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Original Article

Frequency doubling technology and standard automated perimetry in detection of glaucoma among glaucoma suspects

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ABSTRACT

Background: Frequency Doubling perimetry (FDT) has been found to precede visual loss detected by standard automated perimetry (SAP) by as much as four years and the initial development of glaucomatous visual field loss as measured by SAP was found to occur in regions that had previously demonstrated abnormalities on FDT testing.

Methods: A study on 55 glaucoma suspects (determined as per American Academy Guidelines, Preferred Practice Pattern, Oct 2010), was compared to 50 healthy participants (HP). Both glaucoma suspects and HP underwent SAP and FDT in random order. Only reliable fields were compared.

Results: Mean deviation of FDT Matrix was significantly lower than SAP SITA in suspect and healthy group ; two devices showed significant correlation amongst both groups (suspects $p = 0.002$, healthy $p = 0.011$). Significant difference was found in PSD of SAP SITA and FDT Matrix ($p = 0.001$) in the glaucoma suspect group, PSD of FDT Matrix was significantly higher than PSD of SAP SITA in the healthy group ($p < 0.001$). PSD of SAP SITA significantly correlated with FDT Matrix PSD in glaucoma group ($r = 0.579$; $p = 0.001$) but no significant correlation found in healthy group ($r = 0.153$; $p = 0.290$). Percentages of normal test locations significantly higher in FDT Matrix compared to SAP SITA in glaucoma suspects and healthy participants.

Conclusion: FDT correlates well with SAP and may be used for patients who are unable to perform well and reliably with SAP but does not show any features of earlier glaucoma changes in this study.

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Introduction

Glaucoma is a major irreversible cause of blindness in the world, accounting for 15% of all causes of blindness.[1] It is a progressive disease in which visual impairment occurs due to retinal ganglion cells (RGC) death.[2]

As per American Academy Guidelines, Preferred Practice Pattern, "a glaucoma suspect is an individual with clinical findings and/or a constellation of risk factors that indicate an increased likelihood of developing Primary Open Angle Glaucoma (POAG)". Clinical findings that make a person suspect for primary open angle glaucoma, depend on one of the following clinical findings in, at least, one eye of the suspect, with an open angle of the anterior chamber on gonioscopy. These findings are: Appearance of the optic disc or retinal nerve fiber layer that is suspicious for glaucomatous damage, enlarged cup-disc ratio, asymmetric cup-disc ratio, notching or narrowing of the neuroretinal rim, disc hemorrhage, nerve fiber layer defect, visual field suspicious for glaucomatous damage in the absence of clinical signs of other optic neuropathies, arcuate bundle defect, nasal step, paracentral scotoma, altitudinal defect, larger mean pattern standard deviation, consistently elevated intraocular pressure (IOP) associated with normal appearance of the optic disc and retinal nerve fiber layer and with normal visual field test results. Family history is a definite risk factor for glaucoma.[3]

Frequency doubling perimetry (FDP) is a relatively new psychophysical test that has good potential in screening for early glaucomatous damage.[4] It has advantages being easy to administer and interpret, liked by most patients, not greatly affected by refractive error and cataract, has high test-retest reliability, offers rapid screening tests, and has different full threshold programs. Maddess et al. reported that the frequency doubling illusion could be useful in detecting glaucomatous field loss.[4] The frequency doubling technology (FDT) stimulus predominately stimulates the magnocellular ganglion cell pathway, which is primarily involved in motion detection and flicker detection. It is believed that the neurophysiological substrate for the frequency doubling illusion in humans lies in a subgroup of M cells, the proposed My cells, which show nonlinear characteristics to contrast and are thought to be preferentially lost in early glaucoma.[5] Standard automated perimetry (SAP) is considered the gold standard method of measuring the visual field.

A study was done to correlate frequency doubling perimetry (FDP) results with glaucomatous visual field defects, as assessed by standard automated perimetry (SAP), in a glaucoma suspect population. In a study by Kelly DH, the analysis of the FDT examinations during follow up revealed that in 59% of converters, the FDT abnormalities preceded SAP visual loss by as much as 4 years and the initial development of glaucomatous visual field loss as measured by SAP occurred in regions that had previously demonstrated abnormalities on FDT testing.[6] Landers et al, also conducted a study to evaluate if FDT predicted future visual field loss with SAP just as it may be predicted with short wavelength automated perimetry and found that both short wavelength automated perimetry (SWAP) and FDT detected field loss earlier than SAP.[7] With paucity in literature about the ability of FDT to detect field loss in glaucoma suspects, a study was conducted to correlate results of frequency doubling technology to SAP and to study if FDT could detect field loss earlier in comparison to SAP in glaucoma suspects in a subject population where such a study had never been conducted earlier.

Materials and methods

The study was conducted in the outpatient department of ophthalmology at a tertiary eye care center from July 2009 to July 2012 and Cases of Primary Open Angle Glaucoma (POAG) suspects were studied. Glaucoma suspects were those with a family history of glaucoma i.e. mother, father or sibling with glaucoma, Optic nerve heads suggestive of glaucoma i.e. vertically elongated optic cups, notching, disc hemorrhage, asymmetry of discs, intraocular pressure taken by applanation tonometry to be high on more than two occasions.

As no such study has till date been conducted in our setting, a pilot study with 55 cases (glaucoma suspects) was conducted. Additionally, 50 non cases (no family h/o glaucoma, optic nerve head normal, and IOP within normal limits on two readings) were also examined to assess validity of both the techniques. Institutional ethical clearance was obtained for the conduct of the study and written informed consent was obtained from all the participants.

The inclusion criteria for glaucoma suspects were those glaucoma suspects who were not suffering from any ocular or systemic diseases and BCVA minimum 6/9. The exclusion criteria were patients suffering from any other ocular/systemic disease which could have caused optic disc changes and/or ametropia more than ±5 Dsph and ±3 Dcyl.

All patients underwent a comprehensive ocular examination consisting of: Best corrected visual acuity, Slit lamp examination, IOP was measured using applanation tonometer (AT) using the Haag Streit slit lamp attachment, Gonioscopy with single mirror goniolens, dilated fundus examination done with Slit lamp biomicroscopy with +90 D lens to evaluate the optic nerve head. Fundus camera was used to document optic nerve head. Pachymetry for central corneal thickness done with ultrasound pachymeter Pachette 2 (model DGH-550). SAP was done with Humphrey Visual Field Analyzer (Carl Zeiss Meditec, Dublin, CA), using 24-2 SITA Standard. FDT perimetry was done with the Humphrey Matrix (Carl Zeiss Meditec) using 24-2 full threshold using ZEST strategy. SAP and FDT were performed randomly on the same day with a gap of at least 15–20 min given to reduce fatigue related errors. All the subjects were made to wear appropriate refractive corrections for both the tests and the pupils had a diameter of at least 3 mm. Only the reliable (fixation losses <20%, false-positives and false-negatives <33%) visual fields were included in the study. In case of unreliable fields, the test was repeated after few days. If both eyes were eligible for the study, the eye with more reliable field was selected for analytical purposes. All visual field threshold data of the left eye were transposed for the right eye orientation. For comparative analysis, the blind spot thresholds were not used. The two locations above and below the blind spot were excluded, leaving 52 points for analysis in the SAP as well as in FDT Matrix.