral anterior synechia were examined using gonioscopy and ultrasound biomicroscopy before and after the peripheral laser iridotomy.

Results: The central corneal thickness and scleral thickness of the two groups did not show significant differences (p > 0.05). However their anterior chamber depths, anterior chamber angles, trabecular meshwork-iris distances, and angle-opening distances 500 increased significantly after the peripheral laser iridotomy (p < 0.05) in both groups. Even though the increase in the anterior segment biometry was higher in the group of patients with a peripheral anterior synechia, the difference between the two groups was not statistically significant.

Conclusions: Peripheral laser iridotomy can increase the depth of anterior chamber regardless of the presence of peripheral anterior synechia.
DIFFERENCES IN FILTERING BLEB STRUCTURE ASSOCIATED WITH LONG-TERM INTRAOCULAR PRESSURE CONTROL BETWEEN TRABECULECTOMY WITH AND WITHOUT AMNIOTIC MEMBRANE TRANSPLANTATION

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Background: Amniotic membrane transplantation (AMT) has been used to assist trabeculectomy based on the anti-fibrotic ability. The intraocular pressure (IOP) lowering effect of trabeculectomy primarily depends on the structure and the shape of a filtering bleb. However, there has been no study to assess the intrableb morphology after the AMT-assisted trabeculectomy. The purposes of this study were first to determine whether AMT at trabeculectomy affects intrableb structures and then to assess which intrableb parameters are significantly correlated with the IOP control using ultrasound biomicroscopy (UBM) with reference to trabeculectomy alone.

Methods: Included were 64 eyes of 56 glaucoma patients who underwent trabeculectomy with adjunctive use of 0.04% mitomycin C either without (36 eyes) or with the AMT-assisted trabeculectomy (28 eyes) more than one year prior to entry into this study. Bleb morphology was evaluated by slit-lamp biomicroscopy and radial scans of UBM images. Logistic regression analysis was conducted to identify factors that were significantly associated with the good IOP control. Main outcome measures were IOP control, bleb morphology, and intrableb fluid-filled space score (FFSS): The IOP control was defined as good when the eyes had a more than 30% decrease in the preoperative IOP and an IOP value of less than 18 mmHg if the preoperative IOP was higher than 21 mmHg. The bleb morphology was classified into types L (low reflective), H (high reflective), E (encapsulated), or F (flattened). The FFSS was graded into 0 (no space), 1 (limited space), or 2 (space extending posteriorly beyond the field of view).

Results: Intervals between surgery and the timing of the UBM examinations (median; 2.5 years for the eyes both without and with AMT) and the overall frequency of good IOP control (28/36 in the eyes without AMT and 17/28 in those with AMT; chi-square test, p = 0.2276) were similar between the two groups. The eyes with AMT had a significantly lower number of type H or L blebs and a higher number of type E bleb compared to those that did not undergo AMT (chi-square, p < 0.0001). Among independent variables, which included age, sex, glaucoma type, lens status, the number of ocular hypotensives and previous intraocular surgeries, bleb classification, and FFSS, only bleb type F was significantly associated with poor IOP control in the eyes that did not undergo AMT (p = 0.0008, odds ratio = 0.0256, 95% confidence interval = 0.0030 to 0.2205), whereas an FFSS 0 or 1 was significantly associated with poor IOP control in eyes that did undergo AMT (0.0026, 0.0111, 0.0006 to 0.2079 and 0.0071, 0.0167, 0.0004 to
Conclusions: The UBM images of blebs after trabeculectomy alone vs. AMT-assisted trabeculectomy were distinct. The bleb wall reflectivity in the former and the extent of the intrableb fluid-filled space in the latter were factors significantly associated with long-term IOP control.
7 YEAR FOLLOW-UP OF SHALLOW PERIPHERAL CHAMBER EYES BY ULTRASOUND BIOMICROSCOPY

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Background: As far as we could find out, a long time follow-up of eyes with shallow peripheral anterior chamber, but no peripheral anterior synechia (PAS) by ultrasound biomicroscopy (UBM) has not been reported in the literature. We retrospectively quantified 7 year-changes in anterior segment morphology of such eyes after laser peripheral iridotomy (LPI) by gonioscopy and UBM.

Methods: Eighteen eyes with shallow peripheral anterior chamber without PAS from 11 subjects (average age: 65.1 ± 7.9 years) were treated with LPI in 2001. In 2001 before LPI and 2008, these eyes underwent gonioscopy by the same experienced ophthalmologist (A.I.) who graded the angle width according to the Shaffer’s grading system, and confirmed absence or presence of PAS by compression gonioscopy if necessary. On separate days in 2001 before LPI and in 2008, the absence or presence of appositional angle closure, the angle opening distance (AOD500), the trabecular-iris angle (TIA), the trabecular-ciliary process distance and iris thickness were determined in each four quadrants under light and dark conditions using the same UBM apparatus (UBM model 840 with a 50-MHz transducer probe, Humphrey Research Division, Carl Zeiss Inc., Thornwood, NY) by same experienced ophthalmologist (S.K.S.)

Results: Before LPI and 7 years after it, intraocular pressure was 15.1 ± 3.1 mmHg and 14.9 ± 2.1 mmHg (p = 0.84). Seven years after LPI, gonioscopically graded angle width was significantly wider in all 4 quadrants (p = 0.023~0.000), whereas isolated tent-like PAS developed in 12 eyes (67%). AOD500 and TIA significantly were increased (p < 0.0001) and prevalence of appositional angle closure reduced from 78% to 33% in light (p = 0.007) and from 94% to 67% in dark conditions p = 0.04) respectively.

Conclusions: LPI was effective in widening the angle and reducing the prevalence of appositional angle closure for at least 7 years, but was not very effective in preventing future PAS development in Japanese eyes with shallow peripheral anterior chamber, but no PAS.
ULTRASOUND BIOMICROSCOPIC COMPARISON OF PRIMARY OPEN ANGLE GLAUCOMA AND PRIMARY ANGLE CLOSURE GLAUCOMA EYES IN DARK AND LIGHT CONDITIONS

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Background: Ultrasound biomicroscopy is a useful tool in the diagnosis and management of glaucoma. We aim to look at differences in anterior segment parameters of eyes with primary open angle glaucoma (POAG) and primary angle closure glaucoma (PACG) in dark and light conditions.

Methods: Ultrasound biomicroscopy was performed for 30 subjects with PACG and 30 subjects with POAG at initial presentation before any treatment. Measurements of angle opening distance (AOD-500 and AOD-750) and trabecul-iris space area (TISA-500 and TISA-750) 500 and 750 µm from the scleral spur in both dark and light conditions were made. Anterior chamber depth (ACD) and axial length (AL) were also measured.

Results: The mean age of PACG patients was 67.6 ± 9.6 years and POAG patients 62.1 ± 13.9 years. The mean ACD (2.70 ± 0.53 µm) in PACG patients was significantly different from that (3.32 ± 0.52 µm) of POAG patients (p < 0.0001). There was also significant difference (p = 0.0004) in the mean AL of PACG (22.91 ± 0.86 µm) and POAG (24.47 ± 1.67 µm) patients. The light-dark differences parameters in PACG and POAG eyes for the various quadrants were as follows respectively: TISA-500 (0.00035 ± 0.0059 µm and 0.0053 ± 0.038 µm), AOD-500 (0.0027 ± 0.056 µm and 0.052 ± 0.19 µm), TISA-750 (0.000017 ± 0.013 µm and 0.012 ± 0.085 µm) and AOD-750 (0.0016 ± 0.091 µm and 0.10 ± 0.25 µm) for the inferior quadrant; TISA-500 (-0.00050 ± 0.012 µm and 0.0053 ± 0.038 µm), AOD-500 (-0.011 ± 0.044 µm and 0.020 ± 0.15 µm), TISA-750 (0.00086 ± 0.24 µm and 0.019 ± 0.061 µm) and AOD-750 (-0.037 ± 0.40 µm and 0.042 ± 0.20 µm) for the superior quadrant; TISA-500 (-0.0010 ± 0.0058 µm and -0.0025 ± 0.034 µm), AOD-500 (0.0035 ± 0.029 µm and -0.027 ± 0.15 µm), TISA-750 (-0.00073 ± 0.013 µm and -0.0040 ± 0.065 µm) and AOD-750 (-0.0025 ± 0.12 µm and 0.015 ± 0.26 µm) for the nasal quadrant; TISA-500 (0.0060 ± 0.017 µm and 0.0067 ± 0.045 µm), AOD-500 (0.019 ± 0.095 µm and -0.026 ± 0.15 µm), TISA-750 (0.013 ± 0.033 µm and 0.012 ± 0.091 µm) and AOD-750 (0.039 ± 0.16 µm and -0.014 ± 0.25 µm) for the temporal quadrant. Of the above comparisons, the only near significant light-dark difference between PACG and POAG eyes was found in AOD-750 in the inferior quadrant (p = 0.0524). Interestingly, there was no significant difference in light-dark changes between POAG and PACG eyes for all other parameters in all 4 quadrants.

Conclusions: There is significant difference in mean AL and ACD between PACG and POAG eyes. The light-dark difference in PACG eyes is smaller than that of POAG eyes for all AOD and TISA values in all 4 quadrants. However, except for AOD-750 in the
inferior quadrant, there was no significant difference between PACG and POAG eyes in terms of light-dark difference in anterior segment parameters. Further evaluation of the above findings could be done in future with a larger population.
PREVALENCE OF PLATEAU IRIS IN PRIMARY ANGLE CLOSURE SUSPECTS IN INDIA

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Background: To evaluate the prevalence of plateau iris as a mechanism of angle closure in Primary Angle Closure Suspects using ultrasound biomicroscopy (UBM).

Method: This was a cross sectional study for which subjects were recruited from glaucoma clinic of tertiary care university eye centre. PACS patients who had a patent peripheral laser iridotomy and were not on any medical therapy were included. PACS was defined as posterior trabecular meshwork not visible in at least two quadrants on gonioscopy. UBM was performed in a supine position with imaging of the anterior chamber angle and ciliary body area in all 4 quadrants using P 40 machine (Paradigm Medical Industries, Salt lake city, UT) in one eye. Plateau iris was defined by the presence of all of the following: anteriorly directed ciliary body pushing iris anteriorly making it parallel to trabecular meshwork, steep iris configuration followed by downward angulation, absent ciliary sulcus and iridotrabecular contact. Patients were labeled to have plateau iris when this configuration was present in at least two quadrants.

Result: Eighty two subjects were enrolled with mean age (SD) of 54.2 (6.5) years, including 50 females and 32 males. Plateau iris was found in 22 (27%) eyes. Fourteen (26.8%) eyes had plateau iris in two quadrant and 8 (9.7%) eyes had plateau iris in three quadrants. 20 out of 22 patients with plateau iris showed this configuration in the superior quadrant and it was the most commonly involved quadrant.

Conclusion: Plateau iris was found in one-fourth of subjects with PACS in the Indian population using UBM.
DOPPLER IMAGING CORRELATION WITH QUANTITATIVE ANALYSIS BY OPTICAL COHERENCE TOMOGRAPHY IN PRIMARY OPEN ANGLE GLAUCOMA

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Background: The study investigates a correlation between retrobulbar haemodynamics and structural damages detected by retinal nerve fiber layer (RNFL) and optic disc defects in patients with primary open angle glaucoma (POAG).

Methods: 31 patients with POAG were included in this clinical study. Blood flow velocities (peak systolic velocity (PSV) and end-diastolic velocity (EDV)) of the ophthalmic artery, central retinal artery (CRA), posterior ciliary arteries (PCA) and central retinal vein were measured using colour Doppler imaging (Acuson Antares System, Siemens). Optic disc morphometry and RNFL defects have been assessed by Optical Coherence Tomography (OCT). The parameters of the optic nerve head (ONH) and retinal nerve fibre layer (RNFL) were used for analysis.

Results: The study shows: - a significant (p < 0.001) correlation of the PSV of the CRA with rim area. - a significant (p < 0.001) correlation of the minimum velocities of the CRV with RNFL thickness. - no correlation between flow velocities of the OA and of the PCA with morphometric parameters of the optic disc.

Conclusions: The reductions in flow velocities of the CRA and the central retinal vein emphasise the decreased retinal blood flow in POAG. The flow velocities of the CRA and of the CRV decrease with increasing optic disc damage in primary open angle glaucoma. RNFL thickness may be a better indicator, reflecting retinal ganglion cell function and monitoring disease progression.
WOW, WE FINALLY GOT A PACHY!
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Background: In 2002, the five-year report of the Ocular Hypertension Study (OHTS) was released. We read the study with rapt attention. Soon a lot of new studies highlighting the importance of Central Corneal Thickness (CCT) were published. CCT as a significant risk factor for glaucoma had been central to the discussion of its management in all these papers. Our hospital purchased a Pachymeter only in 2009. The reason for the delay was the limited resources available in a developing country. It was with bated breath that we started to analyze our patients with glaucoma with follow-up with us for 15 years. We wanted to see if pachymetry readings would have altered Intraocular Pressure (IOP) targets.

Methods: Field results of 40 glaucoma patients who had been with us for 15 years were analyzed. All of them had achieved target IOP set by us before we got a pachymeter. The patients were classified as thin corneas (< 555) thick corneas (> 555) and very thin corneas (< 500). They were further classified as showing field progression and having stable fields.

Results: None of the patients had progression in field defects at the end of 15 years. Two patients with very thin corneas had field progression (after 6th year and 8th year) while on treatment before the pachy value was known. The target IOP was revised and patients had stabilized at the end of 15 years. When pachy results could be obtained our clinical decision was shown to be correct. Our consultants had already stepped up treatment for patients with thin corneas even before we had pachymetry value.

Conclusion: Our study reinforces the strength of the correlation of CCT to the development of glaucoma over time. Though CCT is a very valuable tool, meticulous clinical examination with field charting can be good enough if lack of resources preclude the purchase of a pachymeter. Role of pachymetry becomes important if the patient does not follow up and meticulous ocular examination and field charting is not done at regular intervals.
CLINICAL EXAMINATION METHODS:
PROVOCATIVE TESTS
TOPICAL IBOPAMINE, D1-DOPAMINERGIC AGONIST, EVIDENCES THE IMPAIRMENT OF OUTFLOW PATHWAYS IN NORMOTENSIVE CHILDREN OF PRIMARY OPEN-ANGLE GLAUCOMA PATIENTS

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Background: The peculiar characteristics of ibopamine, a D1 dopaminergic agonist, at ocular level were evidenced in 1986 by Virno et al. at the Department of Glaucoma and Ocular Pharmacology of the University of Rome “La Sapienza”. It was shown that stimulation of D1-dopaminergic receptors implies an increase in intraocular pressure (IOP). Several clinical studies confirmed the utility of ibopamine in the diagnosis of Primary Open-Angle Glaucoma (POAG) to evaluate the functionality of aqueous humour outflow pathways. The test was positive in 96% of POAG patients and in 52% of Normal Tension Glaucoma patients, whilst it was negative in normal subjects without glaucomatous inheritance. Aim of the study was to show if topical ibopamine is able to evidence, by means of an increase in intraocular pressure (IOP), the eventual impairment of outflow structures in normotensive children, aged 8 to 40 years, of POAG parents.

Methods: Group 1: 163 children (326 eyes), aged 8 to 40 years, 88 females and 75 males, mean age 24.24 ± 11.17 years, of at least one POAG parent showing values of IOP lower than 18 mmHg during repeated tonometric curves and visual fields within physiological limits and presenting no glaucomatous-like changes at the level of the optic nerve; Group 2 (control): 108 children (216 eyes), aged 8 to 40 years, 60 females and 48 males, mean age 27.83 ± 7.23 years, of healthy parents without history or existing glaucoma. Ibopamine test was performed by instilling two drops, 5 minutes apart, in both eyes followed by repeated IOP measurements over a 45-minute period. The test was considered positive if there is an IOP increase \( \geq 3 \) mmHg after 45 minutes following instillation. Data were analyzed by the Student t-test for paired data and Pearson correlation test. P-values of 0.01 were considered statistically significant.

Results: Baseline IOP before ibopamine test was 14.61 ± 2.46 and 14.09 ± 2.17 mmHg in Group 1 and 2, respectively. The test was positive in 40% of cases in Group 1 with a mean IOP increase of 4.82 ± 1.46 (p < 0.01) after 45 minutes from instillation, while in all eyes of Group 2 the test was negative with even 1-2 mmHg IOP reduction (mean -0.74 ± 1.33 mmHg).

Conclusion: D1 dopaminergic stimulation due to ibopamine increases IOP as a consequence of reduced functioning of the outflow structures which becomes unable to maintain hydrodynamic balance. The study evidenced that the test was positive in 40% of normotensive children, aged 8 to 40 years, of at least one parent with POAG showing a statistically significant (p < 0.01) IOP increase following ibopamine administration, whilst in the control group of children of same age of healthy parents the test was negative. The positivity to the ibopamine test stands for an initial functional impairment of the outflow structures with still normal IOP with predictable predisposition to intraocular Hypertension and possible Glaucoma.
Objective: To compare the intraocular pressure (IOP) profiles and discomfort during the water drinking test (WDT) performed with 1000 mL and 650 ml of water.

Methods: This prospective and observational study included 25 patients (mean age 67.1 years, 64% female) with primary open-angle glaucoma under treatment. All patients underwent the WDT twice, first with 650 ml and two weeks later with 1000 ml, always at 10am. IOP was measured at baseline and patients were then instructed to drink the water in 10 minutes. IOP measurements were obtained three times, at 15-minute intervals. At the end of the study, each patient rated the discomfort related to water intake on a scale (0 to 10). Peak IOP agreement was analyzed with Bland-Altman plot, and discomfort scores were compared using Wilcoxon Signed Ranks test.

Results: Peak IOP with 1000ml occurred at 15 min. for 72% patients and with 650 ml at 30 min for 56% patients. Bland-Altman plot revealed a fixed bias of 0.6 for higher peak IOP in 1000ml test (95% limits of agreement -4.7 to 6.0). 56% patients had a difference in peak IOP on both tests smaller than 2 mmHg. Discomfort scores were smaller in 650ml test (0.68 vs 3.52, p < 0.001).

Conclusion: WDT with 1000 ml and 650 ml have moderate agreement in peak IOP. Patients found 650ml WDT more comfortable.
Fig 2: Bland-Altman plot of peak IOP with 95% limits of agreement.

- 1000 ml
- 650 ml
THE DARK ROOM TEST WITH A NEW DIAGNOSTIC CRITERIA AND CLASSIFICATION

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Background: The accuracy of the dark room test judged by intracocular pressure elevation and closed anterior chamber angle after 1 or 2 hours dark adaptation was questioned by many experts. Here we introduce a new diagnostic criteria and classification of the darkroom test in order to improve its diagnostic value in detecting primary closure of the anterior chamber angle and guide the treatment.

Methods: The cross-sectional observational clinical study included suspects of primary angle closure. Using ultrasound biomicroscopy (UBM), we measured the anterior chamber angle configuration at room light and after 3 minutes of dark adaptation. The number of closed angle quadrants assessed on UBM images at room light and after 3 minutes of dark adaptation were recorded. Perkin’s applanation tonometry were performed in room light conditions at baseline and after 1.5 hours of dark adaptation. The dark room test was positive, if intracocular pressure increased by ≥ 8 mmHg after 1.5 hours of dark adaptation. After the test, the eyes were divided into 5 levels according to the number of closed angle quadrants.

Results: The study included 79 subjects (79 eyes). The dark room test was positive in 38 (48%) eyes. The number of closed angle quadrants was significantly higher for the UBM examination performed at 3 minutes of dark adaptation (2.41 ± 1.17) than at room light condition (1.76 ± 1.19), t = -6.65 p = 0.00; the area under the receiver operating characteristics (ROC) curve indicated a significantly diagnostic value for UBM detected closed angle after 3 minutes dark adaptation (0.89; p < 0.001) in predicting a positive dark room test. After test, there were a total of 40 eyes whose closed angle quadrants reached 3 or 4 (approximately grades IV or V using the new grading system), indicated the need for treatment.

Conclusions: The dark room test with the new diagnostic criteria and classification had a higher diagnostic precision in predicting primary angle closure and provides guidelines for treatment.

Key Words: Dark room test; Primary angle closure glaucoma; Primary angle closure; ultrasound biomicroscopy (UBM)
CLINICAL EXAMINATION METHODS: TELEMEDICINE
Background: The traditional model for the care of patients with glaucoma and ocular hypertension in the UK has been Hospital Eye Service (HES) based. Changes in population demography with a larger representation of elderly people have resulted in an increased demand for glaucoma care, services coming under pressure, and the build-up of a significant backlog of patients waiting to be seen for review. Not unreasonably, innovative ways of working using different professional groups in a variety of clinical settings have been suggested. We have developed a novel model with patients being seen in an Ophthalmic Diagnostic and Treatment Centre (ODTC) by members of professions allied to medicine (PAMs - optometry, nursing and orthoptics), using a bespoke electronic patient record (EPR, for clinical findings, visual fields and optic disc imaging) without the physical presence of an ophthalmologist. Clinical advice and quality assurance are provided by a glaucoma specialist consultant ophthalmologist working in a virtual clinic environment.

The aims of this study were to survey the patient experience for those attending the ODTC, their overall impressions of a new system for care, their interactions with the practitioners and the feasibility of providing practitioner support via a specialist in a virtual clinic.

Methods: A QUOTE-type questionnaire survey was administered to patients attending the ODTC. For the purposes of proper comparison with existing patterns of working, a control group was chosen consisting of patients seen within the HES, by non-medical staff, but with ophthalmologists (including consultants with a special interest in glaucoma) available for real-time advice. Thus all patients were seen by PAMs and no patient in person by an ophthalmologist.

Results: 137 consecutive patients provided questionnaire returns. The responses confirmed a high standard of professionalism in practitioner-patient contact for all groups. Essentially patients do not mind where they are seen or by what kind of practitioner as part of their overall package of care. A minority expressed a preference to be seen by an ophthalmologist in person. 55% of the patients seen in the ODTC environment were judged by both the practitioner and the virtual clinic reviewer as suitable for return to the ODTC for their next assessment. 33% of ODTC patients’ PAM consultations received input from the virtual consultant. 90% of patients were happy to continue with some care in the ODTC. Practitioners were unanimous in expressing professional satisfaction with ODTC working. Virtual clinic review time per patient averaged less than five minutes.

Conclusion: Patients with glaucoma and ocular hypertension may be seen in the absence of the physical presence of an ophthalmologist by using the skills of members of various professions allied to medicine. Patients find this experience highly acceptable.
CLINICAL EXAMINATION METHODS: PROGRESSION
(STRUCTURE AND/OR FUNCTION)
PERIPAPILLARY ATROPHY CHARACTERISTICS IN PATIENTS WITH DIFFERENT FORM OF PRIMARY OPEN GLAUCOMA
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\textbf{Purpose:} To define features of the progression peripapillary atrophy in patients with POAG and NTG.

\textbf{Methods:} The retrospective study conducted in ophthalmology department of the Mandryka 2\textsuperscript{nd} Clinical Hospital (Moscow) from April to June 2010. Sixty five patients (106 eyes, average age 64.72 ± 4.16 years) with POAG and NTG were included. All patients were underwent computerized retinotomography.

\textbf{Results:} Statistically significant increase of PPA area in patients with moderate and advanced stages of glaucoma were defined. We determined that supra-nasalis sector in early stage NTG was significant greater than similar in POAG (0.1 and 0.07 respectively; \( p < 0.05 \)), and nasalis and temporalis sectors in moderate stage NTG was significant greater than similar in POAG (\( p < 0.05 \)).

\textbf{Conclusion:} Retinotomography may be proposed as method of calculation PPA area (beta-zone) in glaucoma patients. Observed data dictate necessity for more attention to nasal hemisphere of optic nerve disc in NGT patients. OND of patients with advanced stages of POAG characterized by greater size that may be both independent risk factor of disease and evidence of transformation in the structure of the disc from stage to stage (pathological «flattening effect»).
ABSTRACT WITHDRAWN
THE EFFECT OF PATTERNED SCANNING LASER PHOTOCOAGULATION ON PERIPAPILLARY RETINAL NERVE FIBER LAYER THICKNESS AND OPTIC DISC MORPHOLOGY IN DIABETIC RETINOPATHY
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Background: To determine the effect of patterned scanning laser photocoagulation with short exposure time on retinal nerve fiber layer (RNFL) thickness and optic nerve morphology in patients with diabetic retinopathy.

Methods: In a prospective controlled study, total 84 eyes (53 patients) were included. We measured peripapillary RNFL thickness and cup/disc ratio using optical coherence tomography before and 2 months, 6 months and 12 months after patterned scanning laser photocoagulation in study group and baseline and 6 months and 12 months later in control groups. The relationship between changes of the RNFL thickness and cup/disc ratio and number of laser burns and any other factors were analyzed.

Results: Subjects included 35 eyes for a study group and 49 eyes for a control group. The RNFL thickness of study group changed -2.90 ± 27.19 µm in 2 month, +1.57 ± 13.71 µm in 6 months and +7.36 ± 11.74 µm in 12 months after laser compared to baseline RNFL thickness. In control group, the RNFL thickness changed +1.23 ± 10.89 µm in 2 months, -2.65 ± 10.80 µm in 6 months and -3.02 ± 11.93 µm in 12 months, respectively. However, the changes between the two groups were not statistically significant (p = 0.45, 0.10, 0.25). Optic disc morphology such as C/D area ratio and C/D ratio were not changed after patterned scanning laser photocoagulation.

Conclusion: The peripapillary RNFL thickness was not changed in patients with diabetic retinopathy treated with patterned scanning laser photocoagulation with short exposure time. These finding suggests that shorter pulse duration in patterned scanning laser photocoagulation would contribute to less damage in inner retinal layer in patients with diabetic retinopathy.
A MODEL TO PREDICT GLAUCOMATOUS VISUAL FIELD PROGRESSION USING BASELINE CLINICAL DATA
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Background: There is no accepted clinical prediction model to predict the rate of glaucomatous visual field progression. The aim of this preliminary study is to investigate the performance of a systematically developed prediction model for glaucomatous visual field progression using easily available baseline data.

Methods: Open-angle glaucoma patients were consecutively collected from three Dutch hospitals from 2001 to 2003. All patients were treated with topical glaucoma medication at baseline. Baseline data were collected and patients received routine follow-up examinations until 2010. We included 333 eyes of 333 glaucoma patients with at least two reliable visual field examinations during the follow-up period and calculated their rate of progression using the Visual Field Index (VFI). We built a model to predict the VFI rate of progression using a linear regression analysis and univariate pre-selection (p < 0.1) of eight candidate predictors. The performance of the final model was investigated using $R^2$, the concordance statistic, and calibration plots. Clinical usefulness was assessed with decision curves. The model was internally validated with the use of 200 bootstrap samples.

Results: During a mean follow-up period of 6.2 years, a mean of 5.9 visual fields were performed for each study eye. The mean rate of VFI progression was -1.9% (±3.4) per year. The final internally validated model contained the following predictors: age (-0.04% per year older), baseline intraocular pressure (IOP) (-2.01% for an IOP > 21 mmHg), and baseline visual field status (-1.24% for moderately and -1.58% for severely affected visual fields). In our population, 10.3% of the observed variation in VFI rates was explained by the model. When the prediction model was used to detect a VFI rate ≤ -3% per year, the optimism-corrected concordance statistic was 0.75.

Conclusion: The rate of visual field progression can be predicted with the use of easily available baseline predictors. The model seems to be clinically useful to indicate subgroups of patients with high rates of visual field progression.
THE TOPOGRAPHIC RELATIONSHIP BETWEEN STRUCTURAL AND FUNCTIONAL RATES OF GLAUCOMATOUS PROGRESSION
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Objective: To evaluate the topographic association between rates of visual field loss and progressive optic disc change in glaucoma.

Methods: The study included 939 eyes of 518 individuals with suspect or established glaucoma followed up for an average of 8.0 ± 4.1 years with annual standard automated perimetry visual field and optic disc stereophotographs. Visual fields were divided into 6 topographic locations according to a map proposed by Garway-Heath et al. The presence and location of progressive optic disc damage was graded by masked assessment of longitudinally acquired simultaneous stereophotographs by 2 graders. Linear mixed models were used to evaluate the relationship between progressive damage on the six optic disc sectors and the corresponding visual field locations sectors.

Results: 169 (18%) of the 939 eyes had progressive optic disc change during follow-up. Eyes that had optic disc progression had a faster rate of change in visual field mean deviation compared to non-progressors (-0.195 dB/year vs. -0.043 dB/year, respectively; p < 0.001). Optic disc progression was situated most frequently in the inferotemporal sector (n=113), followed by the superotemporal (n = 72), superonasal (n = 51), inferonasal (n = 32), nasal (n = 29), and temporal (n = 26) sectors. There was a significant relationship between the location of optic disc changes and the location of progressive visual field loss.

Conclusion: Eyes with progressive optic disc damage had faster rates of visual field progression. There was an association between structural and functional localization of glaucomatous progression.
PRIMARY ANGLE CLOSURE: CLINICAL PRESENTATION, SEVERITY AND PROGRESSION IN MALAYS


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Background: Higher prevalence of angle closure and angle closure glaucoma has been reported in Asians especially among Chinese. There is lack of clinical knowledge on angle closure in Malay population.

Methods: A retrospective record review was conducted involving patients diagnosed with primary angle closure glaucoma (PACG), primary angle closure (PAC) and primary angle closure suspect (PACS) in two main tertiary hospitals in Kelantan, Malaysia from January 1993 to June 2010, with at least 5 years follow up from initial presentation. The details of initial presentation including sign and symptoms at presentation, presence of acute attack, intraocular pressure (IOP) measured by using Goldman applanation tonometer, visual acuity using Snellen chart, gonioscopic evaluation, slitlamp biomicroscopic finding, initial documentation on vertical cup to disc ratio and Humphreys visual field (24-2 or 30-2) were recorded. The selected cases were rediagnosed based on the current definition of angle closure (Foster et al, 2000). The progression from PACS to PAC or PAC to PACG was based on HVF and VCDR. The severity of PACG was defined based on HODAPP classification. Stepwise multiple logistic regression test was used to determine predictors affecting progression of angle closure in Malays residing in Malaysia.

Results: A total of 200 eyes (100 patients) were included with 3:1 female to male ratio. The mean age at the initial presentation was 61.43 SD 8.42 years old. Majority were asymptomatic with only 47% presented with acute attack. 135 eyes (67.5%) presented with PACG and 91 eyes were in advanced stage with 34% presented with visual acuity worst than 6/60. Fourteen eyes were already blind at initial presentation. Based on stepwise multiple logistic regression, the absence of laser peripheral iridotomy increased the risk of progression to 8.5 times (95% CI; 1.47, 48.51). The improvement of mean deviation of visual field (less negative value) demonstrated protective effect against progression of the disease (OR 0.87; 95% CI 0.83, 0.93).

Conclusion: Primary angle closure is not uncommon among Malays. Majority presented with chronic asymptomatic type of disease and associated with higher risk of blindness. Laser peripheral iridotomy confers protective effect against progression of the disease. Public awareness and early diagnosis is important in prevention of blindness in Malays.
THE CHANGE OF OPTIC NERVE HEAD AND RETINAL NERVE FIBER LAYER AFTER PANRETINAL PHOTOCOAGULATION IN PATIENTS WITH DIABETIC RETINOPATHY
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Purpose: Primary outcome: To evaluate the change of optic nerve head [ONH] parameters and retinal nerve fiber layer [RNFL] after panretinal photocoagulation [PRP] in patients with diabetic retinopathy[DR]. Secondary outcome: To study the effect of PRP on macular thickness in diabetic retinopathy

Patients and method: This is a prospective, non-comparative study of 29 eyes from 22 patients with Type 2 Diabetes Mellitus. All eyes were eligible for PRP due to severe non-proliferative DR [NPDR] or proliferative DR [PDR] without pre-existing glaucoma suspected ONH or any ocular diseases affected ONH. After completed ophthalmoscopic examination, PRP was performed in several occasions until considered adequate. Retinal nerve fiber layer and ONH were evaluated with Heidelberg Retinal Tomography version 2.0 [HRT II] and macular thickness was recorded with Optical Coherence Tomography before PRP and at 3,6,12 months after PRP.

Results: There were 12 males and 10 females with the mean age of 51.4 years [range 38-72]. Twenty-two eyes [75.9%] had PDR and 7 eyes [24.1%] had severe NPDR. Among all eyes, there were 5 eyes [17.2%], which clinically significant macular edema was observed at presentation. After PRP, mean cup to disc [C:D] ratio was not significantly change [p = 0.81]. The mean RNFL thickness was slightly increased from 0.191 ± 0.118 µm before PRP to 0.198 ± 0.130 µm after PRP at last visit but the difference was not statistically significant [p = 0.69]. Mean central macular thickness after PRP (265.08 ± 71.38 µm) was significantly greater than before PRP (235.69 ± 69.98 µm) [p = 0.026]. Mean foveal thickness was also significantly increased after PRP [p = 0.04]. Mean follow-up was 31.2 ± 19.3 weeks.

Conclusion: The RNFL thickness and C:D ratio were not significantly change after PRP measured with HRT II. Macular and foveal thickness was significantly increased after PRP.
Background: To compare the rates of progression (ROP) of visual field (VF) loss in primary open angle glaucoma (POAG) and primary angle closure glaucoma (PACG) and to analyze the risk factors associated with increased ROP.

Methods: In a clinic-based, retrospective study, we analyzed the data of all POAG and PACG patients who had more than 5 VFs between 1989 and 2008 and were treated by a single physician. Guided Progression Analysis software which provides the rate of progression (ROP) of Visual Field Index per year was used to assess the rate of VF progression. ROP in POAG eyes was compared with that in PACG eyes. Associations between ROP and risk factors for progression namely age, sex, presence of systemic hypertension and diabetes, severity of VF loss (mean deviation on VF) at presentation, number of antiglaucoma drugs at last follow-up, number of VF examinations during follow-up, total follow-up duration, mean intraocular pressure (IOP), maximum IOP and IOP fluctuation during follow-up were analyzed using multivariate regression models separately in POAG and PACG eyes.

Results: VFs of 234 eyes of 151 POAG and 146 eyes of 101 PACG patients were analyzed. Mean (± standard deviation) age of POAG patients (54.3 ± 12.7 years) was similar (p = 0.57) to that of PACG patients (55.1 ± 10.1 years). There were more females (40/101 vs. 34/151, p = 0.004) in PACG group. MD at presentation in POAG group (-12.01 ± 8.38 dB) was similar (p = 0.60) to that in PACG group (-11.53 ± 8.87 dB). Mean number of antiglaucoma drugs were similar (p = 0.82) in POAG (1.08 ± 0.70) and PACG (1.06 ± 0.94) groups. Mean follow-up was similar (p = 0.06) between POAG (7.3 ± 3.4 years) and PACG (6.7 ± 2.5 years) groups. Maximum IOP (20.29 ± 3.60 mmHg vs. 19.49 ± 3.88 mmHg, p = 0.04) and IOP fluctuation (2.90 ± 1.23 mmHg vs. 2.62 ± 1.31 mm Hg, p = 0.04) during follow-up were significantly greater in the POAG compared to the PACG group. The ROP in POAG group was -1.20 ± 2.16% per year. ROP in PACG patients was -1.18 ± 2.08% per year. There was no difference (p = 0.93) in the ROP between POAG and PACG patients. None of the risk factors analyzed were significantly associated with increased ROP in POAG eyes while increasing age (β = -0.03, p = 0.04) and greater number of antiglaucoma drugs (β = -0.52, p = 0.01) were associated with increased ROP in PACG eyes.

Conclusions: In this clinic-based cohort with a long follow-up, ROP of VF loss in PACG was comparable to that in POAG.
PERFORMANCE OF THE VISUAL FIELD INDEX (VFI) ACROSS THE SPECTRUM OF GLAUCOMA SEVERITY


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Background: The Visual Field Index (VFI) provides an estimate of the severity of visual field (VF) loss and was developed to estimate the rate of change in visual function over time. It ranges from 0% (perimetrically blind) to 100% (normal). The VFI is based on the pattern deviation plot (less sensitive to diffuse loss) and places more weight on central, compared to peripheral VF locations. Early glaucomatous defects, however, typically occur in peripheral locations. The goal of this study was to assess the performance of the VFI across a broad range of VF severity. We hypothesized that while the VFI may show strong correlations with other measures of VF severity overall, it may not be sensitive to early glaucomatous VF loss.

Methods: In this cross-sectional study, visual function was assessed in one eye of 89 participants selected from the Indianapolis Glaucoma Progression Study. All participants had primary open-angle glaucoma based on clinical examination. Participants had at least three reliable (less than 33% fixation losses, false positive and false negative errors) standard automated perimetry tests using the Swedish Interactive Thresholding Algorithm 24-2 program. The data from the third test were used to minimize the impact of learning effects. Each VF was reviewed for quality, and VF tests with artifacts were excluded. The VFI, Advanced Glaucoma Intervention Study (AGIS) score, mean deviation (MD), and the number of total (TD) and pattern deviation (PD) points triggered at < 5% and < 1% were derived. Two analyses were performed. 1) The overall association (R²) between the VFI and each parameter was assessed. 2) The VFs were binned into groups based on 5% VFI intervals. We assessed the outcome of the Glaucoma Hemifield Test (GHT) (borderline outcomes were considered normal), abnormal PSD (< 5% or worse) and the VF status (normal/abnormal; abnormal defined as PSD < 5% or worse or GHT outside normal limits) within each VFI bin.

Results: The overall associations (R²) between the VFI and each of the parameters were: 0.89 (MD), 0.88 (PD < 1%), 0.84 (AGIS), 0.79 (PSD), 0.73 (PD < 5%), 0.72 (TD < 1%), 0.48 (TD < 5%) (all slopes were significant at p < .0001). All VFs in bins with a VFI ≤ 90% had GHTs outside normal limits. 69% (11/16) of VFs in the 91-95% VFI bin, and 11% (6/53) of VFs in the 96-100% VFI bin, had a GHT outside normal limits. All VFs in bins with a VFI ≤ 95% had a PSD < 5% or worse and were abnormal (based on the PSD or the GHT). In the 96-100% bin, 36% (19/53) of VFs had a PSD < 5% or worse, and 38% (20/53) of VFs were abnormal.

Conclusions: The results of this study show that overall, the VFI correlates relatively well with other measures of visual field severity. However, visual fields with VFI values higher than 90% show a wide range of severities on other measures. This reduces the ability of the VFI to detect glaucomatous visual field progression in the early stages of the disease.
CLINICAL EXAMINATION METHODS: OTHER
ABILITY OF RAPD TO DETECT GLAUCOMATOUS OPTIC NEUROPATHY
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Background: In its early and moderate stages, glaucoma often causes asymmetric damage to the two eyes. Such asymmetry should yield a relative afferent pupil defect (RAPD). This is detected relatively simply with a swinging torch test. We investigated the correlation of a detected RAPD with standard automated perimetric indices and retinal nerve fibre thickness (RNFL) as measured by optical coherence tomography (OCT).

Methods: For this prospective observational study, we enrolled 204 consecutive glaucoma patients in a Glaucoma hospital clinic. Exclusion criteria were best corrected visual acuity less than 6/18, chronic miotic therapy, pathological mydriasis, previous intraocular surgery or laser treatment and any ocular or neurological disease affecting pupil reactivity. Inclusion criteria were any type of glaucoma. The demographic profile, best corrected visual acuity (BCVA), intraocular pressure, cupping as noted by 90 D examination, Humphrey field indices and RNFL thickness by OCT were recorded. Patients were examined for RAPD by the swinging torch method and graded as follows:
Grade 1 - a weak initial constriction and greater dilatation;
Grade 2 - an initial stall and greater re-dilatation;
Grade 3 - an immediate dilatation.

Results: Forty patients among 204 with glaucoma demonstrated a RAPD. Twenty patients had Grade 1, 13, Grade 2 and 7, Grade 3. The mean age of patients with RAPD (RAPD +ve) was 67.1 ± 10.6 SD, that of 164 patients without RAPD (RAPD -ve) was 67.03 ± 11.8 SD (p > 0.05). In the RAPD +ve patients, the mean scores of the study variables such as Mean Deviation (MD), Pattern Standard Deviation (PSD) and RNFL thickness were significantly different (p < 0.05) between the RAPD affected and unaffected eyes. The mean MD (-10.91 ± 9.27 vs -3.89 ± 4.99) and RNFL average (64.54 ± 0.1576 vs 82.28 ± 13.01) scores were significantly lower (p < 0.05) and the PSD scores (7.45 ± 3.98 vs 3.43 ± 2.88) were significantly higher (p < .05) in RAPD affected eyes. The mean BCVA score in the RAPD affected eye was 0.71 ± 0.28, significantly lower (p < 0.05) than unaffected eyes (0.84 ± 0.26). The mean CDR in RAPD affected eyes (0.85 ± 0.08) was significantly higher (p < 0.05) compared with the unaffected eyes (0.63 ± 0.16). The IOP score was not significantly different (p > 0.05): RAPD affected (15.6 ± 5.16) versus unaffected eyes (14.6 ± 3.59). Similar analyses of these variables in RAPD -ve patients showed no statistically significant differences (p > 0.05) between the eyes. The mean inter eye difference of all the variables when compared between the groups was significant (p < 0.05). In RAPD +ve patients, the comparison of MD PSD and RNFL between Grade 1 (20 patients) and combined Grades 2 & 3 (20 patients) demonstrated that inter-eye differences increase with increased severity of RAPD and these were statistically significant.

Conclusion: RAPD correlated with the extent of asymmetry between both functional (visual field indices) and structural (RNFL thickness analysis) glaucoma damage. This might prove useful in screening for glaucoma by health care workers outside eye care.
PECULIARITIES OF THE CICATRIZATION OF INCISION AFTER THE NON PENETRATING DEEP SCLERECTOMY AMONG PATIENTS WITH GLAUCOMA AND DIABETIC POLYNEUROPATHY
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Background: The risk of resistant glaucoma development is increased in patients with diabetes mellitus, that often leads to the surgery. It is known that vegetative nervous fibres influence on the wound epithelization. Diabetic patients suffer from an early affect of sensitive and vegetative nervous, that can cause a change of epithelization of incision after a non penetrating deep sclerectomy in patients with glaucoma. The aim was to study the cicatrization of incision after the non penetrating deep sclerectomy among patients with glaucoma and diabetic polyneuropathy.

Methods: 22 patients with glaucoma and diabetic polyneuropathy and 27 patients with glaucoma without diabetes mellitus were made the non penetrating deep sclerectomy. Research methods were Corneal Confocal Microscopy, esthesiometry, pupil cycle time, Schirmer, Jones and Norn test.

Results: In patients with glaucoma and diabetic polyneuropathy the epithelization time and the degree of eye inflammation reaction on the non penetrating deep sclerectomy were higher than in patients with glaucoma without diabetes mellitus (p = 0.007 and p = 0.01). Violations of vegetative innervation were also marked in patients with glaucoma and diabetic polyneuropathy due to an increase of pupil cycle time, decrease of corneal sensitivity, reducing of corneal nervous fibres, and also decrease of

Conclusions: In patients with glaucoma and diabetic polyneuropathy the defeat of vegetative nervous fibres and an increase of epithelization time are noted after the non penetrating deep sclerectomy.
ABSTRACT WITHDRAWN
COMPARISON OF PACHMATE ULTRASOUND, PENTACAM AND RTVue OPTICAL COHERENCE TOMOGRAPHY TO MEASURE CENTRAL CORNEAL THICKNESS
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Background: This is the first study to compare fourier domain optical coherence tomography (FDOCT) with ultrasound and Pentacam.

Methods: In this comparative study, 100 normal corneas of 50 patients with no previous corneal surgery were measured.

Results: The mean central corneal thickness measured by ultrasound was 557.4 microns. The mean by FDOCT was 534.1 and Pentacam was 573.1.
On average FDOCT read 23.3 microns thinner than ultrasound (95%CI: 19.7-26.9). The Bland Altman plot showed a random scatter with FDOCT mostly thinner.
On average Pentacam read 15.73 microns than ultrasound (95%CI: 21.2, 10.2). The Bland Altman plot showed a random scatter with Pentacam mostly thicker.

Conclusion: Accurate measurement of the central cornea is important for the evaluation of patients with glaucoma and those wishing to undergo refractive surgery. This study emphasises the differences in measurements obtained and that readings should not be used interchangeably.
NAIL BED HEMORRHAGE: A CLINICAL MARKER OF OPTIC DISC HEMORRHAGE IN GLAUCOMA PATIENTS
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Purpose: To find the characteristics of nailfold capillary changes in glaucoma patients and analyze the relation to clinical characteristics of glaucoma.

Methods: Hundred and eight glaucoma patients and 38 controls were enrolled in the study. Eighty six patients were classified as normal tension glaucoma (NTG) and 22 patients as primary open angle glaucoma (POAG). All subjects underwent a complete ophthalmic examination and then the subjects were referred to Rheumatology, and underwent a complete physical examination and questioned regarding a history of systemic symptoms. Nailfold capillaroscopy were carried out and analyzed by a single observer in a masked manner. Chi-square and multivariate logistic regression analysis were performed to determine which ocular characteristics were associated with the findings of nailfold capillaroscopy.

Results: In the glaucoma patients, 55.6% showed dilated vessels, 35.2% showed loss of capillaries, and 19.4% showed nail bed hemorrhages by nailfold capillaroscopy. Disc hemorrhage was significantly associated with avascular area (OR, 11.133; p < 0.001) and nail bed hemorrhage (OR, 81.592; p < 0.001). By multivariate logistic regression analysis, avascular area and nail bed hemorrhage continued to be independently associated with the presents of disc hemorrhages in glaucoma patients. No significant differences of association were found between NTG and POAG.

Conclusions: Nailfold capillaroscopy may give valuable information of some features of glaucoma patients. Nail bed hemorrhage and loss of nail capillaries were strongly associated with the presence of optic disc hemorrhage and the association was stronger with nail bed hemorrhage. No difference were observed between NTG and POAG patients.
Background: the pressure to cornea index (PCI) was proposed in order to integrate intraocular pressure and central cornea thickness as a single risk factor for glaucoma. The purpose of the study was to correlate the PCI with a structural and two functional measures of glaucoma.

Methods: PCI was calculated for 70 eyes of 36 subjects (glaucoma and suspects). Cup-to-disc ratio (C/D), mean deviation (MD) and pattern standard deviation (PSD) as recorded by Humphrey automated perimetry (SITA 24-2) were correlated with PCI (Pearson correlation coefficient).

Results: Pearson’s correlation coefficient between PCI and C/D was 0.329 (95% IC, 0.099 to 0.526, p = 0.006); between PCI and MD was 0.356 (95% IC, 0.126 to 0.549, P = 0.003); and between PCI and PSD was - 0.215 (95% IC, - 0.433 to - 0.025, p = 0.07).

Conclusion: In addition to serve as a single risk factor, PCI can be used to stage glaucoma severity or as surrogate biological marker in glaucoma.
THE RELATIONSHIP BETWEEN OCULAR RIGIDITY AND CORNEAL PARAMETERS IN GLAUCOMATOUS EYES

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Background: Ocular rigidity, as described by Friedenwald, is a biometric parameter, which may reflect the stiffness or the elasticity of the eye globe. Corneal hysteresis measurement indicates the biomechanical properties of the cornea. We studied the correlation between ocular rigidity, corneal hysteresis (CH) and central corneal thickness (CCT) in glaucomatous eyes.

Methods: We evaluated the ocular rigidity, CH and CCT in 55 eyes of 55 patients with treated primary open angle glaucoma (age 38-77 y), with refractive errors/astigmatism between +2.0 and -2.0 dpt and without any previous ocular surgery. Using the Schiotz tonometer, three consecutive measurements with 5.5 g and 10 g weights respectively were obtained from each eye. The mean values were applied on the Friedenwald’s diagram, which enables the calculation of ocular rigidity coefficient (ORC). CH was determined by the Ocular Response Analyzer and CCT was measured by an ultrasound pachymeter. ORC, CH and CCT values from one eye of each subject, selected in a randomized order, were compared and statistically analyzed (Pearson’s correlation coefficient).

Results: Mean IOP was 16.4 ± 2.5 mmHg. Mean value and standard deviation of ORC, CH and CCT were 0.017 ± 0.006, 9.3 ± 1.5 mmHg and 531.6 ± 33.7 µm respectively. We found a statistically strong positive correlation between ORC and CH (correlation coefficient r = 0.68, p < 0.001)). ORC showed a weaker, but significantly positive correlation with CCT (correlation coefficient r = 0.33, p < 0.05).

Conclusions: In eyes with treated primary open angle glaucoma CH was significantly associated with the ocular rigidity. Ocular rigidity as a concept may rather express the viscoelastic properties of the eye, than its stiffness or elasticity. CH could be further studied as an indicator for the biomechanical properties of the corneoscleral shell.
COMPARATIVE STUDY OF RETINAL NERVE FIBRE LAYER THICKNESS IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA/HYPOPNEA SYNDROME WITH AND WITHOUT GLAUCOMA

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Purpose: To analyze the quantitative changes in retinal nerve fibre layer (RNFL) thickness, evaluated with spectral-domain optical coherence tomography (OCT), in obstructive sleep apnoea syndrome (OSAS) patients with and without glaucoma.

Material and Methods: Prospective study of 52 eyes of 26 patients with severe OSAS. A comprehensive ophthalmological examination and additional tests was carried out, including RNFL thickness measured with OCT. According to the findings in the visual field and the optic nerve head morphology, the eyes were classified in those with glaucomatous damage and healthy. RNFL thickness was compared between both groups.

Results: Seventeen men and 9 women were included. The average age was 59.65 years. Of 52 eyes, 13 were diagnosed of glaucoma. The average global RNFL thickness in eyes with glaucoma was 311.23 microns whereas in healthy eyes it was 380.36 microns (p 0.024). The major difference was found in the inferior sector (90.38 microns in sick eyes opposite to 116.36 microns in healthy, p 0.151).

Conclusions: OCT findings has showed differences in RNFL thickness between eyes with and without glaucomatous optic neuropathy in patients with OSAS. The most quantitative difference between healthy eyes and those with glaucoma in early stages was in the inferior quadrant.