Diagnostic Imaging Assessment in the Evaluation of Glaucomatous Optic Neuropathy

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BACKGROUND

Glaucoma is a progressive optic neuropathy characterized by the loss of retinal ganglion cells resulting in constrictions of visual field and loss of vision as the disease progresses. It was estimated that there were 66.8 million people who suffered from glaucoma world-wide and half of them were East Asians1. An epidemiology study in Chinese population revealed the prevalence of glaucoma was 3.2% in the age group over 40 and glaucoma was the leading cause of blindness2. Early diagnosis of glaucoma is imperative to prevent visual loss through early interventions by medications, laser and surgical procedures to reduce the rate of disease progression. The diagnosis of glaucoma has been relied on the structural evaluations of the optic nerve head and the retinal nerve fiber layer (RNFL) and the functional assessment of visual sensitivity by standard automated perimetry (SAP). Nevertheless, clinical examination of the optic nerve head or the RNFL allows essentially a qualitative assessment. It is for this reason that objective and quantitative evaluations of the structural changes in glaucoma are of great importance in terms of establishing the diagnosis, monitoring the progression and initiating treatment before irreversible damage takes place. A number of different imaging modalities for measurement of optic nerve head parameters and RNFL are currently under active research to serve these purposes.

Optical coherence tomography (OCT), scanning laser polarimetry (SLP) and confocal scanning laser ophthalmoscopy (CSLO) are three commercially available imaging technology for measurements of optic nerve head parameters and RNFL thickness. The design of OCT was based upon the principle of low-coherence interferometry and measurement was determined by the time-of-flight delay from backscattering signals of the retina, analogous to an ultrasound B scan.3 For SLP, the nerve fiber layer phase retardance was measured and a fixed conversion factor is used to calculate the RNFL thickness in μm.4 CSLO works by scanning the retinal surface sequentially in horizontal and vertical directions at multiple focal planes.5 It was designed specifically for the evaluation of the optic nerve head and provides topographic information about the disc. The merits of OCT, SLP and CSLO have been recognized as non-invasive, non-contact and pose no known risk to the examined subjects. These imaging technologies are thus potentially useful for diagnosis and monitoring the progression of glaucoma.
In terms of detection of functional change in glaucoma, two new technologies have been recently developed to allow early detection of visual field loss – the short wavelength automated perimetry (SWAP) and the frequency doubling perimetry. SWAP uses a yellow background and a blue target stimulus. It targets the koniocellular pathway projecting from “blue on” cells in the retina. FDT utilises a test stimulus made up of alternating light and dark lines, with low spatial frequency and high temporal frequency. It was designed to stimulate selectively the magnocellular pathway. Because of little anatomic and physiologic redundancy in these pathways, it was found that SWAP and FDT can detect glaucomatous visual field loss earlier than conventional white-on-white perimetry.\(^6\)\(^8\)

Nevertheless, it is still uncertain whether these visual field tests provide better diagnostic power for early detection of glaucoma compared with structural assessment using the modern imaging devices. Analyses of functional versus structural changes, cross-sectionally and prospectively, would provide the ultimate answer to the selection of the most appropriate strategy for the detection and monitoring of glaucomatous changes.

**OBJECTIVES**

The objective of this study is to assess and compare the functional and structural changes in glaucomatous optic neuropathy using the latest technologies for examination of the visual field, optic nerve head and RNFL. The study comprises cross sectional and prospective follow-up studies. The primary goal of the cross-sectional analysis is to compare the diagnostic performance and the structure function relationship of each of the testing technology whereas the objective of the prospective follow-up studies is to identify the most sensitive strategy for monitoring glaucoma progression. In addition, the study will examine if progressive RNFL thinning measured with the spectral-domain OCT is predictive of development of visual field loss in glaucoma and determine if the association between progressive RNFL thinning and subsequent visual field progression is related to the stages of glaucoma. The patterns and the rates of change of the RNFL and optic nerve head parameters in glaucoma progression will be investigated. Finally, potential risk factors of glaucoma development and progression such as intraocular pressure, corneal biomechanical responses and other biometric variables (axial length, refractive errors, central corneal thickness) will be investigated.
METHODS
Approximately 400 normal, 100 glaucoma suspect and 400 glaucoma individuals, meeting the inclusion criteria (see below) will be enrolled in the study. Recruited subjects are newly referred or having regular follow-up in Hong Kong Eye Hospital. Eligible subjects will also be recruited using a promotional leaflet and Facebook post with a questionnaire for registration attached. In a subset of the normal group, healthy myopic subjects attending the Hong Kong Eye Hospital CUHK Refractive Surgery Clinic are included. All participants will undergo a full ophthalmic examination including visual acuity, biometry including refraction, central corneal thickness and axial length, intraocular pressure measurement with dynamic contour tonometer (DCT), ocular response analyzer (ORA), pneumotonometry (Palm Scan T2000 Tonometer) and Goldmann applanation tonometry (GAT), corneal deformation response measurement with the Corvis ST (Oculus) and dilated fundus examination with stereoscopic biomicroscopy of optic nerve head under slit-lamp and indirect ophthalmoscopy. The inclusion criteria were best corrected visual acuity of not worse than 20/40. Individuals were excluded if they had history of any retinal disease, surgery or laser procedures, diabetes mellitus, or neurological diseases. Normal subjects were individuals who visited the clinic during the same recruitment period and diagnosed to have no ocular or intraocular diseases. In particular, they had no visual field defect based on the Humphrey visual field results, no structural optic disc abnormalities and no history of intraocular pressure measured more than 21mmHg. Glaucoma suspect consisted of individuals with ocular hypertension and / or pre-perimetric glaucoma. Ocular hypertension was defined as having intraocular pressure greater than 21mmHg measured in at least three separate visits. Patients were diagnosed to have pre-perimetric glaucoma when they presented with asymmetric cup disc ratio of more than 0.2 and showed early glaucomatous optic disc changes including thinning of neuroretinal rim and notching. However, all subjects belonging to the glaucoma suspect group had normal visual field results as in the normal group. Glaucoma patients were diagnosed based on the presence of visual field defects (see below). All selected participants will have routine clinical examinations in the eye clinic, together with visual field, RNFL and optic nerve head measurements (see below) at least once a year to monitor the functional and structural changes. In one follow-up visit, subjects will have three measurements for each test (imaging and visual field tests) in order to evaluate intra-visit variability. Most individuals are followed up every 4 months. The maximum number of follow-up visit is 12 per year.
(1) Visual field measurements

Visual fields will be performed with the Humphrey field analyzer (Humphrey Field Analyzer II, central 24 – 2, SITA standard and SITA SWAP programs, Humphrey Instruments, Dublin, CA, USA) and the Humphrey Matrix (Carl Zeiss Meditec, Dublin, CA, USA). A reliable visual field test is defined as having fixation loss less than 20%, false positive and false negative errors less than 25%. A visual field defect was defined as having three or more significant (p<0.05) non-edge contiguous points with at least one at the p<0.01 level on the same side of horizontal meridian in the pattern deviation plot and classified outside normal limits in the glaucoma hemi field test.

(2) Optical coherence tomography RNFL, optic disc and macular measurements

OCT RNFL and optic disc measurements will be obtained with spectral domain OCT [Spectralis OCT (Software version: SPX-1703) (Heidelberg Engineering, Heidelberg, Germany), Topcon Triton OCT (Topcon, Tokyo, Japan), Cirrus HD OCT (Carl Zeiss Meditec)]. Detailed descriptions of the optical principles and applications of OCT have been described.5,12,13 The optic disc cube scan (with 200 x 200 scan points) and macular scan (with 200x200 scan points will be selected for RNFL measurement. A good quality scan was defined as one with signal strength more than 6 and well delineation of the anatomic boundaries. Subjects would not be included in the study if they failed to have good quality OCT image after 3 attempts. For Spectralis OCT, the optic disc is imaged using 6 radial scan lines, each with 1024 A-scans, equally spaced at 30° using both enhanced depth imaging (EDI) and non-EDI modes. Fifteen images at the same location were obtained and automatically averaged by the built-in software to increase the image signal-to-noise ratio. All images included in the study have a signal-to-noise ratio at least 20. The recent availability of spectral domain OCT has permitted visualization of different retinal layers (inner plexiform layer, outer plexiform layer, inner nuclear layer, outer nuclear layer, ganglion cell layer, photoreceptor inner/outer segment layers and choroid) and lamina cribrosa. Measurements of different retinal and optic disc structures will be analyzed using image analysis software (SigmaScan Pro version 5.0; Systat software Inc., Point Richmond, CA) and computer program written by Matlab (ver. 6.5; The MathWorks, Natick, MA) automatically. Measurement of prelaminar surface depth (PSD), anterior laminar surface depth (ALSD), and prelaminar tissue thickness (PTT) is performed using a customized program developed in Matlab R2010a (The MathWorks, Inc., Natick,
The OCT images are exported and the program measures the PSD, ALSD and PTT upon manual detection and tracing of the Bruch’s membrane opening, the internal limiting membrane, prelaminar and the anterior laminar surfaces. The PSD, ALSD and PTT of an optic disc are calculated from the averages of the 6 radial OCT images. Wide field images including the optic disc and the macular regions will be captured with volume scans with scan size ranging from 10°x10° to 35°x25° (up to 12x9mm²) using the Triton OCT and the Spectralis OCT (Software version: SPX-1703) for additional RNFL and optic disc analyses.

(3) Optical coherence tomography angiography retinal vessel density measurements

Two sets of volume scans (3x3 – 6x6 mm²) at the optic disc and macular regions will be collected from the Triton OCT and Spectralis OCT (Software version: SPX-1703) as well as Cirrus HD OCT for OCT angiography retinal vessel density measurements.

(4) Scanning laser polarimetry RNFL measurement

The latest models of SLP are GDx VCC and GDx ECC. It quantifies the RNFL by first measuring the eye-specific corneal birefringence, which is consisted of the corneal polarization axis and magnitude. It is determined with a macular image acquired with the retardance of VCC set to 0. The Henle fiber layer and corneal retardation can then be measured from the macular retardation profile. To ensure accurate corneal measurement, the software provides an image quality check score (1 to 10) based on the correct alignment, fixation and refraction of the scan. A score of 8 is set to be the minimum standard as good quality scans in the present study. The variable corneal compensator is then set to neutralize the anterior corneal birefringence and the retinal retardance is imaged and measured. SLP measures the retardation in nanometers and a fixed conversion factor is used to calculate the RNFL thickness in μm. The result printout from the GDx VCC only analyzes the TSNIT average (total average RNFL thickness), superior average, inferior average, and the TSNIT standard deviation. In the present study, the raw data from the GDx VCC was also extracted to reconstitute the 12 clock hour RNFL measurements so that the respective clock hour RNFL thickness can be compared.
(5) **Confocal scanning laser ophthalmoscope measurement**

The HRT 3 is a confocal scanning laser ophthalmoscope that works by scanning the retinal surface sequentially in horizontal and vertical directions at multiple focal planes. A 3-dimensional topographic image consisting of $384 \times 384$ (total, 147456) pixels is constructed to determine a wide range of optic nerve head parameters. Three topographic images are obtained in succession, which are combined and automatically aligned for a single mean topography used for analysis. The field of view is set at 15°. Before topographic disc analysis, a contour line was placed around the optic nerve head using the inner edge of Elschnig’s scleral ring. The HRT calculates disc area as the area bounded by the drawn contour line. The other stereometric parameters used in this study (cup area, cup-to-disc [C/D] ratio area, rim area, cup volume, and rim volume) are calculated relative to the reference plane, defined as 50 μm posterior to the mean retinal height between 350° and 356° (papillomacular bundle) along the contour line. Quality control indexes are available in the software. Only images with quality of “good” to “very good” will be selected for subsequent analysis.

(6) **Optical coherence tomography**

**Anterior chamber angle and corneal measurements**

Anterior chamber angle and corneal measurements will be obtained with 2 swept-source OCT, Casia2 (Tomey, Japan) and Anterion (Heidelberg Engineering, Heidelberg, Germany) to provide additional information about the condition of anterior chamber angle. Among the 400 healthy individuals and 400 glaucoma patients, 50 healthy individuals and 50 primary angle closure patients will be randomly selected for 3 consecutive scans under dim light to determine the (1) the agreement and (2) test-retest reproducibility of angle and corneal measurements.

(7) **Progression analysis**

**RNFL progression (analysis by Guided Progression Analysis – GPA)**

RNFL thickness and retardance progression is defined with reference to the Guided Progression Analysis (GPA) (Carl Zeiss Meditec, Dublin, CA). The GPA reports results using both trend and event analyses. For trend analysis, progression is defined when there is a statistically significant negative trend between average RNFL thickness and age. For event analysis, progression is identified when changes in RNFL thickness in the RNFL thickness/RNFL retardance map or in the RNFL thickness profile
are statistically greater than the baseline variability. In this study, RNFL progression is defined when progression is detected in trend and / or in event analyses, and observed in at least 2 consecutive examinations.

**RNFL progression (analysis by Trend-based Progression Analysis – TPA)**

TPA is a trend-based algorithm to evaluate progressive RNFL thinning and its rate of change in individual pixels of the RNFL thickness map. The RNFL thickness data in serial RNFL thickness maps are exported from the Cirrus HD-OCT (Carl Zeiss Meditec) and analyzed in MATLAB (The MathWorks, Inc., Natick, MA). Serial RNFL thickness maps from the same eye are registered with reference to the trajectories of the retinal blood vessels. After registering and aligning the retinal blood vessels in the longitudinal image series, a TPA derived RNFL thickness change map is then generated by performing functional response regression analysis on individual pixels of the RNFL thickness maps (described in Statistics). Although the analysis can be performed in a resolution of 200 x 200 pixels, model fitting and hypothesis testing are performed using the averages of 4 x 4 pixel RNFL thicknesses to produce the same pixel resolution (50 x 50 superpixels) as in GPA. To reduce the probability of Type I error (incorrect rejection of a true null hypothesis) because of multiple testing performed on the RNFL thickness map, the significance level of hypothesis testing in individual superpixels was determined after controlling the false discovery rate (FDR) at $\leq 5\%$ by a two-stage procedure (described in Statistics). An FDR of 5% indicates that 5% of the superpixels detected with significant changes in the RNFL thickness change map are likely to be false positives. Progressive RNFL thinning in a superpixel would be encoded in yellow in the RNFL thickness change map if a significant negative trend was found with a $p \leq 5\%$ in an individual regression analysis, and in red if a significant negative slope was detected after controlling the FDR at 5%. Similar to GPA, progression is defined where there are at least 20 contiguous superpixels encoded in red in the TPA RNFL thickness change map.

**Optic nerve head surface height progression (analysis by TCA)**

The HRT Topographic Change Analysis (TCA, Heidelberg Engineering) is used to analyze serial ONH topography images (96 x 96 superpixels; 1 superpixel = 4x4 pixels) for detection of ONH surface depression. Individual superpixel ONH surface height measurements are compared between the baseline and each of the follow-up examinations with an F test. The pooled variability of the baseline
and the follow-up examinations of a particular pixel is compared with the within variability of the baseline and the follow-up examinations (with an error probability of the F-test <5%). If significant ONH surface depression is detected in a superpixel and confirmed with $\geq 2$ consecutive follow-up visits, the superpixel would be encoded in red in the significance map.

**Progression analysis of optic nerve head and macular parameters**

Progressive changes of optic nerve head (e.g. prelaminar surface depth (PSD), anterior laminar surface depth (ALSD), prelaminar tissue thickness (PTT), neural canal opening(NCO)) and macular thickness parameters (e.g. inner plexiform layer, outer plexiform layer, inner nuclear layer, outer nuclear layer, ganglion cell layer, photoreceptor inner/outer segment layers and choroid) are evaluated with trend (regression analysis between the parameter of interest and time) and/or event (with reference to the test-retest variability of the parameter of interest) analyses.

**Visual field progression**

Visual field progression is defined with reference to Humphrey Field Analyzer II-i Guided Progression Analysis (GPA) (Carl Zeiss Meditec, Dublin, CA). The GPA reports results using both trend and event analyses. For trend analysis, progression is detected when there is a statistically significant negative trend between visual field index (VFI) and age. For event analysis, progression is detected according to the EMGT (Early Manifest Glaucoma Trial) criteria. In this study, visual field progression is defined when progression is detected in trend and/or event analyses, and observed in at least 2 consecutive examinations.

**Evaluation of specificity of progression analysis**

The number of normal individuals who demonstrate progressive RNFL/optic disc/macular/visual field changes will be used to evaluate the specificity of the progression analysis. The 95% confidence interval of the estimated specificities will be computed and compared between RNFL and visual field measurements.
DATA AND STATISTICAL ANALYSIS

(1) Comparison of diagnostic sensitivity between structural measures (OCT, SLP, CSLO) and functional measures (SAP, FDT and SITA SWAP)

Area under the Receiver Operating Characteristic curve (AUC) is calculated to assess the diagnostic performance of each structural and functional testing parameter to differentiate glaucoma suspect or glaucoma eyes from normal eyes. Structural parameters include RNFL thickness, ganglion cell inner plexiform layer thickness, macular and circumpapillary vessel density measurements. Functional parameters include visual field mean deviation, visual field index, and visual sensitivity threshold values. An AUC of 1.0 represents perfect discrimination while an AUC of 0.5 represents chance discrimination. Statistical software, Med Calc version 7.4.2.0, is used to compare the AUCs. In HRT, two analytical programs - the Moorfield Regression Analysis and the Glaucoma Probability Score were incorporated in the built-in software to allow diagnostic evaluation of glaucoma. The derived parameters will also be compared with other structural and functional parameters measured in this study using the AUC.

(2) Analysis of structure function relationship

The relationship between the RNFL / optic nerve head / vessel density parameters and visual sensitivity is evaluated with linear and non-linear regression analyses. The details of the statistical method have been described in an earlier study. In brief, the linear model (\( y = ax + b \)) is compared with 4 common non-linear models including the 2nd order polynomial (\( y = ax^2 + bx + c \)), the 3rd order polynomial (\( y = ax^3 + bx^2 + cx + d \)), the 1st order inverse (\( y = a / x + b \)) and the logarithmic regressions (\( y = a \log(x) + b \)).

In regression analysis, the goodness-of-fit of any particular regression model is often expressed as the coefficient of determination – \( R^2 \), which indicates how much of the total variation in the dependent variable can be accounted for by the regression function. However, it is not possible to determine whether model A is more correct than model B in describing the relationship profile based on the value of \( R^2 \) because the model with more parameters will often has a higher \( R^2 \) than the model with fewer parameters. The extra sum of square F test and the Akaike’s Information Criterion are two mathematical approaches that take the model complexity (the number of data points and the number of parameters) into account in the calculation of the F ratio and the AICc difference respectively to determine which regression model to accept.
(3) Prospective analyses of structural and functional measures
Paired t-test will be used to compare the average and the individual clock hour differences in RNFL and ONH measurements between the baseline data and the results at 3 and 5 years of follow-up. Structural progression will also be analyzed with TCA - Topographic Change Analysis incorporated in the HRT software and GPA, and GPA – Guided Progression Analysis incorporated in the Cirrus HD-OCT and GDx software. Vessel density will be expressed in percentage and the change over time will be analyzed with event and trend analyses. Visual field progression is analyzed with visual field scoring system, MD (Mean Deviation) changes, PSD (Pattern Standard Deviation) changes and also Humphrey GPA (Glaucoma Progression Analysis) incorporated in the Humphrey Field analyzer. Each of the visual fields is analyzed to determine the AGIS (Advanced Glaucoma Intervention Study) / CISTS (Collaborative Initial Glaucoma Treatment Study) visual field scores. Both scoring systems use 20-interval scales with 0 representing no defect and 20 being severely damage. In the AGIS scoring system, the 24-2 area of the visual field is divided into superior, inferior and nasal sectors. Each sector is scored with respect to the severity, the extent and the location of the defect recorded in decibel deviations in the total deviation plot. In the CISTS, the categorized probability values in the total deviation plot are used for the score calculation. Each of the 52 locations in the visual field is given a score (0 to 4) based on the severity of depression on the tested location and its neighbors. The sum of each location is then divided by 10.4 to scale it within the range from 0 to 20. The scorings of the visual fields were computed according to the original descriptions in the respect trials10,11. Analysis of test-retest variability will be also performed. The longitudinal profiles of functional and structural measures will be evaluated with event and trend analysis.

(4) Risk factors for glaucoma progression
Linear mixed modeling and survival analysis will be performed to investigate risk factors (e.g. age, IOP, ocular perfusion pressure, axial length, refraction, corneal hysteresis, corneal deformation amplitude, prelaminar and laminar displacement, changes in neural canal opening) for glaucoma progression (i.e. progressive changes of RNFL, optic disc, macular and visual field parameters).
(5) **Comparison of retinal and optic disc structures between normal and glaucomatous eyes**

Independent t-test will be used to compare the retinal and optic disc measurements (PSD, ALSD, PTT, neural canal opening, inner plexiform layer, outer plexiform layer, inner nuclear layer, outer nuclear layer, ganglion cell layer, photoreceptor inner/outer segment layers, and choroid thicknesses) between the normal and glaucoma groups. The relationships between retinal and optic disc measurements and visual field MD, age and axial length will be evaluated with linear and non-linear regression models.

(6) **Analysis of measurements obtained from ORA, DCT, GAT and Corvis ST**

The agreement of IOP measurements among tonometers will be evaluated with Blant-Altman plot. Analysis of test-retest variability of DCT, ORA, GAT and corneal deformation response measurements will be performed. Correlation analyses among ocular pulse amplitude, corneal hysteresis, IOP measurements, corneal deformation response, central corneal thickness, age, axial length, and parameters obtained from imaging and visual field tests results will be computed.

(7) **Analysis of test-retest (intra-visit and inter-visit) variability of imaging and visual field tests**

By setting the confidence interval as 10-20% on either side of the estimate of within-subject standard deviation (Sw): \( n = 1.962/[2 \times 0.22 \times (m – 1)] \), where \( n \) is the number of subjects and \( m \) is the number of observations, the number of minimum subjects required will be calculated. The Sw is calculated as the square root of the within-subject mean square of error (the unbiased estimator of the component of variance due to random error) in a one-way random-effects model. Intersession sectorial and global measurements were compared with repeated-measures analysis of variance. The intersession within-subject standard deviation (Sw), coefficient of variation, reproducibility coefficient (2.77 x Sw), and intraclass correlation coefficient (ICC) will be computed.

(8) **Analysis of the pattern of RNFL, optic disc and macular changes in glaucoma progression**

The spatial pattern of progressive changes of RNFL, optic disc and macular parameters and their relative temporal sequences of change will be investigated with a topographical map display (such as an overlay of the RNFL thickness change maps and topographic change analysis optic nerve head surface change maps) and survival analysis. The associations among RNFL, optic disc, and macular
changes in glaucoma progression are analyzed with linear mixed modeling.

(9) **Comparison of GPA and TPA for detection of glaucoma progression**

The survival probabilities of eyes detected with progression by GPA and TPA were evaluated by the Kaplan-Meier estimator and compared with the log-rank test. The agreement of progression detection between GPA and TPA was calculated with kappa statistics. The area of progressive RNFL thinning detected by GPA and TPA was compared with Wilcoxon signed-rank test. The specificity of GPA and TPA was compared with McNemar’s statistics.

(10) **Investigation of the prevalence of glaucoma in myopic eyes**

The prevalence of glaucoma, determined by OCT and/or perimetry findings, will be calculated for all the healthy myopic individuals recruited to the study. Potential Risk factors (e.g. axial length, average RNFL thickness, central corneal thickness, age) of glaucoma will be analyzed with logistic regression analysis.

(11) **Evaluation of diagnostic performance of RNFL Optical Texture Analysis (ROTA)**

ROTA is a novel algorithm to reveal the trajectory and textural details of the retinal axonal fiber bundles, enabling reliable visualization and detection of RNFL defects which would otherwise be undetectable from conventional OCT analysis of RNFL/GCIPL thickness. The diagnostic sensitivity and specificity ROTA and topographic parapapillary RNFL and macular ganglion cell inner plexiform layer (GCIPL) thickness analysis for detection of glaucoma will be compared using (1) the modified Obuchowski’s test and (2) receiver operating characteristic curve (ROC) regression. The inter-observer and test-retest agreement of ROTA assessment will be determined by Kappa statistics.

**IMPLICATIONS OF THE STUDY**

Detection of early glaucomatous change has been a major challenge in the management of glaucoma. Many new testing strategies are now becoming widely available for functional and structural assessments in glaucoma. And yet, no consensus has been reached in deciding the most sensitive measure to detect the change and monitor the progression of the disease. The criteria for progression varied widely from one anther and there is no widely accepted standard. It is uncertain if the rate of
loss of RNFL is constant at different stages of glaucoma and the temporal relationship between structural and functional change is not completely understood. A structured investigation studying the various approaches in the same cohort would be of paramount importance to fully address the issues concerned. The results of the current study would provide important clinical information in evaluating the rate of glaucoma progression (in terms of structural and functional changes) and selecting the most appropriate monitoring strategy for detecting glaucomatous changes so that timely interventions could be installed to prevent loss of vision.

ETHICS AND SAFETY ISSUES

This study is a non-interventional. All the clinical investigation in this study, including visual field examination, RNFL and optic nerve head parameters measurements with OCT, SLP and CSLP are non-invasive, routinely employed in clinical practice and pose no known medical side effects to the patients. The data collected for the study does not raise sensitive privacy concerns.

REFERENCES


