"SWEDISH INTERACTIVE THRESHOLD ALGORITHM (SITA) VERSUS STANDARD FULL THRESHOLD ALGORITHM IN DETECTING GLAUCOMATOUS VISUAL FIELD DEFECTS USING HUMPHREY FIELD ANALYZER - A DESCRIPTIVE OBSERVATIONAL STUDY."

By

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Dr. Bhagyajyothi. B. Khanagavi.

LIST OF ABBREVIATIONS

ACES	-	Aravind Comprehensive Eye Survey
ACG	-	Angle Closure Glaucoma
APEDS	-	Andhra Pradesh Eye Disease Study
asb	-	apostilbs
C/D	-	Cup/Disc
CPSD	-	Corrected Pattern Standard Deviation
CNTGS	-	Collaborative Normal Tension Glaucoma Study
dB	-	decibels
EMGT	-	Early Manifest Glaucoma Trial
FN	-	False Negatives
FP	-	False Positives
FT	-	Full Threshold
GHT	-	Glaucoma Hemifield Test
HAP	-	Hodapp Anderson Parrish
HFA	-	Humphrey Field Analyzer
IPD	-	In Patient Department
IOP	-	Intra Ocular Pressure
MD	-	Mean Deviation
NTG	-	Normal Tension Glaucoma
NRR	-	Neuroretinal rim

OAG	-	Open Angle Glaucoma
OHTS	-	Ocular Hypertension Treatment Study
OPD	-	Out Patient Department
PD	-	Pattern Deviation
POAG	-	Primary Open Angle Glaucoma
PPA	-	Peripapillary atrophy
PSD	-	Pattern Standard Deviation
RCT	-	Randomized Control Trial
SAP	-	Standard Achromatic Perimetry
SITA	-	Swedish Interactive Threshold Algorithm
SS	-	SITA Standard
STF	-	Short Term Fluctuation
SWAP	-	Short Wavelength Automated Perimetry
TD	-	Total Deviation

ABSTRACT

BACKGROUND

Glaucoma is an ocular condition characterised by raised intraocular pressure, optic neuropathy and a corresponding visual field loss. This loss is usually very insidious and starts in the Bjerrum's area and leaves the patients asymptomatic in the early stages. Having a sensitive and specific test to detect a subtle visual field loss is therefore very important in the management of glaucoma.

OBJECTIVES

1. To find out the sensitivity and specificity of Swedish Interactive Threshold Algorithm (SITA) Standard with the Standard Full Threshold algorithm (FT) as gold standard in detecting visual field defects in primary open angle glaucoma patients using Humphrey Field Analyzer.
2. To compare the test time for SITA Standard and Standard Full Threshold algorithm in primary open angle glaucoma patients.

METHODS

This was a descriptive observational study in which 60 patients of primary open angle glaucoma who met the inclusion criteria were included. After obtaining written informed consent, all patients underwent visual field testing with both Standard Full Threshold Algorithm and SITA Standard algorithm using Humphrey Visual Field Analyzer II - i series perimeter.

RESULTS

The sensitivity of SITA standard in detecting glaucomatous visual field defects with Full Threshold algorithm as gold standard in primary open angle glaucoma patients was 95.24%.The specificity of SITA standard in detecting glaucomatous visual field defects was 94.44% with Full Threshold algorithm as gold

standard. SITA Standard considerably reduced test taking time compared to Full Threshold by 45.84 % in glaucoma patients (p value < 0.0001).

CONCLUSION

The SITA Standard algorithm provides high enough sensitivity and specificity in detecting glaucomatous visual field defects with the Full Threshold algorithm as gold standard in primary open angle glaucoma patients with considerable savings in time.

KEY WORDS : Primary open angle glaucoma; Visual field defect; Full Threshold; SITA Standard; Sensitivity; Specificity.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF GRAPHS

LIST OF PHOTOGRAPHS

LIST OF SINGLE FIELD ANALYSIS PRINT OUTS

INTRODUCTION

Primary open angle glaucoma (POAG) also known as chronic simple glaucoma is characterized by insidious rise of intraocular pressure (>21 mmHg), with characteristic optic disc cupping and other optic nerve head changes and specific visual field defects. A diagnosis of POAG can be made if at least two of these three abnormalities are detected. Glaucoma afflicts more than 67 million people worldwide and is the silent killer of vision.

The visual field loss in POAG is usually very insidious and starts in the Bjerrum's area and the patients are usually asymptomatic in the early stages. Having a sensitive and specific test to detect a subtle visual field loss is therefore very important in the management of glaucoma.

Conventional visual field testing is performed with a white target against a more dimly illuminated white background which is called 'white-on-white' or Standard Achromatic Perimetry (SAP). Two main types of SAP currently used in clinical practice are kinetic and static.

The various methods of kinetic perimetry are confrontation method, lister's perimetry, tangent screen scotometry and Goldmann's perimetry.The major limitations of kinetic perimetry are lack of standardization of the test objects and the background, and as well as problems of patient fixation. The examination of visual field using a Goldmann kinetic perimeter is time consuming and requires a trained technician. Because of these disadvantages of kinetic perimetry, static perimetry is preferred over kinetic perimetry in visual field evaluation of POAG patients. The threshold static perimetry also has been shown to be more sensitive than kinetic perimetry in detecting glaucomatous visual field defects.[(1),(2)]

The various methods of static perimetry adopted are Goldmann perimetry, Friedmann perimetry and automated perimetry. Currently the most widely used instrument in visual field evaluation is Humphrey Visual Field Analyzer(HFA), and most common type of perimetry used is static perimetry [(3)].

Full threshold white-on-white automated static perimetry is currently the gold standard for the diagnosis, grading and detection of progression of glaucomatous visual field defects.

However , the standard Full Threshold method for measuring the visual field is time consuming and it may lead to fatigue effect, resulting in poorer results.[(4)]. The fatigue effect leading to poorer results is more pronounced in glaucoma patients.

The Swedish Interactive Threshold Algorithm (SITA) is a new computer program that has been developed for the Humphrey visual field analyzer II, which reduces test taking time. The SITA standard program has been shown to reduce test-taking time by approximately 50% compared with Full Threshold testing. Overall, the number of stimuli actually presented is reduced by 29% in normal fields and 26% in glaucomatous fields.

The SITA Standard algorithm saves nearly 50% of time and the results of SITA Standard algorithm are nearer to Full Threshold algorithm which is gold standard in detecting glaucomatous visual field defects

The purpose of current study is to find out the sensitivity and specificity of SITA standard in detecting glaucomatous visual field defects using the Full Threshold algorithm as the reference, or "gold" standard and to compare the test time for SITA Standard and standard Full Threshold (FT) algorithm.

AIMS AND OBJECTIVES

1. To find out the sensitivity and specificity of SITA Standard with standard Full Threshold algorithm as gold standard in detecting glaucomatous visual field defects in primary open angle glaucoma patients .
2. To compare the test time for SITA Standard and standard Full Threshold algorithm in primary open angle glaucoma patients.

REVIEW OF LITERATURE

Primary open angle glaucoma (POAG) is succinctly defined by the American Academy of Ophthalmology's 2005 POAG Preferred Practice Pattern as ' a progressive chronic optic neuropathy in adults where intraocular pressure (IOP) and other currently unknown factors contribute to damage and in which in the absence of other identifiable causes, there is characteristic acquired atrophy of the optic nerve and loss of retinal ganglion cells and their axons'. This is associated with an anterior chamber angle that is open by gonioscopic appearance and specific visual field defects.

Glaucoma afflicts more than 67 million people worldwide, of whom about 10% or 6.6 million are estimated to be blind.[5].Glaucoma is the second most frequent cause of blindness in the world, after cataract.[5]

The overall prevalence of POAG in 2010 was 1.96% of total general population, disproportionately affecting more women and Asians.[6] There are 44.7 million people with POAG of the total predicted 60.5 million people with both OAG and ACG in 2010.[6]

A significant number of glaucoma patients go undiagnosed as high as 50%-75% as reported by Baltimore Eye study and Latinos study.

Prevalence of glaucoma in India

The prevalence of glaucoma in India estimated by the population based studies is about 11.2 million persons aged 40 years and older in 2010.[7]

Among them primary open angle glaucoma is estimated to affect 6.48 million persons in 2010.[7]

Glaucoma has been declared to be the second common cause of blindness in adult population in India.[7]

The high rate of blindness in the Indian population is due to high proportion of undiagnosed glaucoma in the community.

The Aravind Comprehensive Eye Survey (ACES), a population based sample survey in rural pockets of Tamilnadu had determined prevalence of POAG to be 1.4% in adults aged 40 years and more.

The Andhra Pradesh Eye Disease Study (APEDS), a population based sample survey in urban Hyderabad had identified prevalence of POAG to be 1.62% in those aged 30 years or more.

Clinical risk factors for primary open angle glaucoma

Demographic risk factors for POAG

Age

Population based studies of prevalence and incidence of POAG consistently show a steady increase with age. As a rule of thumb, prevalence tends to roughly double for each decade over 40 years and is about 10-fold higher in the 80+ group compared to the 40 to 49 year old group.

Gender

There is a marked discordance amongst population based studies on the association between gender and POAG. The Framingham [8] study reported higher rates of POAG amongst males.

The Blue mountains [9] and St Lucia [10] study reported higher rates in females. Others found no significant statistical association. [11],[12],[13]

Race

In general, the prevalence of POAG is highest in black populations, intermediate in whites, Hispanics and southern Asian populations and lowest in northern Asian populations.

Family history

A first degree relative with glaucoma has been consistently associated with an increased risk of POAG in prevalence surveys. [14],[15],[16]

The association between POAG and family history of POAG is stronger when the affected relative is a sibling rather than a parent or child. In the clinically assembled OHTS population no association between family history of POAG and POAG was found.

Genetic factors that influence POAG are complex. Although at least six genes loci have been identified with POAG, only one genetic locus GLC1A on chromosome 1q has been reported in patients with adult onset POAG. A gene that produces the protein myocilin resides within this interval, and myocilin mutations occur in upto 4.6% of patients with adult onset POAG.

Ocular risk factors.

Intra ocular pressure (IOP mm Hg)

There is a strong dose response relationship between IOP and glaucoma that has consistently been shown in prevalence surveys and in longitudinal studies of incidence and progression; individuals who have pressures of 15-20mm Hg have a low prevalence of nerve damage, whereas the prevalence of damage is higher among individuals who have pressures of 25-30 mm Hg. The most decisive new evidence to

be published in recent years was demonstration by RCTs that IOP lowering decreased the incidence and progression of glaucoma compared to no treatment.

Among population based studies, the prevalence of POAG increases with increasing IOP. The causal role of IOP in optic nerve damage is evidenced by experimental production of high pressure in primates that results in glaucomatous damage.

Corneal thickness

Corneal thickness is a risk factor for conversion from ocular hypertension to open angle glaucoma .[17] The people of African ancestry had thinner corneas and this accounted for all of the increased risk for conversion to open angle glaucoma among blacks with ocular hypertension.

Optic nerve head features

A study reported that the incidence of POAG for those with a baseline C/D ratio of more than 0.7 was 8.6 fold higher than for those with a C/D ratio of less than 0.7.[18]

The OHTS showed a 1.4 fold increase in the incidence of POAG among ocular hypertensive patients for every 0.1 unit increase in the baseline C/D ratio. [19] Also optic nerve head vertical disc diameter and the disc area are found to be associated with glaucoma.

Atrophy of neurosensory retina and retinal pigment epithelium about the optic nerve head is known as peripapillary atrophy (PPA) and has been shown to correlate with the presence of glaucoma.[20]

The prevalence of glaucoma was found to be increased 10-fold in those with disc hemorrhages but disc hemorrhages were much more common in NTG (25%) than in high tension glaucoma (8%).

Myopia

An association between myopia, particularly high myopia and open angle glaucoma has long been recognized and is supported by numerous case series and case control studies. However, the OHTS and EMGT studies have shown no association of glaucoma with myopia.

Systemic risk factors for POAG

Diabetes mellitus

The prevalence of POAG appears to be higher in the diabetic population by a factor of about 2 in the most population based surveys. Diabetes has not yet shown to increase the incidence of glaucoma.

Blood pressure

The most meaningful blood pressure variable related to glaucoma appears to be diastolic perfusion pressure or the difference between diastolic arterial pressure and IOP. Several population based surveys have reported a seven-fold increase in the prevalence of POAG in those with lower perfusion pressures. Higher systolic and diastolic blood pressures are associated with increased IOP.[21] [22]

Migraine

There is some support for an association between migraine headaches and NTG. The CNTGS found that a history of migraine increased the risk of progression of POAG by a factor of 2.6.

Smoking and alcohol

No difference in the prevalence of glaucoma were noted with mild, moderate or heavy alcohol consumption in the Beaver Dam Eye Study.[23] While a small increase in IOP was noted in smokers in the Australian Blue Mountain Eye study even after adjusting for numerous other variables, [24] the prevalence of POAG has not been observed to vary between smokers and non smokers in other studies.

Pathogenesis

Raised IOP

A raised IOP results from resistance to the aqueous humor outflow. This obstruction to the aqueous humor outflow in POAG is associated with alterations in conventional outflow pathway. In the trabecular meshwork there is a decrease in the endothelial cell number, alteration in endothelial cell function, decrease in inter trabecular spaces, loss of the trabecular beams and thickening of basement membrane which are all associated with an increased resistance to aqueous outflow resulting in raised IOP. In POAG, within the trabecular meshwork collagen abnormalities like fragmentation, orientation changes and abnormal spacing are noted.

Mechanism of Optic nerve damage

There is a progressive optic neuropathy characterized by morphological changes resulting from death of retinal ganglion cells which may be pressure dependent or pressure independent. A wide variety of hypothesis explain the pathogenesis of optic neuropathy in glaucoma, including ischemia of the papillary nerve head, blockage of retrograde axonal transport, alteration of laminar glial or connective tissue, direct mechanical effect on retinal ganglion cells, and

neurotransmitter (glutamate) mediated excitotoxic death of the retinal ganglion cells. Nitric acid is found in higher concentration in the optic nerve of humans with glaucoma which can also trigger cell death.

Diagnosis and clinical features

POAG is diagnosed by assessing a combination of clinical factors including the level of intraocular pressure (IOP), optic disc appearance and visual field damage.

History

A comprehensive evaluation of an individual with glaucoma should begin with eliciting detailed history which includes a review of the family, ocular and systemic history, use of systemic and ocular medications, past ocular surgery and known local and systemic intolerance to the use of glaucoma medications.

Clinical evaluation

Vision and refraction

Best corrected visual acuity is to be determined. Correction of refractive error is essential for accurate perimetry.

Pupils

Relative afferent pupil defect detects asymmetric optic nerve damage and is an important finding in glaucoma.

Slit lamp biomicroscopy

Anterior segment examination is usually normal in POAG.

Intraocular pressure (IOP mm Hg)

The mean value of IOP in a large normal population is 16 mmHg, with a standard deviation of 3 mmHg.

IOP in general population is not Gaussian in distribution but skewed toward higher pressures and an IOP>22mm Hg does not necessarily indicate abnormality.

IOP is preferably measured with Goldmann type of applanation tonometry or its equivalent before performing gonioscopy or dilatation of the pupil. In case Goldmann applanation tonometer is not available, Schiotz tonometer offer a viable alternative. Time of IOP measurement is to be noted.

Gonioscopy

Gonioscopic evaluation of the anterior chamber angle is an essential diagnostic tool in glaucoma. Goldmann 3 mirror goniscopic lens is the prototype instrument employed in viewing the anterior chamber angle.

Shaffer's system of grading anterior chamber angle

Grade Number	Angle width	Description	Risk of closure
4	45-35	Wide open	Impossible
3	35-25	Wide open	Impossible
2	20	Narrow	Possible
1	10	Extremely narrow	Probable
Slit	Slit	Narrow to slit	Probable
0	0	Closed	Closed

Optic disc evaluation

The optic nerve head is preferably evaluated using a slit lamp biomicroscope and a posterior pole lens (90D or a 78D lens) which offers a stereoscopic and a magnified view of the optic nerve head and retinal nerve fiber layer.

The optic disc is slightly oval in shape and it contains a central area of pallor , the optic cup. The tissue between the cup and disc margin is called neuroretinal rim. The neuroretinal rim is composed of axons of the retinal ganglion cells that exit the eye through optic nerve. Death or destruction of the retinal ganglion cells, as in glaucoma is reflected in loss or thinning of neuroretinal rim and enlargement of the cup.

Optic disc signs in POAG

Generalized

- Large optic cup.
- Asymmetry of cups between the two eyes.
- Progressive enlargement of the cup.

Focal

- Narrowing or notching of the neuroretinal rim.
- Vertical elongation of cup.
- Cupping to the rim margin.
- Regional pallor.
- Splinter hemorrhage.

- Nerve fiber layer defects.
- Bayoneting of retinal vessels.
- Overpass vessel phenomenon.

Non specific signs of glaucomatous damage

- Exposed lamina cribrosa(laminar dot sign).
- Nasal displacement of retinal vessels.
- Barring of circumlinear vessels.
- Peripapillary crescent.

Generalized enlargement of cup may be the earliest change detected in glaucoma. Focal enlargement of the cup may appear as localized narrowing or notching of neuroretinal rim. Deep or localized notching, where lamina cribrosa becomes visible at the disc margin is referred as acquired optic disc pit. The cup becomes vertically oval if notching occurs at one or both of the inferior and superior aspect of the optic disc .Notching or thinning and loss of neuroretinal rim is associated with bayoneting of retinal vessels.

Disc hemorrhages appear as linear red streaks at or near the disc margin. Individuals with normal tension glaucoma are more likely to have such changes than those with POAG.[25] Most eyes with disc hemorrhages tend to a have progressive visual field loss and hence is a reliable prognostic sign.

Retinal nerve fiber layer loss

Glaucomatous optic atrophy is associated with loss of axons in nerve fiber layer. They appear as dark stripes or wedge shaped defects of varying width in

peripapillary area or as diffuse loss of striations and these correlate well with the visual field changes.[26] Focal abnormalities consist of slit like grooves or wedge defects. Diffuse nerve fiber loss is more common in glaucoma but are also difficult to be appreciated. The nerve fiber layer defect may be diffuse or localized and may be the initial sign of glaucomatous damage.[27]

VISUAL FIELD ANALYSIS

Visual field evaluation is a complex task that has become an integral part of glaucoma evaluation.

Visual field testing is used in three distinct ways in glaucoma evaluation and management: diagnosis, assessment of severity and determination of progression.

In 1939, Traquair cleverly described a normal visual field as an island of vision surrounded by a sea of blindness.

The 'top of island ' corresponds to fovea with highest light sensitivity (fixation point); it declines towards periphery, and the bottom corresponds to the peripheral visual field with the lowest light sensitivity.

The normal visual field has an oval shape: temporal field extends to 100-110 degrees, inferior to 70-75 degrees, and superior and nasal to 60 degrees.

A blind spot is an absolute scotoma corresponding to optic nerve head and is located 15 degrees temporal to fovea.

Historical considerations

The concept of visual field dates to the fifth century BC, when Hippocrates described hemianopic defects. As early as 150 BC, Ptolemy attempted to measure the visual field.

In 1801, Thomas Young made the first genuine measurements of the visual field.

In the mid nineteenth century, Foster developed the first arc perimeter, which predominated until 1889 when Bjerrum discovered the tangent screen. In the 1950s, Goldmann discovered hemispheric projection perimeter which became the clinical standard for the next 30 years.

Lynn and Tate demonstrated the first static automated perimeter in 1969. Fankhauser, Heijl and Krakau are credited for the rapid development of automated static perimetry.

Glaucomatous visual field defects

Glaucomatous field damage results from damage to the intraocular portion of the optic nerve extending from the retinal ganglion cells to just posterior to the lamina cribrosa.

Peripheral loss

Defects along the peripheral boundaries of the visual field (peripheral nasal steps, vertical steps,and temporal sector defects) are most often found in association with scotoma in the more central arcuate area, although in some patients with early glaucomatous visual field loss,peripheral defects may be the only detectable abnormality.

Localized visual field defects

The glaucomatous process typically causes initial damage to one or more axon bundles, creating a localized visual field defect which constitute the most definitive early evidence of visual field loss from glaucoma.

Arcuate defects

Bjerrum described an arcuate visual defect, which he showed is strongly suggestive of glaucoma. This arcuate scotoma starts from the blind spot and arches above or below fixation, or both, to the horizontal median raphe, corresponding to the arcuate retinal nerve fibers.

Early visual loss in glaucoma commonly occurs within this arcuate area, especially in the superior half which correlates with predilection of the inferior and superior temporal poles of the optic nerve head for early glaucomatous damage.[(28)] They most often appear first as one or more localized defects, or paracentral scotomas.

Occasionally, the early arcuate defect may connect with the blind spot and taper to a point in a slightly curved course, which has been referred to as a seidel scotoma.

As the isolated defects enlarge and coalesce, they form an arching scotoma that eventually fills the entire arcuate area from the blind spot to the median raphe, which is called an arcuate or Bjerrum scotoma.

With further progression, a double arcuate (or ring) scotoma develops.

Although the arcuate defect is probably the most reliable early form of glaucomatous field loss it is not pathognomonic.

Nasal steps

The loss of retinal nerve fibers rarely proceeds at the same rate in the upper and lower portions of an eye. Therefore, a step like defect is frequently created where the nerve fibers meet along the median raphe. Because the superior field is involved somewhat more frequently than the inferior portion in the early stages of glaucoma, the nasal step more often results from a greater defect above the horizontal midline, which is referred to as a superior nasal step. However, inferior nasal steps are not uncommon.

Unequal contraction on the peripheral side of the defect due to loss of corresponding bundles of peripheral arcuate nerve fibers, produces a defect that has been called the peripheral nasal step of Ronne. Nasal step often begins as an isolated scotoma in nasal periphery.[29]

Vertical step

A stepwise defect along the vertical midline, referred to as a vertical step or hemianopic offset, is a less common feature of glaucomatous field loss than the nasal step, but has been reported to occur in approximately 20% of cases.[30]

Generalized and central depression of the visual field

Central vision is typically one of the last regions to be totally lost, but studies have shown mild central and diffuse reduction in the visual field even in the early stages of glaucoma.[31][32][33] The mechanism for this is uncertain, although it appears to represent pressure induced damage, with diffuse nerve fiber loss.

Concentric contraction

Generalized reduction in the visual field may become manifest as a concentric constriction of the visual field which has been noted to precede other detectable glaucomatous field defects in many patients.[34]

Isopter contraction, as an early field defect of glaucoma, is often more marked in the nasal field, which has been called" crowding of the peripheral nasal isopters".[35]

Enlargement of the blind spot

Enlargement of the blind spot, due to depression of peripapillary retinal sensitivity, is also considered to be an early glaucomatous field change.

Enlargement of the blind spot can also be produced in normal individuals with threshold targets so that it is not a pathognomonic sign of glaucoma.[36]

Angioscotomata

Angioscotomata are long, branching scotomas above and below the blind spot which are presumed to result from shadows created by the large retinal vessels. Angioscotomata may represent an early glaucomatous visual field defect,[37] although it is technically difficult to demonstrate and not highly diagnostic.

Temporal sector defect

Because the retinal nerve fibers nasal to the optic nerve head converge on the disc by a direct route, a lesion involving these fiber bundles produces a sector defect temporal to the blind spot.[38] This defect usually appears later in the course of glaucomatous field loss.

Advanced glaucomatous field defects

The natural history of progressive glaucomatous field loss is the eventual development of a complete double arcuate scotoma, which coalesce nasally at the horizontal meridian and may extend to the peripheral limits in all areas except temporally. This results in a central island and a temporal island of vision in advanced glaucoma.

With continued damage, these islands of vision progressively diminish in size until the tiny central island is totally extinguished, which may occur abruptly. The temporal island of vision is more resistant and may persist long after central vision is lost. However, it too will eventually be destroyed if the glaucoma is not controlled, leaving the patient with no light perception.

Visual field testing and glaucoma diagnosis

Visual field testing is critical in diagnosis of glaucoma

Changes in the optic disc appearance in the form of focal or diffuse loss of neuroretinal rim resulting in an increase in size of cup, while diagnostic for glaucoma, generally take years to develop and it is difficult to document this change.

For these reasons, testing visual function with the visual field is a helpful diagnostic tool, although less sensitive than observed changes of the optic disc or retinal nerve fiber layer.

A guideline for minimal abnormality on a visual field required to make the diagnosis of glaucoma by SAP are

1. Abnormal glaucoma hemifield test
2. Pattern standard deviation abnormal at P<5% level

3. Cluster of 3 or more points on pattern deviation plot abnormal at p < 5 % , at least 1 at the P<1% level in an expected area of the visual field.

The first two criteria, the glaucoma hemifield test and pattern standard deviation, were used in the Ocular Hypertension Treatment Study (OHTS) as visual field endpoints for the development of primary open angle glaucoma.(39)

The latter criterion, pointwise analysis may be more sensitive to very early defects.

If any of the three criteria listed are present in the absence of other causes, such as nonglaucomatous optic neuropathies or chorioretinal pathology, then diagnosis of glaucoma should be considered.

False positive testing in glaucoma suspects and ocular hypertensives has been found to be fairly common, so repeat testing of a suspected early visual field defect is important before concluding that glaucoma is present. In the OHTS, for instance 86% of suspected new visual field defects disappeared on repeat testing.(40)

Most defects are localized taking the form of a paracentral scotoma or nasal step. As glaucoma progresses, these defects typically enlarge and coalesce into arcuate defects, corresponding to thinning of the retinal nerve fiber layer.

The best place to look for early glaucomatous visual field defects is the pattern deviation plot rather than the gray tone printout or total deviation plot.

Visual field and assessing the severity of glaucoma

The severity of the visual field defects can be used to judge the severity of functional damage to the visual system from glaucoma.

This is important to determine the aggressiveness of initial therapy and to assess the success of ongoing treatment. There are several visual field severity

grading scales including those used in the Advanced Glaucoma Intervention Study, the Collaborative Initial Glaucoma Treatment Study, the Glaucoma Staging System developed by Brusini and colleagues and the Hodapp Anderson Parrish system. [41]

The preferred one to use is an expanded version of visual severity scale proposed by Hodapp Anderson and Parrish for the Humphrey Field Analyzer.

This scale is easy to use in clinical practice, captures the full range of stages in glaucoma progression and is based on three distinct features of the visual field that should be assessed when deciding on the severity of the functional loss, which include the size of the defect, the depth of the defect, and the proximity of the defect to fixation.

The pattern of visual field progression in glaucoma, from early to severe, is predictable in light of the pattern of thinning of the retinal nerve fiber layer which usually begins with the superior and inferior arcuate fibers, then the papillomacular bundle, and finally the nasal fibers.

When the arcuate fibers are lost, the visual field shows only the central and temporal islands remaining which correspond to the remaining papillomacular and nasal fibers.

The next fibers to be lost are typically the papillomacular fibers which results in central visual acuity loss and eccentric fixation.

Visual field severity grading system for the Humphrey visual field analyzer (Stage 0-5)[42]

Stage O: No or minimal defect/Ocular Hypertension.

Does not meet any criteria for stage 1

Stage 1: Early defect

Mean deviation (MD) ≤-6.00 dB and at least one of the following

A On pattern deviation plot, there exists a cluster of 3 or more points in an expected location of the visual field depressed below the 5% level at least 1 of which is depressed below the 1% level.

B Corrected pattern standard deviation/pattern standard deviation significant at P<0.05.

C Glaucoma hemifield test "outside normal limits".

Stage 2: Moderate defect

MD of -6.01 to 12.00 dB and at least one of the following

A On pattern deviation plot, greater than or equal to 25% but fewer than 50% of points depressed below the 5% level, and greater than or equal to 15% but fewer than 25% of points depressed below 1% level.

B At least 1 point within central 5^0 with sensitivity of <15dB but no point within central 5^0 with sensitivity of <OdB.

C Only 1 hemifield containing a point with sensitivity <15dB within central 5^0 of fixation .

Stage 3 : Severe defect

MD of -12.01 dB to – 20.00 dB and at least one of the following :

A On pattern deviation plot, greater than or equal to 50% but fewer than 75% of points depressed below the 5% level and greater than or equal to 25% but fewer than 50% of points depressed below 1% level .

B Any point within central 5^0 with sensitivity of < 0 db.

C Both hemifields containing a point(s) with sensitivity <15dB within 5^0 of fixation.

Stage 4: Advanced defect

MD of -20.00dB and at least one of the following :

A On pattern deviation plot, greater than or equal to 75% of points depressed below the 5% level and greater than or equal to 50% of points depressed below 1% level.

B At least 50% of points within central 5^0 with sensitivity of <OdB.

C Both hemifields containing greater than 50% of points with sensitivity <15dB within 5^0 of fixation.

Stage 5: End stage disease

Unable to perform Humphrey visual fields in "worst eye" due to central scotoma or "worst eye" visual acuity of 20/200 or worse due to primary open angle glaucoma.

Visual field and assessing progression in glaucoma

Glaucoma progression is due to the death of retinal ganglion cells and their axons, which results in peripheral, followed by central vision loss.

Assessment of changes in the visual field, optic disc and retinal nerve fiber layer are the primary ways one diagnoses progression in glaucoma. It is generally believed that structural changes in the optic nerve and retinal nerve fiber layer can be detected before functional changes with SAP, although the Early Manifest Glaucoma

Trial found all of their progressive cases except one with SAP rather than optic disc photographs evaluated with flicker chronoscopy.[43]

In clinical practice following SAP for signs of change is critical in the management of glaucoma and is typically performed every 1-2 years or more frequently if glaucoma is poorly controlled or rapidly progressive.[44]

There are several ways in which a visual field can progress in glaucoma. Localized defects can enlarge or deepen, and finally a new distinct localized defect can appear. When looking for enlarging or deepening of existing defects, one can apply numerical pointwise criteria such as that used in the Collaborative Normal Tension Glaucoma Study [45] or one of several statistical programs that analyze individual points such as the Glaucoma Progression Analysis program for the Humphrey visual field analyzer.[46]

Using the global indices such as worsening of the mean deviation (MD) and pattern standard deviation (PSD), can be difficult. The MD is a single measure of the depression of the patient's visual field compared to age matched controls. It may be getting worse from localized or diffuse changes, the latter most commonly a manifestation of cataract worsening.

The pattern deviation value is not the best measure of a worsening visual field in glaucoma, however, because it gets higher initially in glaucoma but then lower as more and more of the visual field becomes affected.

If the MD and PSD are both worsening, this is better evidence of worsening of a localized defect such as commonly occurs in glaucoma.

Standard Achromatic Perimetry

Perimetry

Perimetry is the science of measuring the peripheral vision ("Peri = Peripheral and "metry" =measurement)

Perimetry aims to draw the map of the island of vision, such that it is a true representation for each eye and also aims to present it in a way which is clinically useful.

Standard visual field testing involves measuring the contrast sensitivity or the ability of an observer to just distinguish the target from the background.

Conventional visual field testing is performed with a white target against a more dimly illuminated white background [white on white or Standard Achromatic Perimetry (SAP)]

Two main types of SAP currently used in clinical practice are kinetic and static.

Kinetic perimetry

Kinetic perimetry defines threshold by moving the test object from a nonseeing (subthreshold) to a seeing (suprathreshold) area and recording the point at which it is first seen in relation to fixation. The boundaries, or contour lines, are called isopters.

Kinetic perimetry is typically performed manually by confrontation, on a tangent screen or with a Goldmann perimeter.

In kinetic perimetry, the stimulus usually is presented approximately 2^o per second toward fixation until the patient first perceives it. The stimulus is subsequently moved to another meridian in an periphery out of view and advanced toward fixation again until the patient sees it.

By repeating these manoeuvres at approximately 15^0 intervals around 360^0 of the visual field, the examiner defines a series of points that can be connected to describe an isopter corresponding to the stimulus used.

The careful examination of a visual field using Goldmann perimeter is time consuming and requires a highly trained technician. However it allows for a careful peripheral examination, and some patients especially elderly or those with advanced field loss, perform better on manual perimeters compared to automated devices.

Static perimetry

Static perimetry involves the presentation of stationary test objects, using either suprathreshold or threshold presentations.

Basic principles of visual field testing

1. Technician

To accurately interpret visual fields, the interpreter must be familiar with the skills and variations of the technician performing the tests. The technician can improve patient performance by monitoring the patient consistently during the examination.

2. Stimuli

The typical stimuli used in clinical perimetry are spots of light of various predefined combinations of diameter and intensity projected on the background. The

visibility of the stimulus also depends on how far the eye is positioned from the screen and the brightness of the background. The other factors affecting perception of the stimulus include the length of time the stimulus is presented, colour of the stimulus and of the background and the condition of the eye and the patient.

The Humphrey perimeter uses projected stimuli. The standard white stimuli can be varied in intensity over a range of 5.1 log units (51 decibels) between 0.08 and 10,000 apostilbs (asb). The decibel (dB) value refers to retinal sensitivity, rather than to stimulus intensity with 0dB corresponding to the maximum brightness that the perimeter can produce (10,000 asb) and 51dB to 0.08 asb.

In standardized testing with a size III white stimulus, the dimmest stimulus that can be seen foveally by a young, well- trained observer is at most about 38 to 40dB. Thus the upper 10 decibels of stimulus range from 41 to 51dB really fall outside the range of human vision.

3. Stimulus size

The standard target for both kinetic and static perimetry is a white disc, the stimulus value of which can be adjusted by varying the target size or luminosity relative to that of the background. In normal subjects, the mean retinal sensitivity has been shown to increase with the increasing size of the test object.[47]

The Humphrey perimeter is capable of testing with the five Goldmann stimulus sizes but the 0.43 degree Goldmann size III stimulus is used most of the time.

In practice, size V which is occasionally employed in advanced field loss, is the only other commonly used stimulus size. Size V is also the standard stimulus size in blue yellow perimetry (SWAP) .

4. Stimulus duration/exposure time

The exposure time will also affect the stimulus visibility. The stimulus presented over a larger period of time may become more visible, the phenomenon called temporal summation.

However, after the temporal summation is complete, which happens typically after 0.1 second, the image is not seen any better.

The Humphrey perimeter uses a stimulus duration of 200 milliseconds (ms), which is long enough for visibility to be little affected by small variations in duration, but still shorter than the latency for voluntary eye movements (about 250ms).

5. Background illumination

The level of background illumination affects the contour of the hill of vision and thus appearance of the visual field. Brighter background illumination increases the slope of the central field and may influence the appearance of field defects.

Standard Humphrey perimetry projects stimuli against a background with a brightness of 31.5 apostilbs. This background illumination was originally used by the Goldmann perimeter and has been adopted as a standard by the International Perimetric Society.

5. Area tested

To compare visual field charts, the same region of the visual field must be tested during serial examinations. For most purposes, tests examine alongside vertical and horizontal meridians.

Physiologic factors that influence visual field

The following factors should be compensated for, if possible or otherwise should be considered when interpreting the fields.

Patient variables

Age

Increasing age is associated with a reduction in retinal threshold sensitivity.[48]

This effects starts as early as 20 years of age, progresses linearly throughout life and involves the peripheral and superior areas more than the pericentric and inferior portions of the field.

Standard automated perimetry protocols compensate for age influence by using age bracketed databases.

The increase in fluctuation that occurs as the test moves toward the periphery is also greater with age. Mean sensitivity of the visual field decreases approximately 0.58-1.0 dB per decade. Increased age may be associated with increased variability in repeated test results over time.

Ocular variables

1. Pupil size

Pupillary diameter of less than 3mm can cause generalized depression of the visual field. It is usually best to test the field with a pupil that is at least 3mm in diameter.

Significant miosis may depress central and peripheral threshold sensitivities and exaggerate field defects.

Mydriasis has less influence on the visual field, although pupillary dilatation with tropicamide 1% in healthy subjects was shown in one study to significantly reduce threshold sensitivity with automated perimetry.[49]

2. Clarity of ocular media

Cataracts produce glare and change the intensity of the stimulus. Therefore, a cataract can cause or exaggerate central or peripheral field defects, which could be mistaken for the development or progression of glaucomatous field loss.

Reduced clarity of the ocular media from other causes such as corneal disturbance, a cloudy posterior lens capsule after cataract surgery or vitreous opacities may also affect visual fields.

Applanation tonometry before automated static threshold perimetry was found in a study to have no detrimental effect on the visual field results.[50]

3. Refractive error and retinal blur

When the projected stimulus is not focused on the retina, the edge of the stimulus is blurred, contrast is decreased and the stimulus may not be detected by the patient. The larger the stimulus, the less it is to be affected by the blur.

Refractive errors primarily influence the central field.[51] When a size III stimulus is used refractive errors of 1 diopter or less may not need to be corrected, because it usually will cause only slightly more than 1dB of general reduction of sensitivity.[52]

Mild myopia does not need correction, unless the refractive error exceeds 3 diopters.

Hyperopia has a greater influence on perimetric results, especially for the central field, and even small hyperopic refractive errors can significantly alter threshold sensitivity.[51][52][53]

Age tables are available to aid in determining the appropriate correction for presbyopia.

Astigmatism should be corrected unless the cylinder is less than 1 diopter in which case it can be included as the spherical equivalent.

Psychological factors that influence visual fields

The patient's understanding of the test and his or her alertness, concentration, fixation and co-operation all influence the results of visual field testing.

Fatigue effects

Full Threshold protocols take a long time to complete, and patients usually find visual field testing exhausting.

Fatigue causes artificially decreased sensitivity in the areas of existent glaucomatous defect.[54] Fatigue may also cause decreased performance in patients with glaucoma within central 10 degrees, as well as increased deterioration of the mean defect and localized loss in the periphery.[4]

Automated static perimetry

Automated perimetry is accepted as the standard way of measuring the visual field.

The major limitations of tangent screens and arc perimeters were lack of standardization of the test objects and the background, as well as patient fixation.

These needs were addressed in the era of standardization, which began in the middle of the 20th century with the contributions of Goldmann. The main problem that remained however was the subjectivity of both the patient and perimetrist.

Although the subjectivity of the patient has not been eliminated, the influence of the perimetrist was eliminated to variable degrees with the advent of automated perimetry in the 1970s.

In the last half of the twentieth century, several automated perimeters became available. Currently, the most widely used one is the Humphrey Field Analyzer (HFA) and the most common type is static perimetry.

Advantages of automated static perimetry are

- Shorter test duration
- Reproducible standardized testing conditions.
- No examiner bias.
- Can compare visual fields obtained in different centers.
- Availability of normative data.
- Sophisticated statistical analysis and more accurate monitoring.
- Better data storage capability.

- Higher sensitivity.
- Stimuli presentation at random locations and therefore improved patient fixation and absence of local retinal adaptation .
- No need for highly trained perimetrists.

The Humphrey field analyzer consists of four basic elements : the bowl or projection surface, the optical system, the central processor and the patient interface.

The bowl

The bowl of the HFA II is a patented, aspherical or bullet shaped surface upon which stimuli are projected. It was adopted because it improves patient ergonomics and reduces instrument size.

The distance from the eye to the centre of the bowl is 30 centimeters.

The bowl surface is textured to provide an almost perfectly matte finish known as a Lambertian surface which provides no direct or specular reflections.

The optic system

The Humphrey perimeter's optical system provides stimuli of known brightness for a known amount of time in a known location, and against a background of known brightness.

All five standard Goldmann stimulus sizes (I through V) are available, although most testing is done with the size III.

Stimuli are presented by aiming the projection system at the particular location to be tested, adjusting a set of neutral density filters to obtain the correct stimulus brightness and then opening the mechanical shutter for a fixed time, usually 200

milliseconds. Background brightness and stimulus brightness is checked at the beginning of each test and constantly during testing.

The central processor

The Humphrey's perimeters central processor not only fulfills many of the functions commonly seen in a standard desktop computer, it also must control the optical system as well as make complex, split second strategy adjustments based upon each patient response.

The system has a hard disk for program and data storage, a disk drive, and a video screen. All clinical data must be safeguarded by frequent backing up.

A printer is also available so that visual field test results may be printed for future reference.

The patient interface

The patient interface consist of a chin rest, a forehead rest, a trial lens holder, the patient response button and the instrument table and chair.

Test patterns/test programs

The standard programs on the Humphrey are the 30-2, 24-2, 10-2 and the macular grid program. The most commonly used are limited to the central 24 to 30 degrees with a 6 degrees separation between test locations.

In the 30-2, the central 30 degrees of the visual field are tested. It consists of 76 points 6 degrees apart on either side of the vertical and horizontal axis, such that the innermost points are three degrees from fixation.

In the 24-2 program, 54 points are examined. It is near similar to the 30-2 except that two peripheral nasal points at 30 degrees on either side of the horizontal axis are included while testing the central 24 degrees.

The 10-2 program tests 68 points 2 degrees apart in the central 10 degrees. This program helps to assess and follow up fixation characteristics in patients with an advanced disease along with the macular test which examines 16 points in the central 5 degrees each being 2 degrees apart.

Programs are also available to study the peripheral field beyond 30 degrees either in the nasal quadrant or for 360 degrees. The peripheral studies can be performed alone or in conjunction with a central field program and usually have wider target separation. Static testing of the peripheral nasal fields has been shown to provide valuable additional information in detecting glaucomatous field defects.

Testing strategies

Fully automated perimeters provide suprathreshold and full threshold measurements.

1. Suprathreshold static perimetry
2. Threshold related screening
3. Full threshold perimetry

Suprathreshold static perimetry

Suprathreshold static perimeters present a stimulus brighter than the anticipated normal value for the corresponding retinal location.

Threshold related screening

Herein, the intensity of the light presented is 5dB brighter than the actual threshold at the test point in question. This allows the entire field to be screened quickly. It can used as a screening test for detection and follow up known pathologies.

Full threshold perimetry

In automated perimetry, threshold values are defined as stimuli intensity detected 50% of the time. The most commonly used programs measure the retinal threshold at 70 to 80 points within the central 24 to 30 degrees.

In the Full Threshold strategy, stimuli are presented at predetermined locations using a 4-2 algorithm where the threshold is crossed twice, initially in a 4dB increments followed by 2dB increments.

Examination of the central 24^0 visual field using this technique takes 15-20 min.

Fastpac

Another thresholding strategy to reduce testing time is the FASTPAC program of the Humphrey field analyzer which estimates threshold from a single threshold crossing in 3dB increments, in contrast to the standard double threshold crossing with 4dB and 2dB. This strategy has been evaluated by several investigative teams most of whom agree that it provides time reduction at some expense of accuracy and reliability.

Swedish Interactive Threshold Algorithm (SITA)

In recent years, the new threshold strategy known as SITA has become increasingly popular. This algorithm uses standard 24-2 or 30-2 patterns to assess the

visual field based on the probability analysis of the patterns of glaucomatous damage and is more time efficient than standard threshold strategies.

Two versions of SITA are currently available

SITA Standard and SITA Fast

SITA standard takes approximately half the time to complete as compared to the Standard Full Threshold program and SITA Fast takes about half the time of the FASTPAC algorithm.

During the SITA test, the computer also produces an information index, which stops the test at the location being examined when threshold reaches a preselected level.

The goal of any test of the visual function is to improve test sensitivity and specificity. In the world of perimetry, one way to achieve this is by improving test reliability and variability by decreasing test duration without sacrificing the quality of the results. This has been accomplished using a Swedish Interactive Threshold Algorithm (SITA). The SITA strategy uses more efficient mathematical methods for estimation of threshold values based on normative data, patient age and patient responses during the test.

The threshold values are adjusted in real time during the test and pace is altered depending on the patient response speed.

The test time is also reduced by eliminating retest trials for short term fluctuation determination and redundant questioning for assessing false positive (FP) and false negative (FN) responses. By using this smart strategy of dynamic testing adjustment, SITA standard reduced the test duration by 50% compared to the Full

Threshold strategy, importantly this reduction in the test duration is not done by sacrificing quality. SITA matches and even surpasses the accuracy of the Full Threshold strategy.[55][56]

To further decrease the test duration by 30-50% SITA fast strategy was designed. However test retest reliability for this strategy is worse compared to the SITA standard.

Currently, the most common clinically used strategy of SAP is the SITA standard. One retrospective study found that defects assessed with SITA were often more pronounced when compared with standard Full Threshold perimetry but there were essentially no significant differences in quality.

Average time reduction by SITA standard depended on the severity of glaucomatous stage.

No significant time difference was found for advanced glaucoma, whereas normal fields using SITA were performed in half of the time of Full Threshold strategy.

The reduction of test time reduces the fatigue factor and thus a better detection of early glaucoma or progressing visual field damage.[3]

Humphrey single field printout

There are eight parts to the single field printout. Each has to be examined serially before drawing a conclusion.

Reproducibility (Zone – 1)

First assess the reproducibility of the concerned fields at the onset, check the printed information at the top of the page, to ensure listing of the correct patient, the

type of test done (30-2, 24-2, 10-2), eye in question and date of birth (the software package statistically compares the patients response with age corrected normal population).

The recorded visual acuity, refraction and pupil size are important parameters as they all can affect the data.

Reliability (Zone-2)

Interpretation of any visual field should start with the analysis of reliability indices. These indices are located in the upper-left corner of the single field analysis printout. Below are the reliability indices available on a Full Threshold and SITA printouts.

Fixation losses

Fixation losses are noted as the ratio of the number of times the patient responded when he saw a target placed in the blind spot against the total number of times fixation was tested.

Several methods of fixation monitoring are available on the HFA II

1. Fixation monitoring on the screen – A technician can monitor the patients eye on a screen to ensure a steady fixation.
2. Heijl Krakau technique (blind spot monitoring)- When a fixation monitor is set at blind spot, a Heijl Krakau technique[57] is used, where stimuli are projected several times during the test into an area of a previously mapped blind spot. If a patient responds to such stimuli it is assumed to be a fixation loss.
3. Gaze tracker – HFA II also has an option of a gaze tracker where the alignment of corneal reflexes and pupil is used to assess subjects fixation throughout the test.

Fixation losses exceeding 20% of the total trials are flagged, it is bracketed (XX) and is indicative of questionable reliability. However, not all fixation losses are due to unsteady gaze.

A "pseudo loss" of fixation is seen when there is a improper location of the blind spot, or when the initial blind spot is present near the edge of a scotoma, so even though it is presented throughout the test, it is occasionally visible.

Another source of error in this method is patient head tilt during the test. Even a small tilt can move the blind spot and result in artificially high fixation losses.

False positive(FP)errors

It is expressed as a ratio of the number of times the patient responds to a pause in the testing sequence without presentation of the target against the total number of pauses. It is the single most significant reliability indicator.

Bracketing occurs when FP's are 33% but often 15-20% rate can also destroy credibility of a field.

A high FP ratio, will be accompanied by a high positive mean defect, white areas on the gray scale which is an indication of very high threshold levels (white scotomas), a high number of fixation losses and a message of abnormal high sensitivity on GHT.

In a Full Threshold or FASTPAC strategy, false positive (FP) errors are registered when a patient responds to a catch trial in which an auditory stimulus is given in the absence of a visual stimulus.

SITA does not use 'catch trials' to register FP, instead it calculates them as responses that occurs outside the normal response time window. Patients with high FP

errors may be overly anxious and reassuring them that it is normal to miss 50% of the stimuli can usually cure “trigger happy” patients.

False negative(FN)errors

False negative errors are expressed as a ratio and occur when the patient does not respond when a point previously thresholded is retested with a brighter stimulus.A 33% FN ratio is considered excessive and makes the test unreliable.

However the presence of a scotoma and a high number of FN errors, with all other reliability measures being normal is indicative of a reliable field.

In a Full Threshold or FASTPAC strategy, false negative errors are recorded when a patient does not respond to stimuli 9dB brighter than previously registered at that location.

Two common causes of increased FN are

1. Patient fatigue (can produce a 'cloverleaf field')

2. End stage glaucoma.

SITA does not spend extra time during a test on catch trial; instead, FN errors are estimated at the end of the test as stimuli when, during threshold testing, a patient denied seeing a stimulus that was later found to be brighter. Only test points from the relatively normal parts of the visual field are considered in this analysis.

Visual field plots

Threshold sensitivity values (dB) are plotted from stimuli presentations at predetermined test locations.

Gray scale (Zone-3)

The gray scale is a schematic representation of threshold values. It helps to appreciate a general pattern of the visual field and draws attention to abnormal areas which require further careful studying.

It is a rough indicator of the extent of field damage but can be misleading.

Each point on the grayscale is represented by a symbol of varying darkness which corresponds to the threshold level at that point.

Total deviation plots (Zone-4)

Total deviation plots are calculated as a difference between the patient's threshold values and those of the age- matched normals, at each point.

This depending on whether the patient did better or worse than expected is expressed as a positive or negative number.

TD plots are center-weighted such that an abnormal central point is assigned more significance than a peripheral point. These are presented as dB plot (top left plot on the single field analysis) and as a probability plot (bottom left plot on the single field analysis).

These probability symbols increase in significance from a set of 4 dots to a black box, P<5%, <2%, <1% and 0.5%. The presence of black box indicates that a few normal subjects will have that score and it does not necessarily correspond to an absolute defect. Many points with P<0.5% are relative defects and their actual threshold is available from the raw data.

Pattern deviation plot (Zone-5)

Pattern deviation (PD) dB and probability plots are located to the right of the TD plots on the single field analysis printout.

PD is calculated by adjusting the overall sensitivity (TD values) of the visual field by the seventh most sensitive non-edge point, to differentiate focal defects from generalized changes.

Therefore, PD plots highlight focal visual field defects and ignore generalized changes.

Raw data/numeric data (Zone-6)

It is the actual threshold score for each threshold point.

Areas flagged in the pattern and total deviation plot should be inspected carefully for confirmatory signs like double threshold points of abnormal or foci of high local fluctuation. This should be followed by a geographic survey of the entire numeric data.

Global indices (Zone-7)

The global indices are presented in the lower right hand corner of the printout and include.

Mean deviation (MD)- It represents an average deviation of the patients visual field from the age matched controls.

Its calculation is centre weighted .A negative MD indicates a depressed field while a positive value represents a higher than normal sensitivity.

MD does not help in differentiating diffuse from focal loss.

Pattern standard deviation (PSD)

It represents the degree of irrregularity in the field. The higher the value the more uneven is the field indicating a focal visual field defect.

Usually an increase in PSD in a patient with glaucoma suggest progression.

Short term fluctuation (STF)

STF is available in the Full Threshold, but not in the SITA strategy

It represents the consistency of patient responses during a single test and determined by retesting the same ten points.

Corrected pattern standard deviation (CPSD)

CPSD represents a PSD corrected for STF. This is done in the attempt to eliminate irregularities in the visual field secondary to unreliable patient responses.

It is available in the full threshold but not in the SITA strategy.

Glaucoma Hemifield test (Zone-8)

The glaucoma Hemifield test (GHT) is used to identify localized visual field typical of glaucoma.[3]

In the test, both inferior and superior hemifield are divided into five zones and the average threshold values of the superior and inferior mirror images are compared.

Five different outcomes of the GHT are possible

1. GHT within normal limits.
2. GHT borderline.
3. GHT outside normal limits.
4. General reduction of sensitivity.
5. Abnormally high sensitivity.

MATERIALS AND METHODS

This was a descriptive observational study conducted in the Department of Ophthalmology from January 2010 to December 2010 to find out the sensitivity and specificity of Swedish Interactive Threshold Algorithm (SITA Standard) algorithm with the standard Full Threshold (FT) algorithm as gold standard in detecting glaucomatous visual field defects using the Humphrey Field Analyzer and also to compare the test time for SITA Standard and Standard Full Threshold algorithms.

SOURCE OF DATA

All diagnosed glaucoma patients attending ophthalmic OPD and IPD in KLE's Dr Prabhakar Kore Hospital and MRC Belgaum were included in the study. The procedure and investigations were explained to the patients and informed written consent was taken.

Method of Collection of Data

Study Design: Descriptive observational study

Sample Size: 60

Based on previous statistics of patients input.

Duration: One year (01st Jan 2010 to 31st Dec 2010).

A total of 60 patients who fulfilled the following inclusion criteria were included in the study.

Inclusion criteria:

1. A known diagnosis of primary open angle glaucoma.
2. Patients older than 17 yrs of age.
3. An applanation tonometer intraocular pressure of $\geq$ 21 mm of Hg.
4. Gonioscopically open angle.
5. A combination of optic disc changes like cupping, notching, thinning, or pallor of the neuroretinal rim suggestive of POAG.

The following patients were excluded from the study

1. Participants not willing to give informed consent.
2. Subjects in the eye care field.
3. History of congenital colour vision defect.
4. Refractive error of > 5 diopters of sphere or 2.5 diopters of cylinder.
5. History of ambylopia.
6. History of any disease, surgery or trauma to the eye being tested.
7. Abnormal pupillary reaction.
8. History of use of any medication that may affect the visual field.
9. History of cerebrovascular accident .
10. Patients with dense cataracts.
11. Eyes with any retinal pathologic condition that may affect visual field.
12. Suspicious appearing optic nerves or visual field defect associated with identifiable cause such as chorioretinal scar.

Effort was not made to have equal number of male and female patients. The eye selected for the study in a given patient was randomly selected by picking among the chits written with either R-Right eye or L-Left eye by the investigators. Doing visual fields with both SITA standard and FT algorithms for both the eyes was very time consuming for patients which may lead to fatigue effect resulting in poorer results, so only one eye was included in the study in each patient.

After obtaining informed written consent, a comprehensive evaluation of an individual with glaucoma was begin with eliciting detailed history which includes a review of the family and ocular and systemic history, use of systemic and ocular medications, past ocular surgery and known local and systemic intolerance to the use of glaucoma medications.

Clinical evaluation

Vision and Refraction

Best corrected visual acuity was determined and correction of refractive error was essential for accurate perimetry.

Pupils

Pupil size was noted and both direct and consensual light reflex was noted. The relative afferent pupillary defect was tested with swinging flash light test.

Biomicroscopy

Biomicroscopy of the anterior segment was performed with the help of slit lamp to detect signs of underlying disease.

Conjunctiva was examined for vasodilation and presence of papillae and follicles. Cornea was examined for punctate epithelial defects, microcystic epithelial edema and endothelial abnormalities.

The anterior chamber depth was estimated with a narrow slit beam directed at an angle of 60 degrees onto the cornea at limbus (Van Herick method).

Evaluation of iris was performed before dilatation to know the presence of heterochromia, atrophy, transillumination defects and ectropion uvea.

The lens was examined after dilatation and exfoliative deposits, phacodenesis, subluxation, and dislocation was noted along with lens size, shape and clarity.

Intraocular pressure (IOP mm Hg)

IOP was measured with Goldmann type of applanation tonometer before performing gonioscopy or dilatation of the pupil.

Technique of IOP estimation by applanation tonometer was as follows:

A drop of topical anaesthetic was placed in each eye and the tip of moistened fluorescein strip was touched to the tear film on the inner aspect of the lower lid. The tonometer and prism were set in correct position on slit lamp. The tension knob was set at 1 gm and the 0 graduation mark of the prism was set at white line on the prism holder, the cobalt filter was used with the slit beam opened maximally. The angle between the illumination and microscope was 60 degrees. The patient was seated comfortably on the slit lamp and the tonometer prism was advanced until the tip of the prism touches the cornea. A monocular view of the central applanated zone and the fluorescein stained tear film was obtained. The tip of the applanation prism was adjusted until the two equal semicircles were seen in view. The fluorescein rings were

approximately 0.25-0.30 mm in thickness. If fluorescein rings were thinner IOP was underestimated and additional fluorescein may be added. A wide fluorescein ring may over estimate IOP and excessive dye was dried with a tissue and IOP was estimated. The tension knob was rotated until the inner border of fluorescein rings approximate. The reading obtained was multiplied by 10 to give the IOP in millimetres of mercury. IOP was measured in each eye until three consecutive readings were found within 1 mm Hg.

GONIOSCOPY

Gonioscopic evaluation of the anterior chamber angle was done with help of Goldmann 3 mirror gonioscopic lens.

Technique

The patient sits with the head firmly against the head rest of the slit lamp and a local anaesthetic (4 % lignocaine) was instilled. 1 % methylcellulose solution was placed on the corneal aspect of the gonioscopic mirror. With the patient looking up , one edge of the lens was placed in the lower fornix, the upper lid was elevated, the patient was instructed to gaze straight and the lens was rotated against the eye. An inverted image of the opposite angle was viewed in the mirror. The scleral spur and the Schwalbe's line were most consistent angle landmarks which were used for identification of angle structures and their grading. Schwalbe's line was identified as the termination of the corneal light wedge; using a narrow slit beam sharply focussed, one could observe two linear reflections, one from the external surface of the cornea and its junction with sclera, and other, the internal surface of cornea. These two reflections meet at the Schwalbe's line. The scleral spur was identified by the site of insertion of the iris on the ciliary face, convexity of iris and the prominence of the

peripheral iris roll. The Shaffer's system was used to grade the anterior chamber angle.

OPTIC DISC EVALUATION

All patients had pupillary dilatation with 1% tropicamide and 5% phenylephrine. The optic nerve was evaluated using a slit lamp biomicroscope and a posterior pole lens (90 D lens) which offers a stereoscopic and a magnified view of the optic nerve head and retinal nerve fiber layer. The slit beam rather than diffuse illumination was used in detecting changes in the contour of the optic disc. These techniques require patient cooperation and pupillary dilatation for an adequate view of the optic disc details. The cup: disc ratio was measured and recorded. The presence of peripapillary atrophy, notching and optic disc hemorrhage was noted.

After the patient fulfilled the inclusion criteria from the above investigations, the patient was called on the next day for visual field evaluation as testing the visual field on the same day may give erroneous results due to corneal haziness.

VISUAL FIELD EVALUATION

All visual field examinations were carried out using the same Humphrey Visual Field Analyzer II- i series (Zeiss company) and by same perimetrist.

For patients receiving miotic therapy, the pupils were dilated with topical tropicamide 1 % and phenylephrine 5 % eye drops.

Each patients distance correction was entered into the perimeter's software. The software calculates the trial lens power needed according to the date of birth of the patient entered. This correction was used for all examinations, even those under cycloplegia.A rest period of 15 minutes was given between the two tests.

The order of testing was alternated between patients to equalize the fatigue effects among testing algorithms. However the order of the tests was kept constant for each patient over all testing sessions.

A standard Full Threshold (FT) test using program 30-2 and size III white stimulus on a white background was performed using a Humphrey Visual Field Analyzer II- i series perimeter (Zeiss company). Calculations of the total and pattern deviation plots and global indices (mean deviation,MD and corrected pattern standard deviation,CPSD) were derived using STATPAC, version 9.31.

Using the Humphrey Visual Field Analyzer II- i series (Zeiss), SITA standard test using program 30-2 and a size III stimulus on a white background was performed. Calculations of the total and pattern deviation plots and global indices (mean deviation,MD and pattern standard deviation,PSD) were derived using STATPAC for SITA, version A10.1.

Visual fields with any abnormal reliability parameter (fixation losses > 33 %, false positive responses >33%, or false negative responses> 33 %) were excluded and repeat testing was performed on a subsequent date.

SINGLE FIELD ANALYSIS PRINT OUT OF BOTH 30-2 FULL THRESHOLD AND SITA STANDARD ALGORITHMS WERE TAKEN AND ANALYSED AS FOLLOWS

All the 8 zones of the single field analysis print out were examined serially for detecting the glaucomatous visual field defect.

Minimal criteria for glaucomatous visual field defect were as follows:

1. Glaucoma hemifield test (GHT) outside normal limits.

2. Corrected PSD (for FT algorithm) or PSD(for SITA standard) with p values < 5%.
3. A cluster of three or more points on the pattern deviation plot in a single hemifield (superior or inferior)with p values < 5% , one of which must have a p value < 1%.

Any one of the preceding criteria was considered sufficient evidence of a glaucomatous visual field defect. Patients were not required to meet the same criteria on repeat testing, but were required to meet any one of the three criteria.

Full threshold(FT) and SITA(SS) Standard fields were used to classify patients into mild, moderate, or severe glaucomatous defects using the Hodapp Anderson Parrish (HAP) system.

Hodapp Anderson Parrish Visual Field Severity Score

Criteria for Early Defect

1. Mean deviation no worse than - 6 dB.
2. On pattern deviation plot, fewer than 25% of points depressed below the 5% level, and fewer than 15% of points depressed below the 1% level.
3. No point within central 5^0 with sensitivity < 15 dB.

Criteria for Moderate Defect

1. Mean deviation worse than - 6dB but no worse than -12 dB.
2. On pattern deviation plot, fewer than 50% of points depressed below the 5% level, and fewer than 25% of points depressed below the 1% level.
3. No point within central 5^0 with sensitivity of < 0 dB.
4. Only one hemifield containing a point with sensitivity < 15 dB within 5^0 of fixation.

Criteria for Severe Defect

1. Mean deviation worse than -12 dB.
2. On pattern deviation plot, more than 50% of points depressed below the 5% level and more than 25% of points depressed below the 1% level.
3. Any point within central 5^0 with sensitivity of < 0 dB.
4. Both hemifields containing a point or points with sensitivity < 15 dB within 5^0 of fixation.

STATISTICAL METHODS

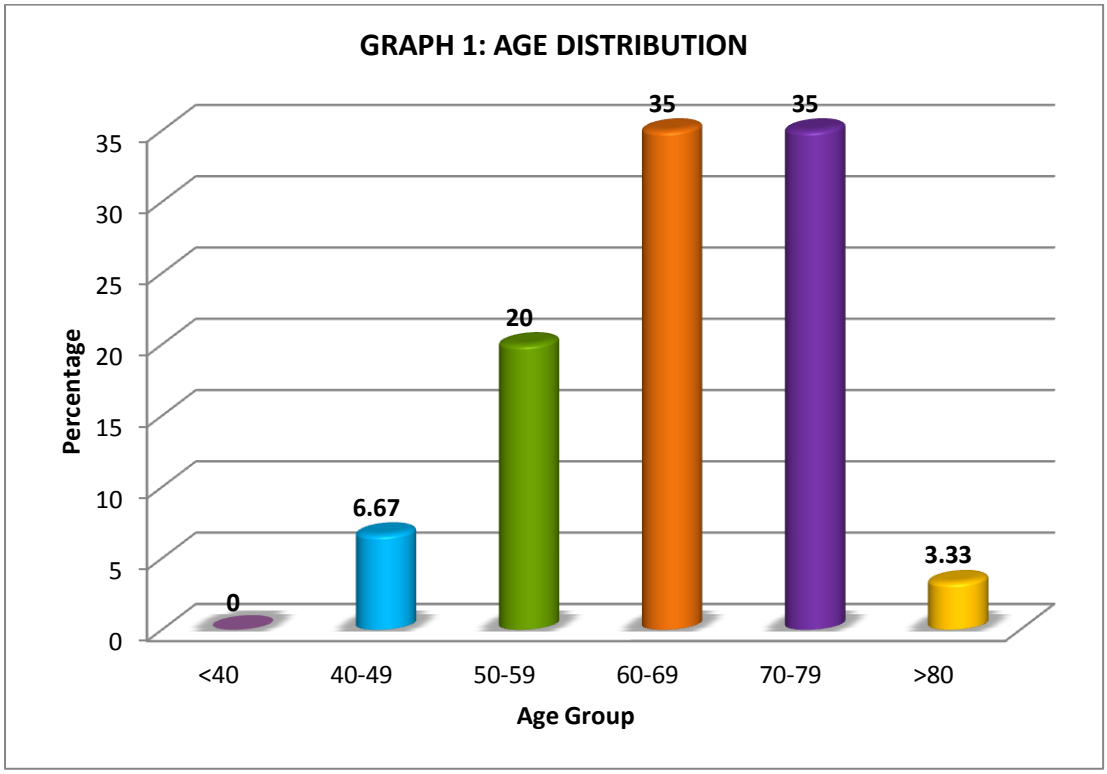
Distribution of demographic and clinical characteristics were noted. Correlation between IOP and C:D ratio was calculated using chi square test. Sensitivity and specificity of SITA Standard was determined using the Full Threshold fields as the reference or gold standard. Time for test completion of SITA Standard algorithm was compared with Full Threshold algorithm using chi square test. Mean deviation and Pattern standard deviation were averaged. Data analysis was performed using SPSS statistical data package editor, version 17.0.

OBSERVATIONS AND RESULTS

The present study was conducted at KLES Dr Prabhakar Kore Hospital and MRC, Belgaum and J N Medical College during the period of 01st January to 31st December 2010. During this period 60 patients who fulfilled the selection criteria were included in the study. The eye selected for the study in a given patient was randomly selected by the investigators. The eye for which visual fields was done was included for all the analysis of the results.

TABLE 1 - AGE DISTRIBUTION

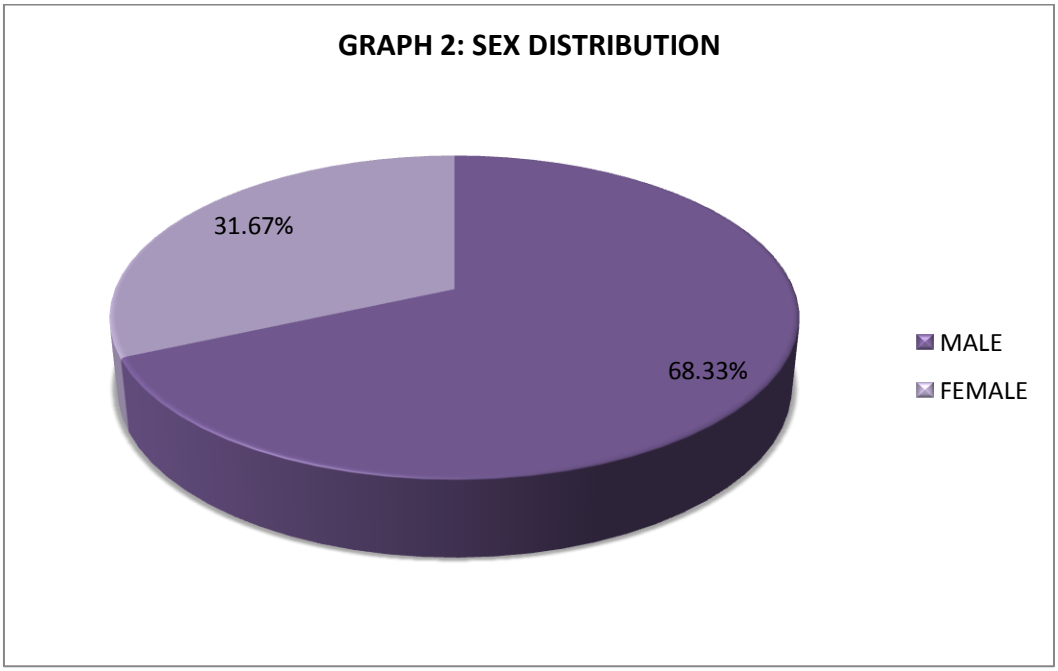
AGE GROUP	NUMBER OF PATIENTS	PERCENTAGE
< 40	0	0.00%
40-49	4	6.67%
50-59	12	20%
60-69	21	35%
70-79	21	35%
>80	2	3.33%
TOTAL	60	100%



Out of 60 patients, 21 patients (35%) belonged to the age groups of 60 to 69 years and 21 patients (35%) belonged to the age group of 70 to 79 years of age. 12 patients(20%) belonged to 50 to 59 years of age group, 4 patients(6.67%) belonged to the age group of 40 to 49 years and 2 patients (3.33%) belonged to the age group of > 80 years. No patients were found below 40 years of age. Maximum number of patients belonged to 6^{th} and 7^{th} decade of age. We had less number of patients below 50 years (6.67%) and above 80 years (3.33%). Mean age of patients was 63.63 years ± 9.81.

TABLE 2- SEX DISTRIBUTION

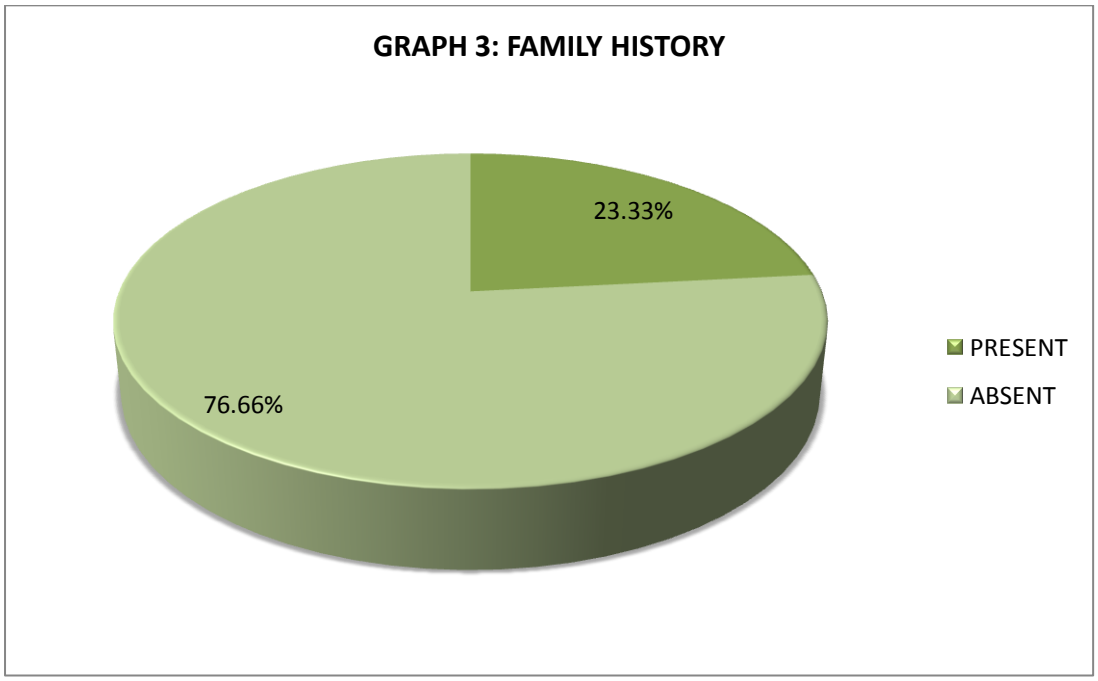
SEX	NUMBER OF PATIENTS	PERCENTAGE
MALE	41	68.33%
FEMALE	19	31.67%
TOTAL	60	100%



In the present study out of 60 patients , 41 (68.33%) were male and 19 (31.67%) were female patients.

TABLE 3- FAMILY HISTORY

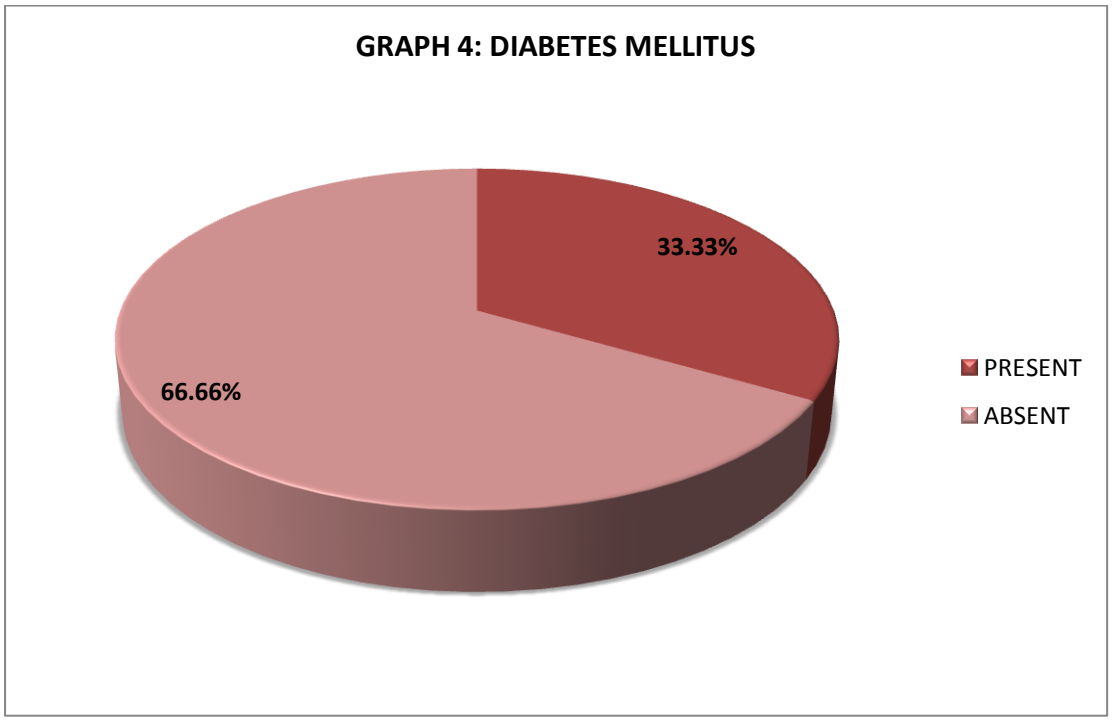
FAMILY HISTORY	NUMBER OF PATIENTS	PERCENTAGE
PRESENT	14	23.33%
ABSENT	46	76.66%
TOTAL	60	100%



In the present study, 14 patients (23.33%) had a positive family history of POAG in first degree relative (sibling, parent, or child) and 46 patients (76.66%) had negative family history.

TABLE 4- DIABETES MELLITUS

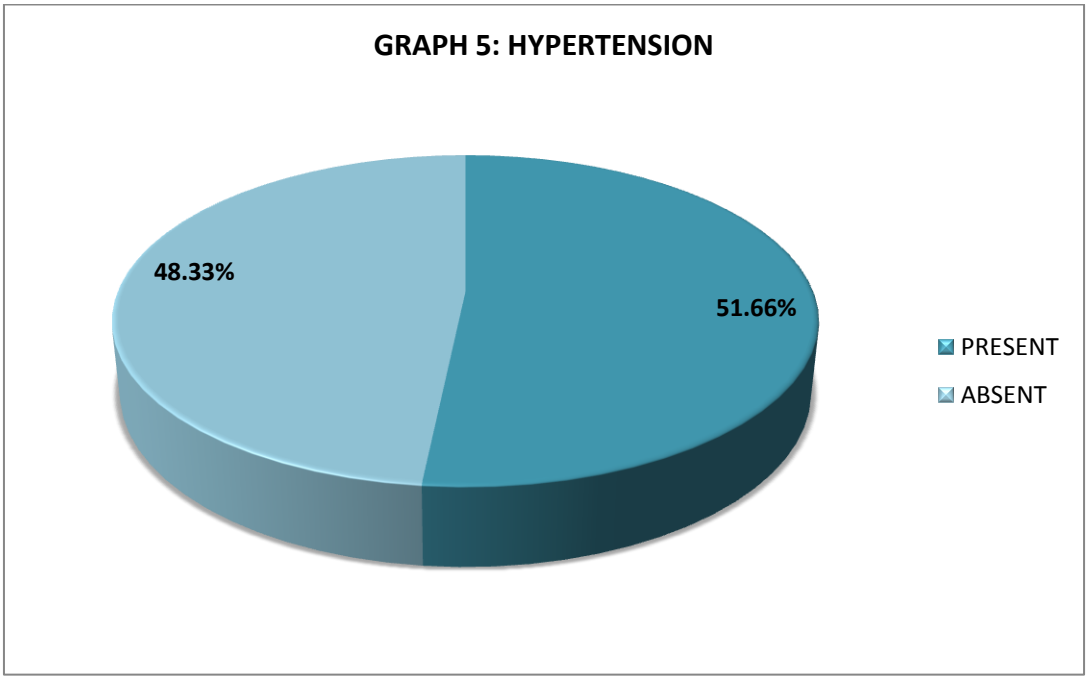
DIABETES MELLITUS	NUMBER OF PATIENTS	PERCENTAGE
PRESENT	20	33.33%
ABSENT	40	66.66%
TOTAL	60	100%



Out of 60 patients in the present study, 20 patients (33.33%) had diabetes mellitus and 40 patients (66.66%) did not have diabetes mellitus.

TABLE 5 - HYPERTENSION

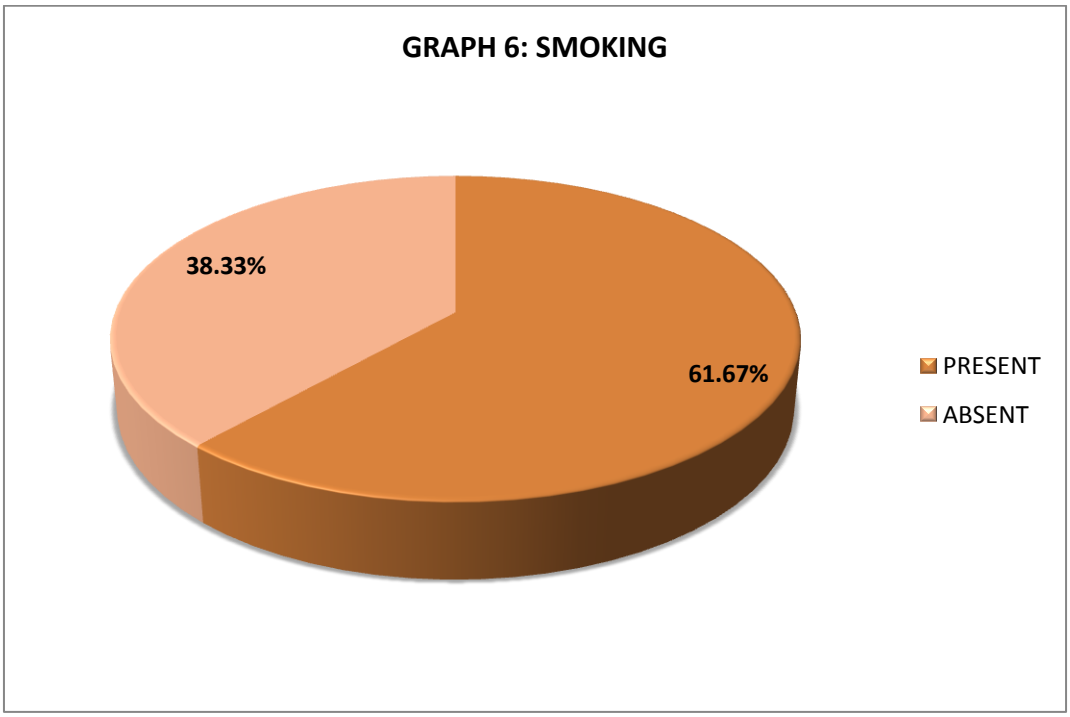
HYPERTENSION	NUMBER OF PATIENTS	PERCENTAGE
PRESENT	31	51.66%
ABSENT	29	48.33%
TOTAL	60	100%



Out of 60 patients in present study, 31 patients (51.66%) gave history of hypertension and 29 patients (48.33%) did not give history of hypertension.

TABLE 6 - SMOKING

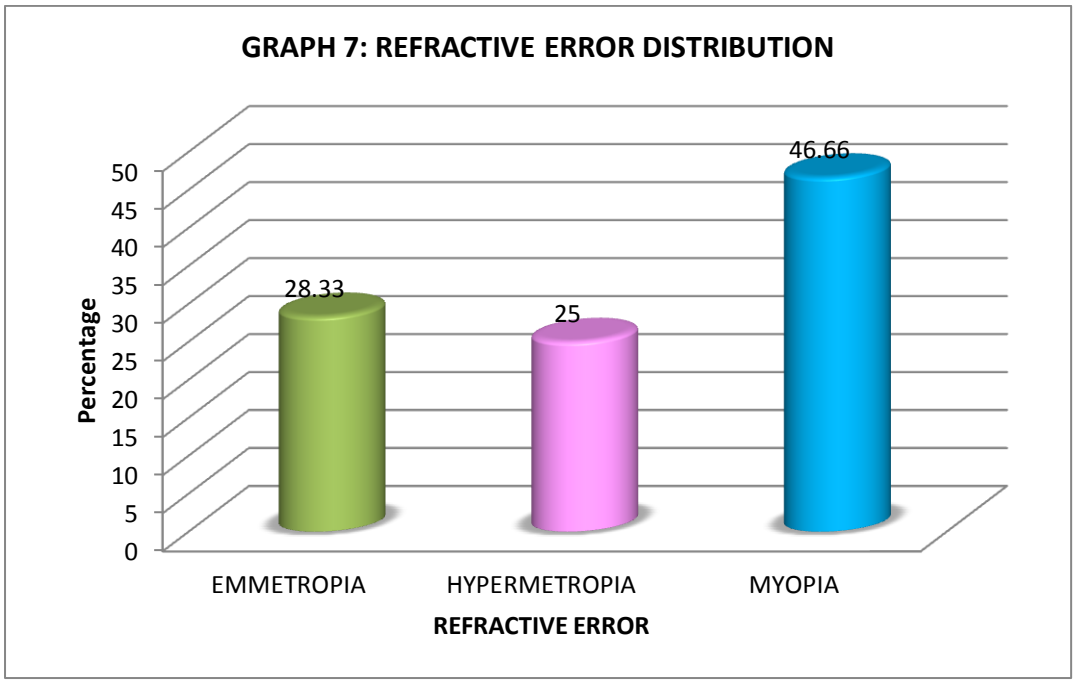
SMOKING	NUMBER OF PATIENTS	PERCENTAGE
PRESENT	37	61.67%
ABSENT	23	38.33%
TOTAL	60	100%



Out of 60 patients in the present study, 37 patients (61.67%) were smokers and 23 patients (38.33%) were non smokers.

TABLE 7 - REFRACTIVE ERROR DISTRIBUTION

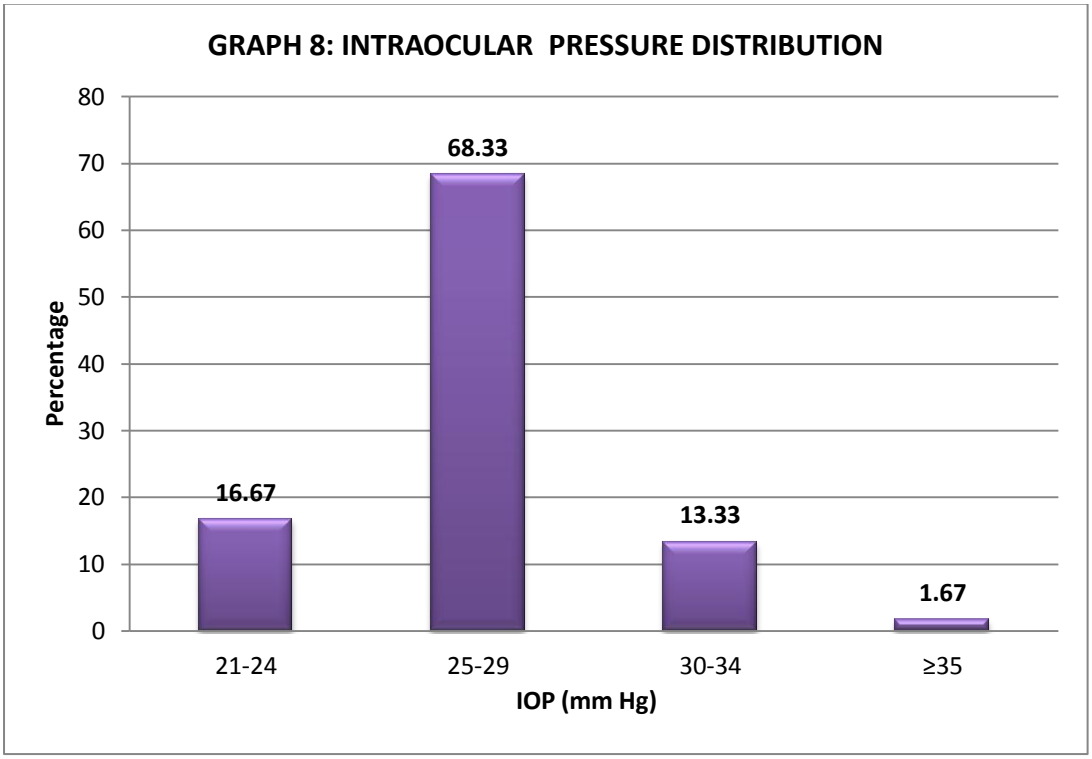
REFRACTIVE ERROR	NUMBER OF PATIENTS	PERCENTAGE
EMMETROPIA	17	28.33%
HYPERMETROPIA	15	25%
MYOPIA	28	46.66%
TOTAL	60	100%



Out of 60 patients in the present study, 28 patients (46.66%) were myopic, 15 patients (25%) were hypermetropic and 17 patients (28.33%) were emmetropic.

TABLE 8 - INTRAOCULAR PRESSURE (IOP mm Hg) DISTRIBUTION

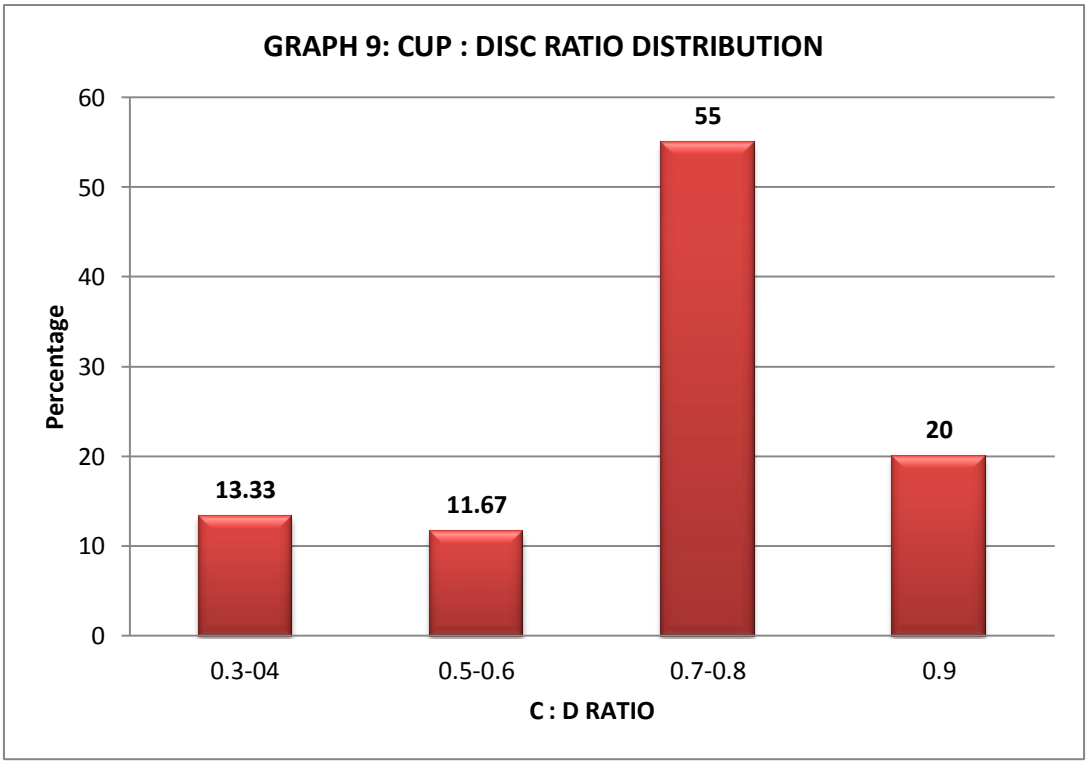
IOP (mm Hg)	NUMBER OF PATIENTS	PERCENTAGE
21-24	10	16.67%
25-29	41	68.33%
30-34	8	13.33%
≥35	1	1.67%
TOTAL	60	100%



In the present study, 41 patients (68.33%) had IOP in the range of 25 to 29 mm Hg, 10 patients (16.67%) had IOP in the range of 21 to 24 mm Hg and 8 patients (13.33%) had IOP in the range of 30 to 34 mm Hg. More number of patients (68.33%) had IOP in the range of 25 to 29 mm Hg and 1 patient had IOP ≥ 35 mm Hg. Mean IOP of 60 patients was 27.50 ± 3.30 mm Hg.

TABLE 9 - CUP : DISC RATIO DISTRIBUTION

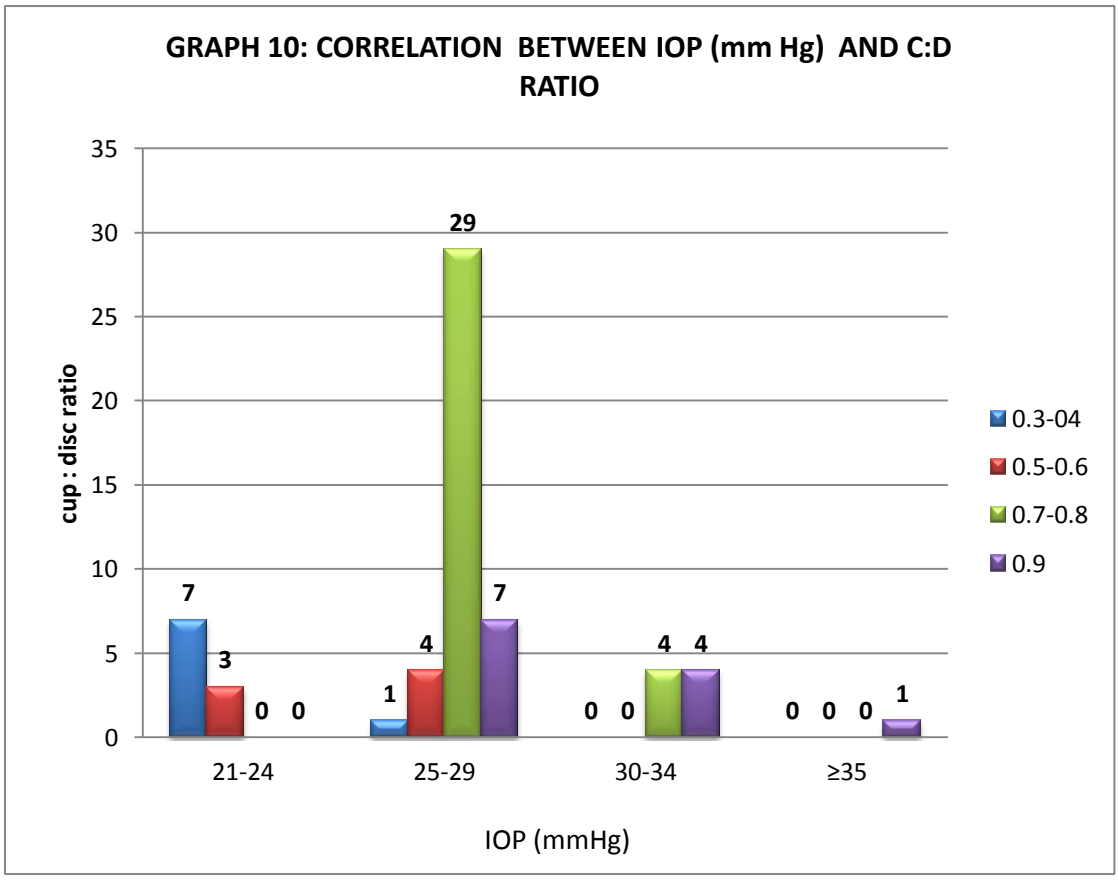
C : D RATIO	NUMBER OF PATIENTS	PERCENTAGE
0.3-0.4	8	13.33%
0.5-0.6	7	11.67%
0.7-0.8	33	55%
0.9	12	20%
TOTAL	60	100%



Out of 60 patients included in the present study, 33 patients (55%) had C:D ratio in the range of 0.7 to 0.8 . Around 12 patients (20%) had C:D ratio of 0.9 , 8 patients (13.33%) had C:D ratio in the range of 0.3 to 0.4 and 7 patients (11.67%) had C:D ratio in the range of 0.5 to 0.6. More number of patients(55%) had C:D ratio in the range of 0.7 to 0.8. Mean C:D ratio of 60 POAG patients was 0.71 ± 0.17.

TABLE 10 -CORRELATION BETWEEN IOP (mm Hg) AND C:D RATIO

C : D RATIO	IOP (mm Hg)			
	21-24	25-29	30-34	≥35
0.3-0.4	7	1	-	-
0.5-0.6	3	4	-	-
0.7-0.8	-	29	4	-
0.9	-	7	4	1
TOTAL	10	41	8	1

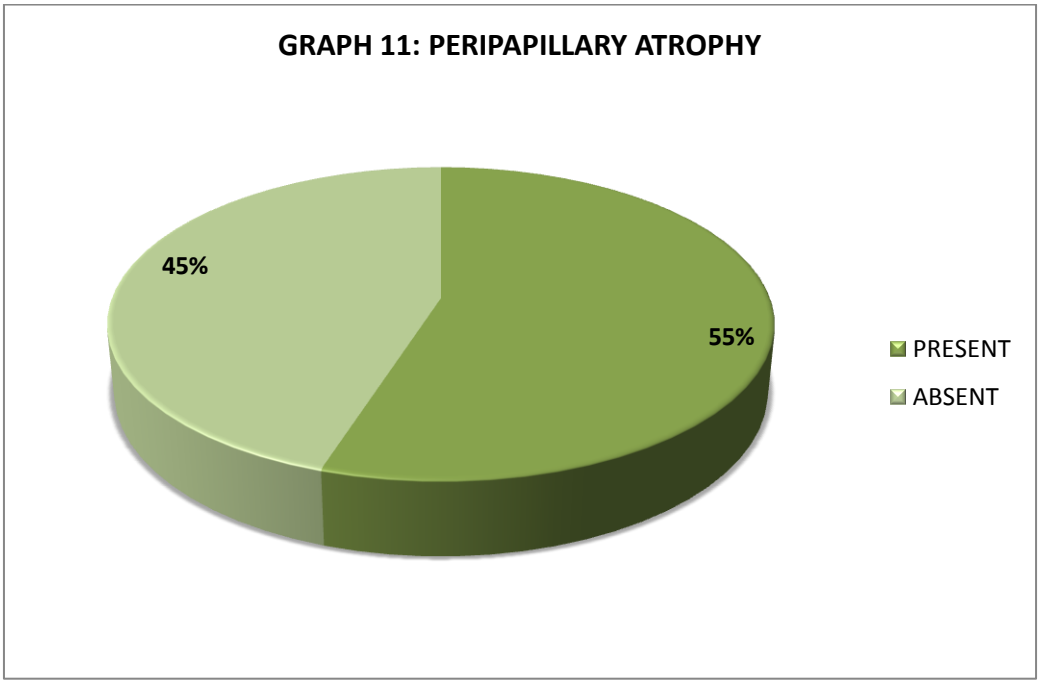


In the present study, among10 patients with IOP in the range of 21 to 24 mm Hg, 7 patients had C:D ratio of 0.3 to 0.4 and 3 patients had C:D ratio of 0.5 to 0.6. In patients with IOP in the range of 25 to 29 mm Hg, 1 patient had C:D ratio of 0.3 to 0.4, 4 patients had C:D ratio of 0.5 to 0.6, 29 patients had C:D ratio of 0.7 to 0.8 and 7 patients had C:D ratio of 0.9 and in patients with IOP more than 30 mm Hg, 4 patients had a C:D ratio of 0.7 to 0.8 and 5 patients had C:D ratio of 0.9.

When the increasing IOP was correlated with larger C:D ratio, p value was found to be < 0.0001 which indicates statistically significant good correlation between IOP and C:D ratio.

TABLE 11 - PERIPAPILLARY ATROPHY

PERIPAPILLARY ATROPHY	NUMBER OF PATIENTS	PERCENTAGE
PRESENT	33	55%
ABSENT	27	45%
TOTAL	60	100%



Out of 60 patients of POAG, peripapillary atrophy was present in 33 patients (55%) and was absent in 27 patients (45%).

In the present study, among 60 patients of POAG only 4 patients (6.66%) showed focal thinning or notching of the neuroretinal rim which was very negligible.

In the 60 patients of POAG, no patient showed optic disc splinter hemorrhages.

TABLE 12 - SENSITIVITY AND SPECIFICITY OF SITA STANDARD CALCULATED WITH THE FULL THRESHOLD ALGORITHM AS GOLD STANDARD IN DETECTING GLAUCOMATOUS VISUAL FIELD DEFECTS

SITA STANDARD (SS)	FULL THRESHOLD (FT)		
	Number of patients showing presence of visual field defect with FT	**Number of patients showing absence of visual field defect with FT**	**TOTAL**
Number of patients showing presence of visual field defect with SS	40 True positives	1 False positives	41
Number of patients showing the absence of visual field defect with SS	2 False negatives	17 True negatives	19
TOTAL	42	18	60

$$\text{SENSITIVITY} = \frac{\text{True positives}}{\text{True positives} + \text{False negatives}} \times 100 = 95.24\ \%$$

$$\text{SPECIFICITY} = \frac{\text{True negatives}}{\text{True negatives} + \text{False positives}} \times 100 = 94.44\ \%$$

$$\text{PREDICTIVE VALUE OF A POSITIVE TEST} = \frac{\text{True positives}}{\text{True positives} + \text{False positives}} \times 100 = 97.56\%$$

$$\text{PREDICTIVE VALUE OF A NEGATIVE TEST} = \frac{\text{True negatives}}{\text{True negatives} + \text{False negatives}} \times 100 = 89.47\%$$

DIAGNOSTIC ACCURACY OF TEST= 95.00%

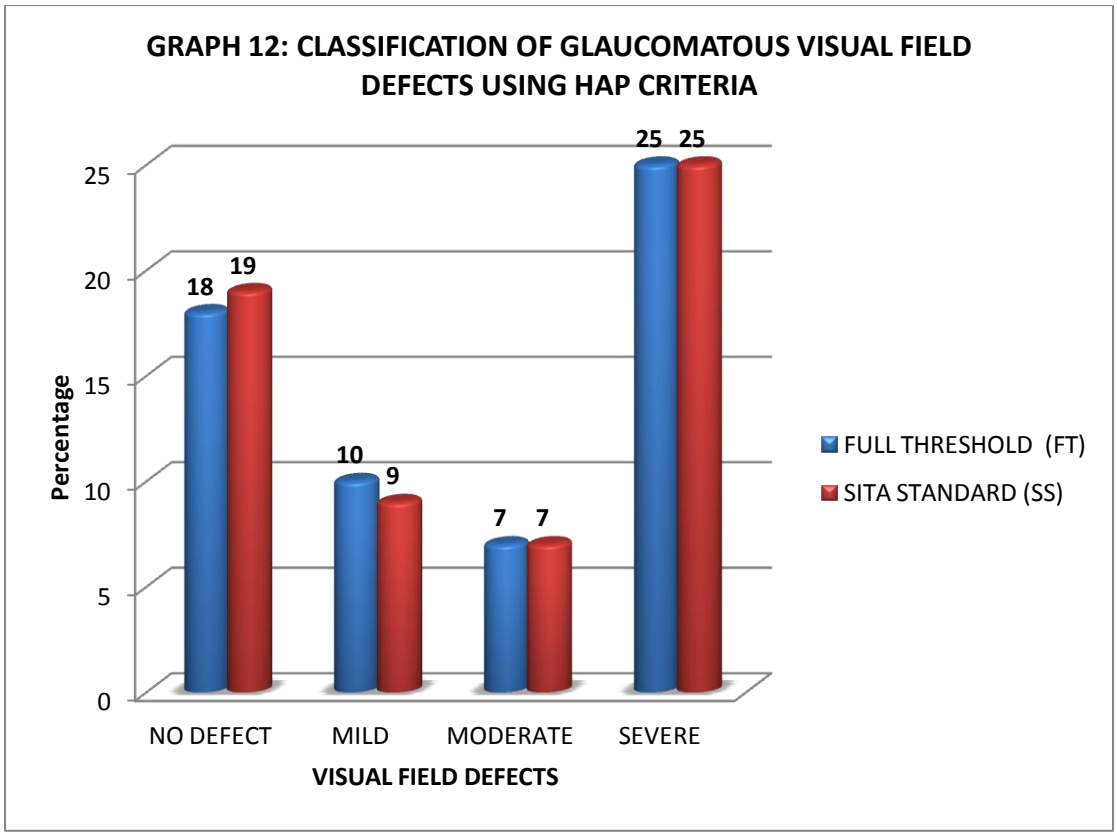
Sensitivity of a test is defined as ability of a test to identify correctly all those who have the disease.

Specificity of a test is defined as ability of a test to identify correctly those who do not have the disease.

The Sensitivity of SITA Standard was 95.24% in detecting visual field defects in POAG patients with the Full Threshold Algorithm as gold standard. The Specificity of SITA Standard was 94.44% in detecting visual field defects in POAG patients with the Full Threshold Algorithm as gold standard. The SITA Standard has low false positive and false negative rates. SITA Standard failed to detect glaucomatous defects in 2 cases(False negative). SITS Standard detected a visual field defect in 1 case(false positive) which was not detected by Full Threshold which is currently considered gold standard.

TABLE 13 - CLASSIFICATION OF GLAUCOMATOUS VISUAL FIELD DEFECTS USING HODAPP ANDERSON PARRISH (HAP) CRITERIA

VISUAL FIELD DEFECTS	FULL THRESHOLD (FT)	SITA STANDARD (SS)
NO DEFECT	18	19
MILD	10	9
MODERATE	7	7
SEVERE	25	25
TOTAL	60	60



The visual field defects were classified as mild, moderate and severe visual field defects according to Hodapp Anderson Parrish (HAP) criteria and the results of SITA standard were compared to that of Full Threshold algorithm respectively. There were 18 patients with POAG who had no visual field defects in Standard Full threshold algorithm and 19 patients did not show visual field defect with SITA standard algorithm. There were 10 patients with mild visual field defects in Full threshold of which only 8 were picked up by SITA standard algorithm to have visual field defect and one patient was false positive case where SITA Standard detected visual field defect which was not detected by Full Threshold. In 7 patients who had moderate visual field defects according to Full Threshold, all 7 were detected to have moderate visual field defects by SITA standard algorithm. In the remaining 25 patients having severe visual field defects by Full Threshold, all 25 had severe visual field defects by SITA Standard Algorithm.

From the findings of classification of visual field defects we find that 90 % results of the mild defects of SITA standard matched with results of Full Threshold.whereas for moderate and severe visual field defects there is 100% match between the results of SITA standard and Full Threshold algorithm.

In the classification of severity of visual field defects using the Hodapp Anderson Parrish (HAP) severity scale for the Full Threshold (FT) and SITA Standard (SS), there was no significant differences in the distribution of HAP severity scores among both algorithms.

TABLE 14 - TEST TAKING TIME IN POAG PATIENTS WITH FT AND SITA ALGORITHMS.

	FULL THRESHOLD (FT) ALGORITHM	SITA STANDARD ALGORITHM
TEST TAKING TIME IN MINUTES	14.33 ± 3.31	7.76 ± 1.44 (P< 0.0001)

All values are expressed as mean minutes ± standard deviation.

Mean reduction = 6.57 minutes

Percentage reduction = 45.84%

p value < 0.0001 (p value are compared with full threshold)

The SITA Standard reduced test taking time by 45.84% and it reduced test taking time at a statistically significant level in glaucoma patients (p< 0.0001).

TABLE 15 - MEAN DEVIATION (dB) IN POAG PATIENTS

	FULL THRESHOLD	SITA STANDARD
MEAN DEVIATION (dB)	-13.47 ± 9.80	-13.55 ± 9.91

All values are expressed as mean ± standard deviation.

p value was 0.9667 which was not statistically significant.

Mean deviation value was 0.08 dB better in SITA Standard fields compared with Full Threshold fields in POAG patients.

TABLE 16 - PATTERN STANDARD DEVIATION,PSD (dB) IN POAG PATIENTS

	FULL THRESHOLD	SITA STANDARD
Pattern standard deviation,PSD (dB)	8.69 ± 3.58	8.72 ± 3.84

Difference between Full Threshold (FT) Pattern standard deviation, PSD and SITA Standard Pattern standard deviation,PSD was 0.03 dB and with p value of 0.9692 which was not statistically significant.

DISCUSSION

The present descriptive observational study included 60 known POAG patients who met inclusion criteria.

Visual field analysis and optic nerve visualization are critical features used in the diagnosis and management of glaucoma. Full threshold white-on-white automated perimetry is currently the gold standard for the diagnosis, grading and detection of progression of glaucomatous visual field defects. However the standard Full Threshold method for measuring the visual field is very time consuming for patients and is subject to fatigue effect, which has been shown to result in poorer results. This effect may be more pronounced in glaucoma patients. The Swedish Interactive Threshold Algorithm (SITA) is a computer program developed for the Humphrey visual field analyzer II , which reduces test taking time considerably.

Because of the time savings that SITA provides, it has been suggested that this testing algorithm should replace the Full Threshold algorithm, which has been the gold standard for detecting and following glaucomatous visual field defects. However, few studies have been performed to determine the sensitivity and specificity of SITA in diagnosing glaucomatous visual field defects. So the current study was done to determine sensitivity and specificity of SITA standard and to compare the time taken by SITA Standard in detecting glaucomatous visual field defect using the Full Threshold algorithm as the reference, or "gold" standard.

When the age distribution was studied in our 60 POAG patients, the youngest patient was of 41 years and the oldest was of 87 years .The mean age of the studied population was 63.63 years and a standard deviation of 9.81 years. Suzuki et al [(58)] in his study found the mean age of 119 POAG patients was 63.8 ± 12.0 years which

correlates with our study. Gyasi et. al [59] in his study found that the mean age of the studied population was 53.2 ± 16.3 years which was slightly lower because the mean age of onset of POAG is usually lower in African population than Asian population.

Even though our inclusion criteria for age started at 17 years of age, no patient in the present study was below 40 years of age. Lin[60] in his study found that 80.97 % of POAG patients were over 40 years old .In a study by Song [61] he showed that in the POAG patients, age range was between 18 and 78 years and peak was seen in the population over 40 years old. From the results of above studies it is seen that POAG is uncommon before 40 years of age.

The number of POAG patients significantly increased from 6.67% in 40 to 49 years of age group to 35% in 60 to 69 years and 35% in 70 to79 years age group indicating that there is an increase in the number of patients with POAG with each subsequent decade of life. Increased age may reflect the cumulative effects of many factors that cause the aging optic nerve head to be more vulnerable to IOP, even of normal range leading to POAG.

The influence of gender on glaucoma has not been as straight forward as may be expected from the generally skewed elevation in IOP among women after 40 years of age. Results from different prevalence studies have not been conclusive in showing gender preponderance as some studies report male prevalence of POAG to be twice as high as females or vice versa while others report no such association at all. In the present study, there were more than double number of male patients compared to the female patients. Our findings are similar to the hospital based study done by Gyasi et al[59] , where among the total of 446 POAG patients, there were nearly twice as many males (n=292[65.5%]) compared to females (n=154[34.5%]).Lin et al[62] in his

investigation showed that the number of male POAG patients was 2.55 times that of female POAG patients which also correlates with our study. C. Hong et al[63] in his study found that POAG showed a slightly higher frequency of occurrence in males (54.2 %). These findings probably reflect the socio-cultural aspects of male dominance in our rural and sub-urban population where men control the family wealth and are more likely to have the upper hand in acssessing ' pay- for- health ' care services.

A family history of POAG is generally considered to be an important risk factor for POAG and having a first degree relative with glaucoma has been consistently associated with an increased risk of POAG. In the present study only 23.33% of patients had a positive family history of POAG in first degree relative (sibling, parent or child) . Kellerman et al[64] in his study found that a family history of glaucoma was found in 13 to 25 % of glaucoma patients which correlates with the results of our study. In the Tajimi Study, the information obtained in the interview with participants about the family history of glaucoma was very less (5/119).[58]

As with any observational study, this study had important limitations of high degree of illiteracy in our rural and suburban population leading to the decreased awareness of glaucoma in our study population and the use of oral reports of glaucoma history among relatives and also recall problems in patients about family history of POAG because of which less number of patients gave a positive family history.

There is an association between diabetes mellitus and POAG, as people with DM are more prone to POAG and diabetics tend to have higher IOP compared to nondiabetics. In the present study of 60 POAG patients, 33.33 % of patients were

having diabetes mellitus. Lin et al[65] found that in his study group of 76,673 POAG patients, more than 30 % (30.2 %) had diabetes mellitus which is similar to the results obtained in the present study. Similar results were found by Jau- Der Ho et al[66] in their study of 4032 patients with POAG and found that 1043 patients (25.9%) gave a positive history of diabetes mellitus. In our study quite a number patients of POAG were found to be diabetic indicating that diabetes mellitus may be commonly seen in POAG patients.

Systemic hypertension may be associated with primary open angle glaucoma as the capillary circulation at the disc may be more precarious in a patient with systemic hypertension. In the present study 51.66 % of POAG patients gave a positive history of hypertension. Lin et al[65] in the study of 76,673 POAG patients found that more than half (50.5%) of patients had hypertension which correlates with present study. Jau- Der et al[66] in his study of 4032 POAG patients found that 1968 patients (48.8%) had a positive history of hypertension which is similar to the results of present study. Leighton et al[67] found that systolic and diastolic blood pressure readings were significantly greater in open- angle glaucoma than either normal controls or in low tension glaucoma.

Smoking is one of the risk factors for POAG. So when the history of smoking was evaluated in the present study, 61.67% of patients were found to be smokers. Hasnain et al[68] in his study found that out of 66 patients with POAG, 41 were smokers (62.12%) which was similar to the results obtained in the present study. Suzuki et al[58] found that among 119 POAG patients in his study 51 patients (42.85%) were smokers.

Myopia is a one of the risk factor for POAG and patients with POAG were more likely to have myopia than hypermetropia which is commonly associated with angle closure glaucoma.In the present study more number of the patients were found to be myopic (46.66%) and hypermetropia was less common (25%).Suzuki et al[58] in his study found that among 119 patients with POAG, 40.18% of patients were myopic. We did not evaluate the association of POAG with high degrees of myopia which has long been recognized by various studies as our exclusion criteria included refractive errors of > 5 diopters of sphere.

Intraocular pressure remains the most significant risk factor for the POAG and indeed the only one that can be currently modulated. The mean IOP of 60 patient's in the present study was found to be 27.50 ± 3.30 mm Hg. Chul Hong et al[63] in his clinical study of 206 Korean glaucomatous patients found that mean IOP of POAG patients was 33.4 ± 15.5 mm Hg. In the present study the mean IOP of 60 POAG patients was slightly lower may be due to the fact that maximum number of patients included in the study were known POAG patients already on antiglaucoma medications.

When the distribution of IOP across the present study was studied , more number of patients (68.33%) were found to have IOP in the range of 25 to 29 mm Hg compared to the 21 to 24 mm Hg(16.67%) , 30 to 34mm Hg(13.33%) and ≥ 35mm Hg (1.67%) which indicated tha there are more number of patients were with higher IOPs. In the present study, 81.66 % of patients had IOP in the range of 25 to 34 mm Hg which indicated that delay in seeking help and poor glaucoma status in our rural and suburban population.

The cup disc ratio is the parameter that is used to define glaucoma and is also treated as a risk factor as many studies have reported a higher CD ratio in POAG patients. Mean C:D ratio of 60 POAG patients was 0.71 ± 0.17. Wensor et al[69] in the study of prevalence of glaucoma in the Melbourne Visual Impairment Project found that in 56 diagnosed POAG patients the mean C : D ratio was 0.74 with standard deviation of 0.28 which was similar to the results of present study.

In the present study 75 % of patients had cup : disc ratio more than 0.7 .In the study by Gyasi et al[59] on presentation patterns of primary open angle glaucomas in North Eastern Ghana more than seventy percent (70.2 %) eyes had cup to disc ratio greater than 0.8 which correlates with our study. Sommer et al[70] found that 70 % of glaucomatous eyes showed vertical contour cup:disc ratios greater than, or equal to, a value of 0.6 at the time glaucomatous visual field loss first became evident. Armaly[71] reported that cup : disc ratio was increased when visual field loss was first detected in patients with glaucoma.

It is found that higher the IOP, the larger the cup-disc ratio. In the present study correlation between IOP > 21 mm Hg and cup disc ratio of > 0.7 was found to be statistically significant with p value < 0.0001 which indicates that higher C:D ratio was found in patients with high IOP. Varma and colleagues[72] found that the higher the IOP, the larger the cup-disc ratio. Gyasi et al[59] in his study found that the relationship between high intraocular pressure (IOP > 30 mm Hg) and vertical cup disc ratio = 1.0 was found to be statistically significant (p= 0.0001).It is possible that these findings derives from simple back-ward forces associated with the IOP, causing the disc surface to be positioned in a way that it enlarges the cup at higher IOP.

In the present study among 60 patients of POAG, peripapillary atrophy was present in 55 % of patients. Primrose et al[73] in a survey of new glaucoma patients over 40 years of age found that in 52 POAG patients the typical peripapillary halo was observed in 28 patients (53.8 %).

In the present study of 60 POAG patients, only 4 patients (6.66%) showed focal thinning or notching of neuroretinal rim . Focal thinning or selective loss of neural rim tissue in glaucoma occurs in the early stages of damage and in the present study maximum number of patients presented with severe disease because of which notching or thinning of NRR was found in negligible number of patients in the present study.

In the present study of 60 POAG patients, no patient showed optic disc hemorrhage . Optic disc hemorrhages usually occur more commonly in patients with normal-tension glaucoma than in patients with POAG .

In the present study other disc changes of POAG like nasalisation of vessels , laminar dot sign and barring of circumlinear vessels were observed but were not evaluated as they may not be specific for POAG.

The visual field evaluation was usually done previously by Full Threshold white-on-white automated static perimetry which is currently the gold standard. But because of the considerable time savings with the new SITA standard algorithm by reducing the number of stimuli by 26%,changes in the pacing of the test and elimination of retest trials to calculate short term fluctuation, SITA Standard is now preferred over Full Threshold . SITA standard 30-2 program is more commonly used in the present era in the busy glaucoma clinic to detect the glaucomatous visual field defects. Despite the widespread adoption of the SITA Stanadard for the detection and

follow up of glaucomatous visual field defects, relatively little has been published on the sensitivity of this algorithm compared with Full Threshold perimetry, long considered the " gold standard " in visual field testing. Because the diagnosis of glaucoma relies on a constellation of clinical signs (progressive characteristic optic nerve cupping usually accompanied by characteristic visual field defects), currently there is no gold standard for the diagnosis of glaucoma. However, in deciding whether individual patients have characteristic visual field loss, Full Threshold automated perimetry is currently considered the gold standard in clinical trials and clinical practice. Any new perimetric algorithm must be compared with this standard.

In our study, sensitivity and specificity of SITA Standard was found with Full Threshold as gold standard. The sensitivity of SITA Standard in detecting glaucomatous visual defects was 95.24% in primary open angle glaucoma patients. The specificity of SITA Standard in detecting glaucomatous visual field defects was 94.44%. Our minimal criteria for glaucomatous visual field defect included, glaucoma hemifield test (GHT) outside normal limits, corrected PSD (for FT algorithm) or PSD (for SITA Standard algorithm) with p values < 5%, or a cluster of three or more points in the pattern deviation plot in a single hemifield (superior or inferior) with p values < 5%, one of which must have a p value < 1%.

Budenz et al[(74)], compared the sensitivity and specificity of SITA Standard using Full Threshold testing as the reference standard. The sensitivity of SITA Standard in detecting glaucomatous visual field defects was 98% and specificity was 96% in 82 glaucoma patients. Their criteria for glaucomatous visual field defect was similar to criteria used in the present study.

Sekhar et al[75] compared the sensitivity of SITA Standard with Full Threshold algorithm. In their study of 48 glaucoma patients using Full Threshold as the gold standard, the SITA standard algorithm yielded a sensitivity of 95%. Their criteria for abnormality did not include the corrected pattern standard deviation(CPSD) / PSD or point- wise criteria used in the present study , but only GHT; and a GHT that was borderline was considered positive in that study.

Sharma et al[76] reported the sensitivity and specificity of SITA standard in 102 patients. Their study included patients with ocular hypertension and glaucoma suspects. Only one test was performed on each subject using Full Threshold and SITA standard programs and seven different criteria for abnormality were assessed. Sensitivity for detecting a glaucoma defect ranged from 83% to 93%, depending on the criteria used for identifying glaucomatous defects, and specificity ranged from 79% to 96%.

From the results of the above studies we can see that even though different criteria were used to determine sensitivity and specificity in different studies there was not much difference in the sensitivity and specificity in all the above studies.

In the classification of severity of visual field defects using the Hodapp Anderson Parrish (HAP) severity scale for the two algorithms Full Threshold (FT) and SITA Standard (SS), there was no significant differences in distribution of HAP severity scores among both algorithms.

Budenz et al[74] compared the glaucomatous visual field defects using Standard Full Threshold and SITA algorithms and found that there was no significant differences in Hodapp Anderson Parrish severity scores among algorithms ($p= 0.19$).

Results of FT and SITA tests did not differ substantially using the HAP scale, indicating that the classification of defects as mild , moderate or severe is similar between algorithms and does not require modification. This scale can be helpful in classifying glaucoma severity to set target intraocular pressure goals.

In detecting moderate and severe visual field defects, SITA Standard(100%) was as good as Full Threshold algorithm, but in mild visual field defects there was a chance of missing the defects by SITA standard(90%) which were picked up by Full Threshold Algorithm.

The test time saved with SITA standard was calculated as the Standard Full Threshold algorithm for measuring the visual field is very time consuming and is subject to fatigue effect which may lead to poorer results. In our study, the mean test taking time with Full Threshold algorithm was 14.33 ± 3.31 minutes and for SITA standard algorithm it was 7.76 ± 1.44 minutes. The mean reduction in test taking time with SITA standard compared to Full Threshold algorithm was 6.57 minutes and percentage reduction was 45.84% . p value was < 0.0001 which was statistically significant (p value are compared with Full Threshold).

Budenz et al[74] in their study on 82 glaucoma patients showed that test time saved with SITA standard was approximately 47 % compared with Full Threshold.

Sekhar et al[75] in a study on 48 glaucoma patients showed that the mean time saved with the SITA standard strategy was 53.12% as compared with the Standard Full Threshold program.

Sharma et al[76] in his study found that mean duration of the Full Threshold test was 11.02 ± 1.8 minutes (range 7.5 to 16.5 minutes) and mean duration of SITA test was 5.65 ± 1.2 minutes (range 4.1 to 10.2 minutes). The mean difference between

length of Full Threshold test and that of SITA for all participants was 5.4 minutes, representing a 48.8% decrease ($p < 0.0001$).

Bengtsson et al[77] in their evaluation of SITA strategy in 20 normal subjects found that in all subjects test times were shortest with SITA, 6.14 minutes in average, which was 50% as compared to Full Threshold ($p < 0.001$) with an average of 12.27 minutes.

Wild et al[78] in his study of 29 patients of POAG experienced in automated perimetry found that the group mean examination duration was approximately 53 % shorter for the SITA Standard algorithm compared to the Full Threshold algorithm (p value < 0.001), regardless of the number of visits and age.

Bengtsson et al[79] in his study of 32 patients with manifest and suspect glaucoma found that SITA test consumed 54% less time of the time taken by Full Threshold test on average and SITA test time was significantly shorter than Full Threshold ($p < 0.0001$).

So from the above studies it is seen that SITA standard considerably reduces the test taking time resulting in less patient and retinal fatigue with better results.

In the present study, Mean deviation (MD) value was 0.08 dB better in SITA Standard fields compared with FT fields in POAG patients with p value of 0.9667 which was not statistically significant.

Budenz et al[74] compared Mean deviation(MD) in 82 glaucoma patients using Full Threshold and SITA Standard algorithms and found that Mean deviation was shown to be only slightly better in SITA Standard algorithm compared with Full

Threshold algorithm. Mean deviation values were 0.7 dB better in SITA Standard field compared with Full Threshold field in glaucoma patients.

Wild et al[80]compared Mean deviation(MD) in normal and glaucoma subjects using Full Threshold and SITA Standard algorithms and found marginally better values with the SITA Standard algorithm than with the Full Threshold algorithm.

In a study of 330 normal subjects, Bengtsson and Heijl[81] found that Mean deviation(MD) was 1.2 dB higher using SITA Standard than Full Threshold.

Budenz et al[82] in his another study of comparision of glaucomatous visual field defects using Standard Full Threshold and Swedish Interactive Threshold Algorithms found that Mean deviation(MD) was worse in the FT fields compared with SITA Standard algorithm.

Given the results of these studies, there appears to be little, if any, difference between the FT and SITA algorithms in mean deviation scores.

In the present study, difference between Full Threshold (FT) Pattern standard deviation(PSD) and SITA Standard(SS) Pattern standard deviation(PSD) was 0.05 dB and p value was 0.9343 which was not statistically significant.

Budenz et al[74] in his study found that Pattern standard deviation(PSD) values using SITA Standard algorithm compared with Full Threshold algorithm was not statistically significantly (p value 0.35) different in glaucoma patients.

Budenz et al[82] in his another study of comparision of glaucomatous visual field defects using Standard Full Threshold and Swedish Interactive Threshold Algorithms found that there was no significant difference in Pattern standard

deviation(PSD) values of SITA Standard compared with Full Threshold (p value 0.08).

In the present study, Pattern standard deviation(PSD) values were not significantly different and it may be suggested that this factor may be compared if follow-up fields are obtained with a SITA Standard test in a patient who has previously undergone testing with Full Threshold (FT).

CONCLUSION

The conclusions drawn from the present study were as follows

- In the present study, the SITA Standard showed high sensitivity(95.24%) in detecting glaucomatous visual field defects with Full Threshold algorithm as gold standard in primary open angle glaucoma patients. The SITA Standard algorithm showed high specificity(94.44%) in detecting glaucomatous visual field defects with Full Threshold algorithm as gold standard.
- The SITA Standard showed considerable time savings(45.84%,6.57minutes) when compared to Full Threshold algorithm in detecting glaucomatous visual field defects in primary open angle glaucoma patients and the reduction in test taking time was statistically significant.
- Because of the considerable time savings with SITA standard algorithm, it produces more accurate representation of the visual fields in glaucoma patients than Full Threshold algorithm because reduction in test-taking time results in reduced patient and retinal fatigue producing better results.
- Hodapp Anderson Parrish (HAP) scale can be helpful in classifying glaucoma severity to set target intraocular pressure goals.
- In the present study, Pattern Standard Deviation(PSD) values were not significantly different in glaucoma patients when SITA standard was compared with Full Threshold algorithm may be suggested that this parameter may be compared if follow- up fields are obtained with a SITA standard test in a patient who has previously undergone testing with Full Threshold.

- The present study may suggest that SITA Standard algorithms provide high enough sensitivity and specificity and it may replace Full Threshold algorithm in the detection of glaucomatous visual field defects in primary open angle glaucoma patients and also provides considerable savings in test taking time.

SUMMARY

A one year descriptive observational study was done to find out the sensitivity and specificity of SITA standard (Swedish interactive threshold algorithm) with the Standard Full Threshold(FT) algorithm as gold standard in detecting glaucomatous visual field defects using Humphrey Visual Field Analyzer at KLES Dr Prabhakar Kore Hospital and MRC , Belgaum.

A total of 60 primary open angle glaucoma patients fulfilling the inclusion criteria were included in the study. The intraocular pressure was measured by applanation tonometry and gonioscopy was done with Goldmann's 3 mirror gonioscopic lens. The optic disc was evaluated by slit lamp biomicroscopy using 90D lens.

Central field testing was performed with the 30-2 program using Standard Full Threshold (SFT) and SITA standard strategies with a rest period of 15 minutes between the two tests.Sensitivity, specificity and time saved in the SITA standard was calculated with the Standard Full Threshold as gold standard or reference standard.

Mean age of patients was 63.63 years ± 9.81. Forty one of 60 glaucoma patients were male (68.33%) and 39 were female (31.67 %). There were more number of males in the present study.

The mean IOP of 60 patients was 27.50 ± 3.30 mm Hg and the mean C:D ratio was 0.71 ± 0.17.

In present study, sensitivity of SITA Standard in detecting glaucomatous visual field defects with Full Threshold algorithm as gold standard was 95.24% in primary open angle glaucoma patients. The specificity of SITA Standard algorithm in

detecting glaucomatous visual field defects with Full Threshold algorithm as gold standard was 94.44%. SITA Standard has low false positive and false negative rates. SITA Standard failed to detect glaucomatous defects in 2 cases which were picked up by Standard Full Threshold algorithm.

There was no significant differences in distribution of Hodapp Anderson Parrish severity scores among both algorithms.

The SITA Standard reduced test taking time by 45.84% and that too at a statistically significant level in glaucoma patients ($p< 0.0001$).

Mean deviation value was 0.08 dB better in SITA Standard fields compared with FT fields in POAG patients but with p value of 0.9667 it was not statistically significant.

Difference between Full Threshold(FT) Pattern Standard Deviation (PSD) and SITA Standard Pattern standard deviation(PSD) was 0.03 dB, with p value of 0.9692 and was not statistically significant.

Thus the current study demonstrates high sensitivity and specificity for the SITA standard algorithm in detecting glaucomatous visual field defects with Full Threshold algorithm as the gold standard with the considerable time savings.

The present study shows that the SITA standard algorithm provide high enough sensitivity and specificity and it may replace Full Threshold testing algorithm in the detection of glaucomatous visual field defects in primary open angle glaucoma patients and also provides considerable savings in test taking time.

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80. Wild JM,Pacey IE, O'Neill EC, Cunliffe. The SITA perimetric threshold algorithms in glaucoma. Invest Ophthalmol Vis Sci 1999;40:1998-2009.

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ANNEXURE – I: PROFORMA FOR DATA COLLECTION

Patient ID No ☐☐☐

Name of the Patient:

Age: ☐☐ Years

Sex: ☐ (1-Male, 2-Female)

OP No: ☐☐☐☐☐☐☐

IP No: ☐☐☐☐☐☐

Date: ☐☐ ☐☐ ☐☐

Is the patient eligible for study ☐ 1- Yes, 2-No

Has informed consent been given ☐ 1- Yes, 2-No

Chief complaints and history of present illness

1. Diminution of vision (Tick whichever is applicable)

Gradual ☐ Distant ☐ Painless ☐

Sudden ☐ Near ☐ Painful ☐

Duration ☐ (1 –Right eye, 2 –Left eye, 3-Both)

2. Coloured haloes ☐ (1-Yes, 2-No) if yes specify

3. Photophobia ☐ (1-Yes, 2-No) if yes specify

4. Lacrimation ☐ (1-Yes, 2-No) if yes specify

5. Redness of eye ☐ (1-Yes, 2-No) if yes specify

6. H/o wearing spectacles ☐ (1-Distance, 2- near, 3-Both)

7. H/o Frequent change of presbyopic glasses ☐ (1- Yes, 2- No)

Past History (1-Yes, 2- No) if yes , specify the details

1. Any disease, surgery, trauma to the eye being tested ☐

2. Diabetes ☐ Duration

3. Hypertension ☐ Duration

4. Thyroid disease ☐

5. Cerebrovascular event ☐

6. Any retinal pathologic condition affecting the visual field ☐

Family History –of Glaucoma ☐ (1-Yes, 2-No) if yes, specify the details

Treatment history/Drug intake (1-yes, 2-No) if yes, specify the drug used, duration, frequency.

1. Miotics ☐

2. Systemic medication ☐

3. Steroids ☐

Personal History

1. Smoking ☐ (1-Yes, 2 –No)

2. Alcoholism ☐ (1-Yes, 2 –No)

3. Diet ☐ (1-Veg,2-Non Veg,3-Mixed)

4. Appetite ☐ (1-Good, 2- Reduced)

5. Bowel and bladder ☐ (1-Regular, 2-Not regular)

GENERAL PHYSICAL EXAMINATION

Pulse /minute

BP mm of Hg

RR /minute

CVS ☐ 1-Normal, 2-Abnormal, if abnormal specify

RS ☐ 1-Normal, 2-Abnormal, if abnormal specify

CNS ☐ 1-Normal, 2-Abnormal, if abnormal specify

P/A ☐ 1-Normal, 2-Abnormal, if abnormal specify

OCULAR EXAMINATION

	Right Eye	Left Eye
1) Visual Acuity	☐	☐

1-6/6to6/9,2-6/12to6/18,3-6/24to6/36,4-6/60 ,5-cf 3 mt to cf mt, 6-cfcf,7-PLPR

1. With pinhole	☐	☐
2. With spectacles	☐	☐
3. Near vision	☐	☐

(1-n6,2-n8,3-n10,4-n12,5-n18,6-n36,7-n<36)

2) Adnexa	1-Normal	☐	☐
	2-Abnormal		
	If abnormal specify		

3) Conjunctiva 1- Normal ☐ ☐

2 -Congested

4) Sclera 1-Normal ☐ ☐

2-Abnormal (If abnormal ,then specify)

5) Cornea

a) Corneal sensation 1-Normal ☐ ☐

2-Diminished

3-Absent

b) Corneal oedema 1-present, 2-absent ☐ ☐

c)Vascularization 1-present, 2-absent ☐ ☐

d)Bullous keratopathy 1-present, 2-absent ☐ ☐

e)Keratic Precipitates 1-present, 2-absent ☐ ☐

6) Anterior chamber Depth 1-Normal ☐ ☐

2-Shallow

3-Deep

7) Iris 1-Normal ☐ ☐

2-Abnormal (if abnormal, then)

2a) Loss of pattern (1-present,2 –absent) ☐ ☐

2b) Atrophic patches (1-present,2-absent) ☐ ☐

2c) Posterior synechiae (1-present,2-absent) ☐ ☐

2d) Peripheral anterior synechiae (1-present,2-absent) ☐ ☐

2e)Neovascularization (1-present,2-absent) ☐ ☐

2f) Coloboma (1-present,2-absent) ☐ ☐

2g) Holes (1-present,2-absent) ☐ ☐

2h) Glaucoma flaken (1-present,2-absent) ☐ ☐

8) Pupil

1-Size (mm) ☐ ☐

2-Shape ☐ ☐

3 Reaction i-Brisk

ii-Sluggishly reactive

iii-non-reactive

A direct light reflex ☐ ☐

B Consensual light reflex ☐ ☐

4 Afferent pupillary defect ☐ ☐

(1-Present, 2-Absent) ☐ ☐

9) Lens 1. Normal

2-Cataract A-Immature, B-Mature, C-Hypermature

3. Pseudophakia

Right eye Left eye

10.Refraction Correction

INVESTIGATIONS

Intraocular pressure (IOP mm Hg) measurement

Applanation Tonometer

RE mm Hg

LE mm Hg

2)GONIOSCOPY

According to Shaffer's system of grading the angle width

RE

	Superior	Inferior	Temporal	Nasal
Grade				

LE

	Superior	Inferior	Temporal	Nasal
Grade				

3) FUNDUS EXAMINATION by 90 D Slit Lamp Biomicroscopy

		OD	OS
1. Glow	1-Good,2 –faint,3-absent		
2. Media	1-clear,2-hazy		
3. Disc	1- normal,2-abnormal		
4. C:D	1- 0.3 to 0.4		
	2- 0.5 to 0.6		
	3- 0.7 to 0.8		
	4- 0.9		
5. Vessels A Arteries	1-Normal		
	2-Narrowing		
B Veins	1-Normal		
	2-Dilated		
	3-Tortous		
	4-Sheathing		
C AV ratio			
6. Background			
7. Macula			

Disc examination in glaucoma by 90 D slit lamp biomicroscopy

OD OS

a) Cup :disc ratio

1- 0.3 to 0.4

2- 0.5 to 0.6

3- 0.7 to 0.8

4- 0.9

b) Neurorentinal rim 1-normal,2-thining

c) Notching 1-present,2-absent

d) Pallor areas on the disc 1–present,2-absent

e) Position of blood vessels 1-normal,2-nasalisation

f) Splinter hemorrhages 1–present,2-absent

g) Peripapillary atrophy 1–present,2-absent

h) Pulsations of retinal arterioles 1–present ,2-absent

i) Bayoneting sign 1–present,2-absent

j) Laminar dot sign 1–present,2-absent

k) Atrophy of retinal nerve fiber layer 1–present,2-absent

l) Barring of circumlinear vessels 1- present,2-absent.

4) Visual field evaluations

It is done with 30-2 program of Full Threshold algorithm and standard Swedish Interactive Threshold Algorithm(SITA Standard) using Humphrey field analyzer.

FT SITA Standard

A) Glaucoma hemifield test

1-within normal limits

2-borderline

3-outside normal limits

B) Mean deviation (MD)

1 < -6dB

2 > -6 dB but < - 12 dB

3 > -12dB

C) Pattern deviation plot

1- <25% points depressed below 5% level

<15% points depressed below 1% level

2- >25% points depressed below 5% level

<25% points depressed below 1% level

3- >50% points depressed below 5% level

>25% points depressed below 1% level

FT SITA Standard

D) PSD

E) CPSD

1-Depressed to the P<5%

2-Not depressed to the P<5%

F) Sensitivity in central 5^0 field

I- No point within the central 5^0 with sensitivity less than 15dB

II- No point within the central 5^0 with sensitivity less than 0dB

III-Any point within the central 5^0 with sensitivity less than 0dB

G) Superior and inferior hemifield

i-No hemifield containing a point(s) with sensitivity less than 15dB within 5^0 fixation.

ii- Only one hemifield containing a point(s) with sensitivity less than 15dB within 5^0 fixation

iii-Both hemifield containing a point(s) with sensitivity less than 15dB within 5^0 fixation

H) Time taken

I) Reliability indices

a) Fixation losses 1<20%

2>20%

b) False positive errors	1<33%
	2>33%
c) False negative errors	1<33%
	2>33%
d) Short term fluctuations	1<4dB
	2≥4dB

ANNEXURE - II

CONSENT FOR PARTICIPATION IN RESEARCH STUDY

Mr/Mrs/Miss

You are invited to participate in our research study titled **"SWEDISH INTERACTIVE THRESHOLD ALGORITHM (SITA) VERSUS STANDARD FULL THRESHOLD ALGORITHM IN DETECTING GLAUCOMATOUS VISUAL FIELD DEFECTS USING HUMPHREY FIELD ANALYZER- A DESCRIPTIVE OBSERVATIONAL STUDY"** conducted by **Dr. Bhagyajyothi B. Khanagavi,** Post Graduate in MS Ophthalmology under guidance of **Dr. U. S. Dandavatimath M.S, D.O.M.S,** Professor in the Department of Ophthalmology, J.N.Medical College, Belgaum.

Respected Sir/Madam, we request you to participate in our study as you are eligible for doing so.

Your participation in the research is voluntary. Your decision whether to or not to participate in the study will not affect your relationship with J. N. Medical College. If you decide to participate you are free to withdraw at any time. You will be told all the new information available about the study and you will be given free will to decide about participation and continuation in this study.

PURPOSE OF THE STUDY

The purpose of the current study is to determine the effectiveness of SITA standard in detecting glaucomatous visual field defects using the Full Threshold algorithm as the reference or gold standard.

Procedure involved

If you agree to enroll yourself in this study, I will ask your present, past, ,family and personal history. Then you will be clinically examined in detail by slit lamp examination, refraction done for best corrected visual acuity, IOP measured by applanation tonometer, gonioscopy done by Goldmann three mirror lens to look for the angles, fundoscopy by 90D SLE for detailed examination of the optic disc.

Then visual field evaluation will be done with SITA Standard and Full Threshold algorithm using Humphrey field analyzer.

Risks and benefits

With all the necessary precautions taken there is a minimal risk involved with the tests.

Your participation may benefit you and others suffering from the same disease in future by helping us to learn more about the disease process and the efficiency of these tests in detecting glaucomatous field defects.

COSTS FOR PARTICIPATING IN THIS RESEARCH

There will be no extra cost incurred by the participant. The participant will however have to pay for the investigations and tests which are part of the existing management protocol for this ailment.

There is no commitment for any reimbursement or any other compensation for the participant.

PRIVACY AND CONFIDENTIALITY

The only people to know that you are a research subject are members of the research team. No information provided by you during the research will be disclosed to others without your written permission.

AUTHORIZATION TO PUBLISH RESULTS

When the results of this study/research are published in a conference, no information will be displayed that would disclose your identity. Any information that is obtained in connection with this study and that can be identified with you will remain confidential.

CONTACT DETAILS

If you have any questions and clarifications or if you need help at any time during the study period about this research/study. You may please contact.

1) Chief Investigator Dr. Bhagyajyothi B.K, Dept of Ophthalmology, JNMC, Belgaum, Ph.No : 9743420888.
2) Dr. U. S. Dandavatimath, Professor, Guide, Department of Ophthalmology. JNMC, Belgaum. Ph : 944818915
3) Dr. V. D. Patil, Principal, JNMC, Belgaum and Chairman of Institutional Ethics Committee. Ph . 0831- 2471350.

CONSENT FOR PARTICIPATION IN RESEARCH TRIAL

I , Mr/ Mrs / Ms voluntarily agree for the participation as a subject for this study. By signing this consent form , I am not giving up any of my legal rights , I may withdraw from the study anytime . I am signing the consent form after having read or been read for me in my vernacular language about the study in detail including the risks and benefits and having all my questions answered .

Signature or the Left Thumb Print of participant :

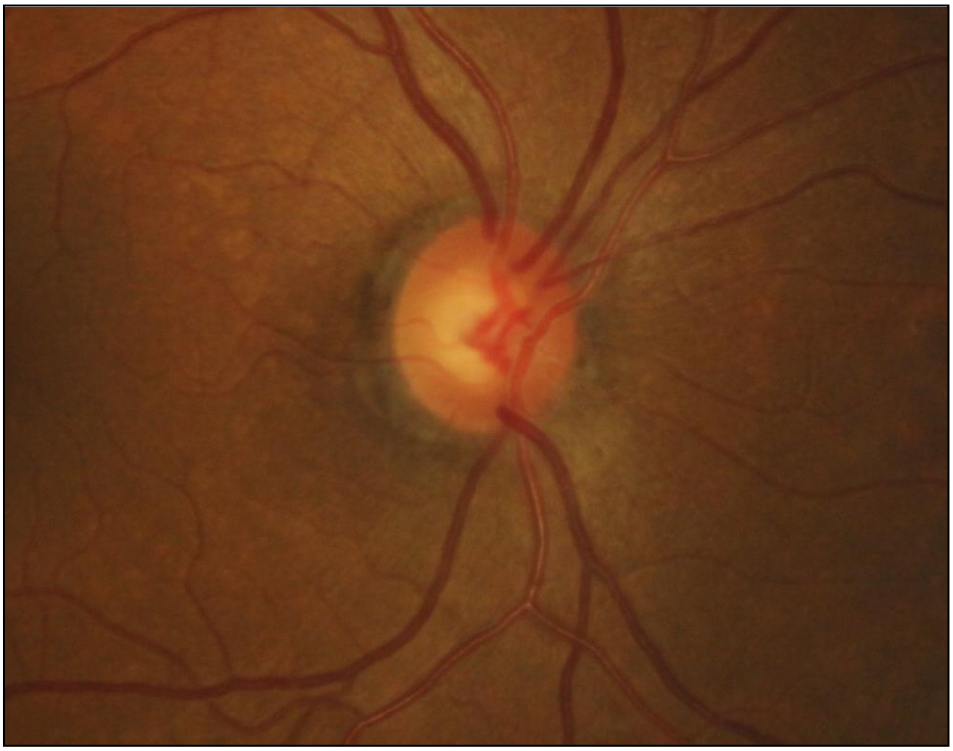
Investigators Name :

Investigators Signature :

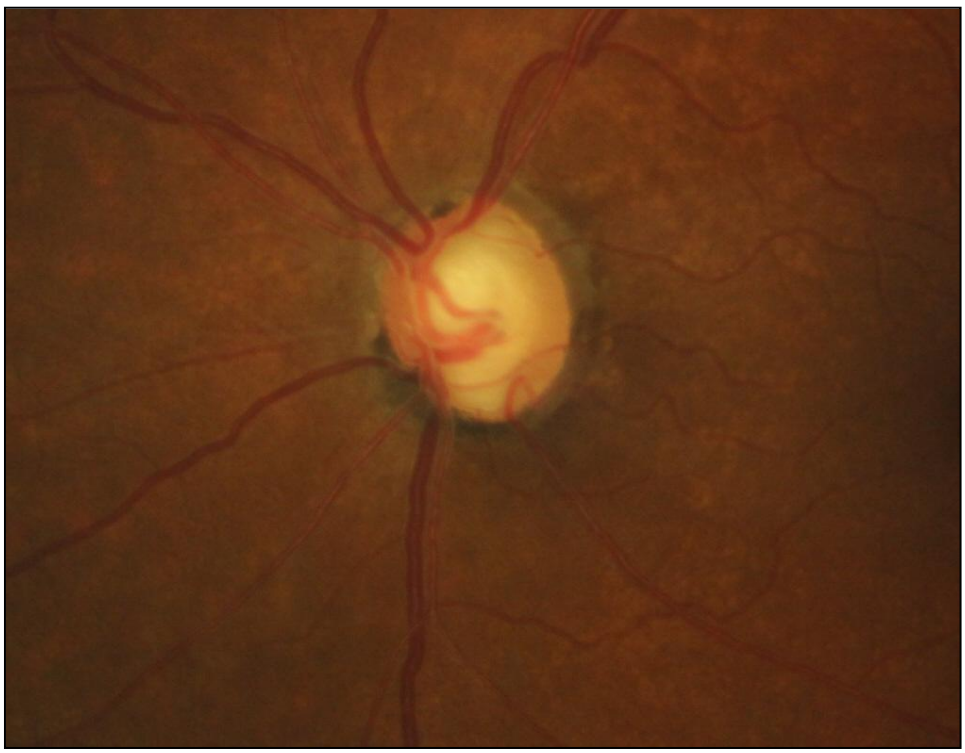
Date :

Place :

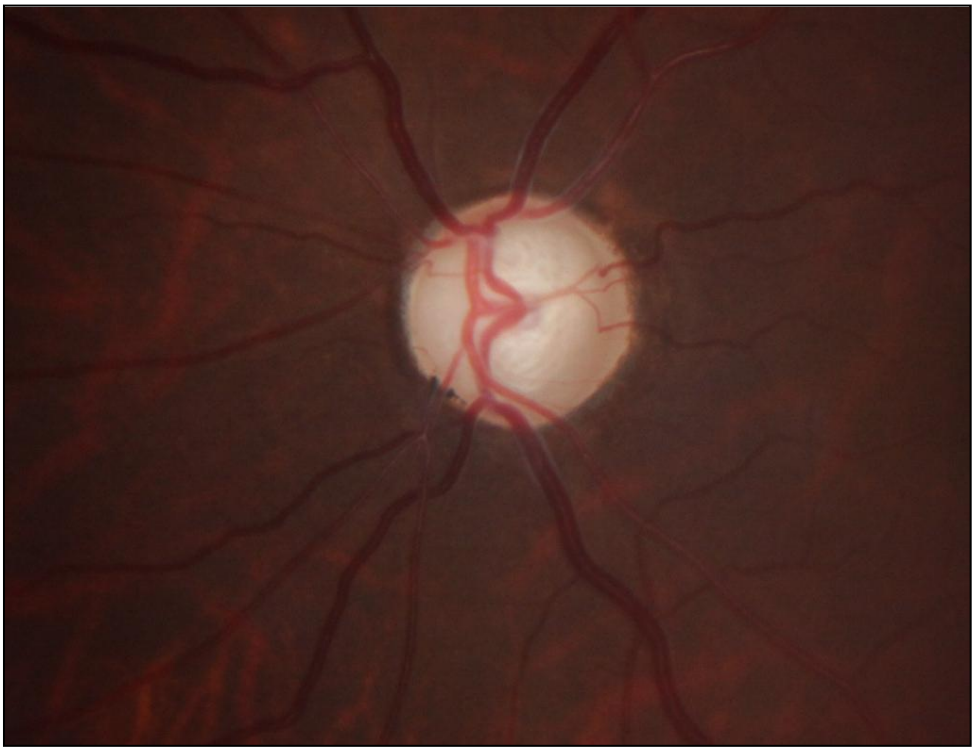
ANNEXURE – III : PHOTOGRAPHS



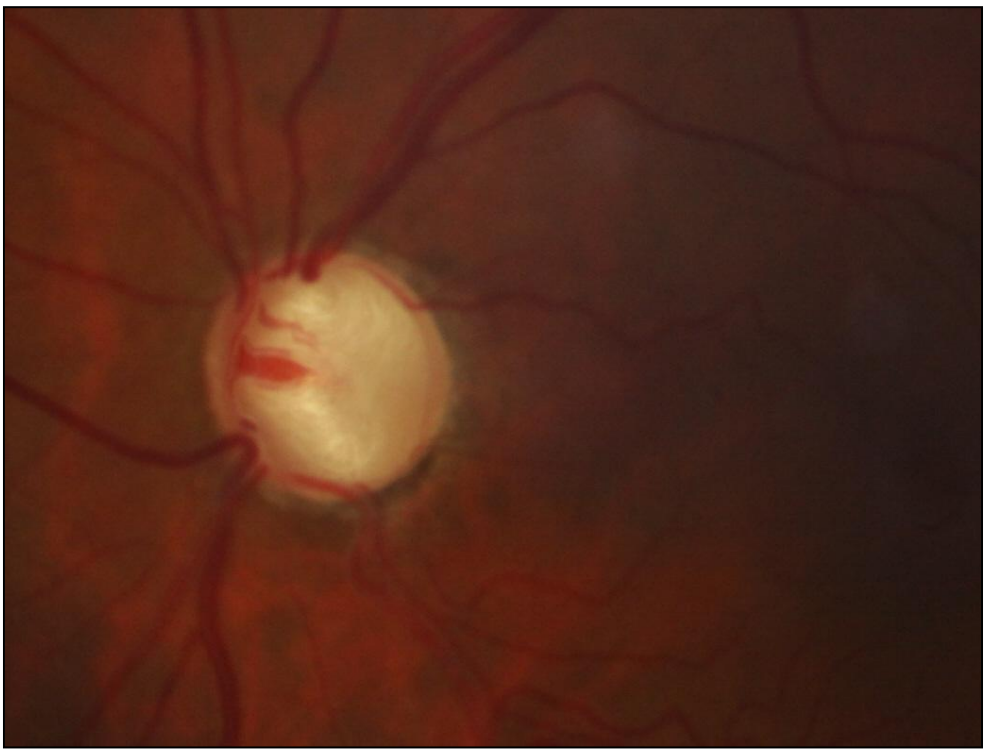
Photograph No.1: Fundus photograph of optic disc showing normal C:D ratio of 0.3 to 0.4 with healthy neuro retinal rim



Photograph No.2: Fundus photograph of optic disc showing inferior notching with peripapillary atrophy



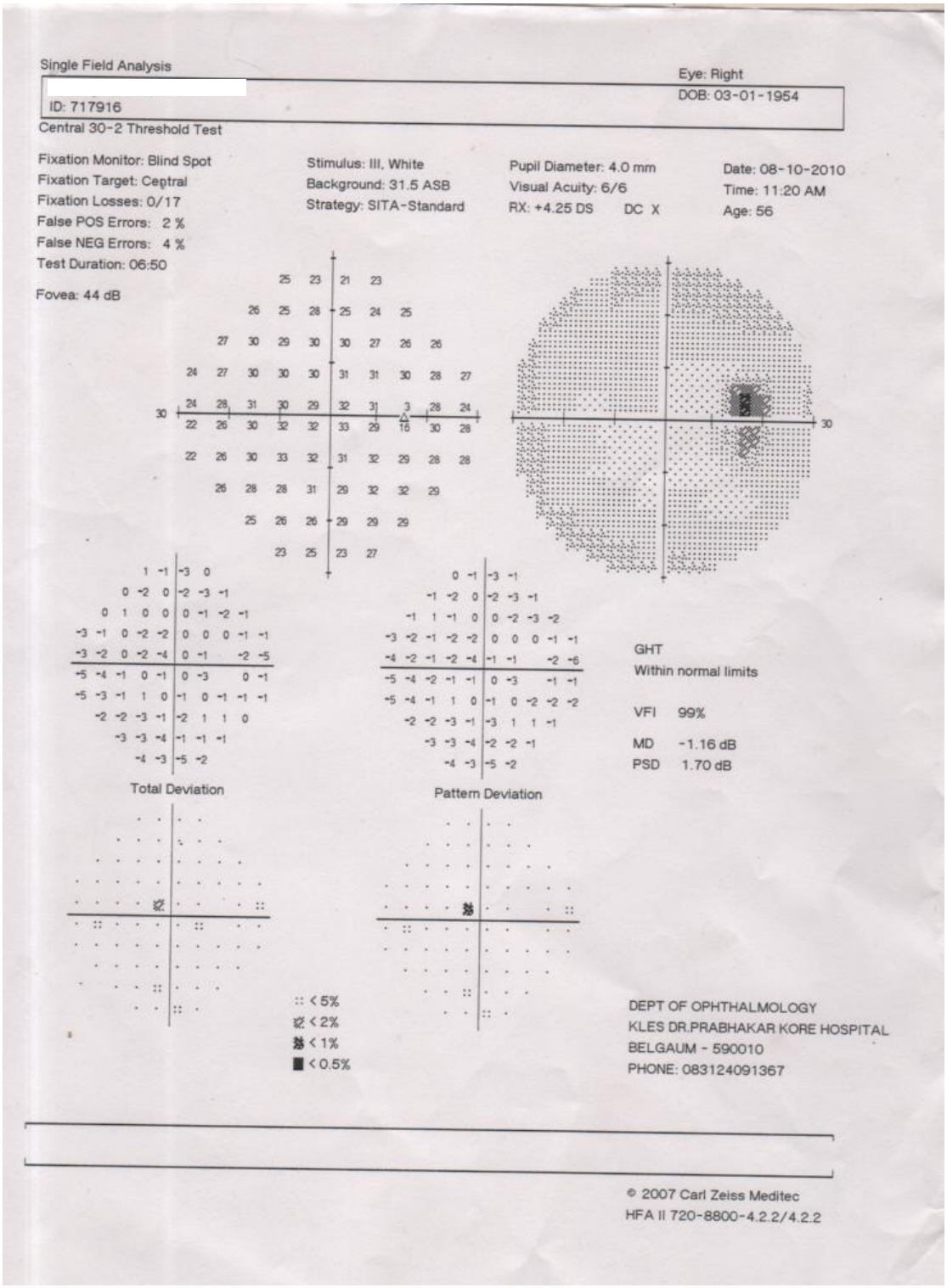
Photograph No.3: Fundus photograph of optic disc showing diffuse thinning of NRR,0.7 cupping with laminar dot sign



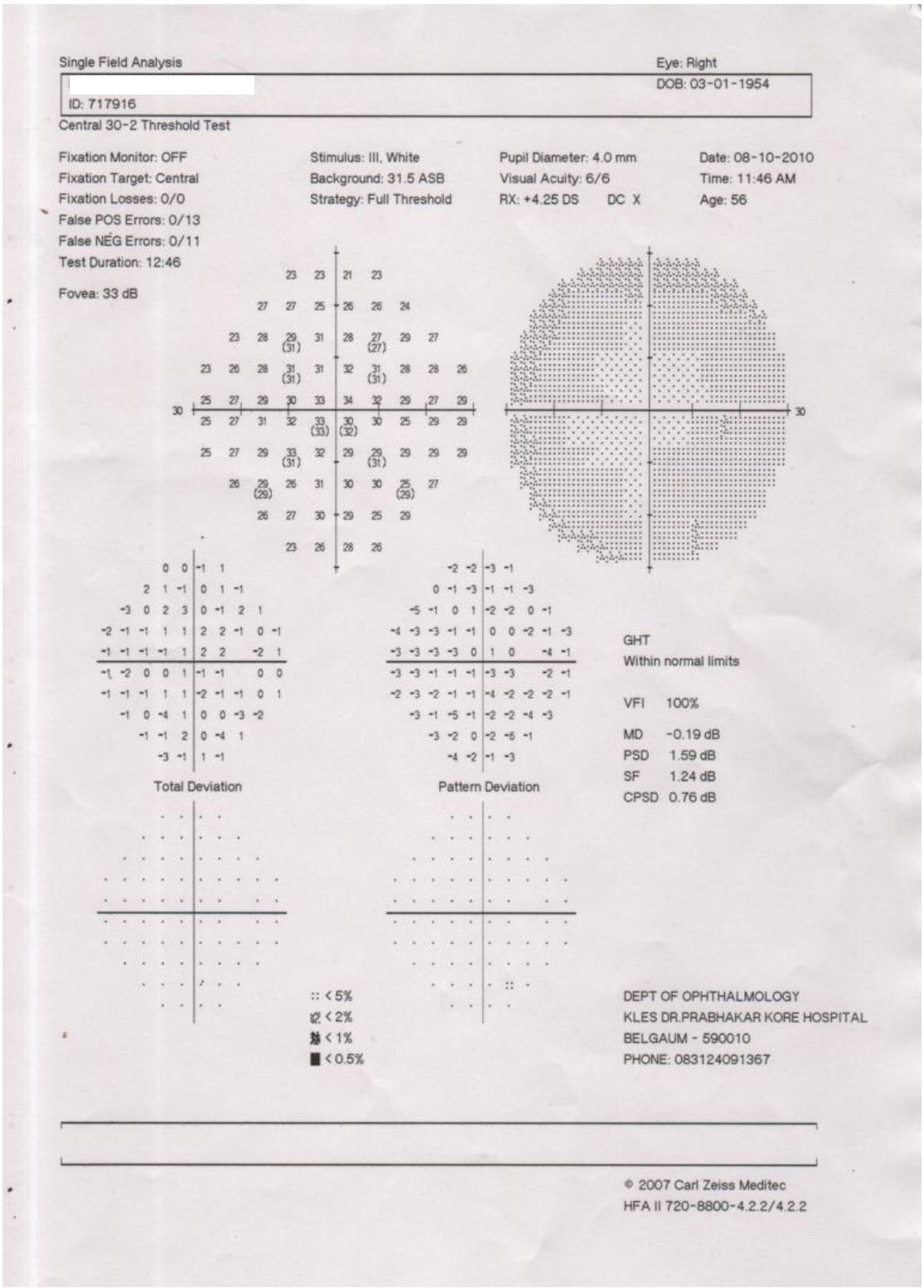
Photograph No.4: Fundus photograph showing 0.9 cupping, nasalization of vessels and peripapillary atrophy

ANNEXURE – IV: LIST OF SINGLE FIELD ANALYSIS PRINTOUTS

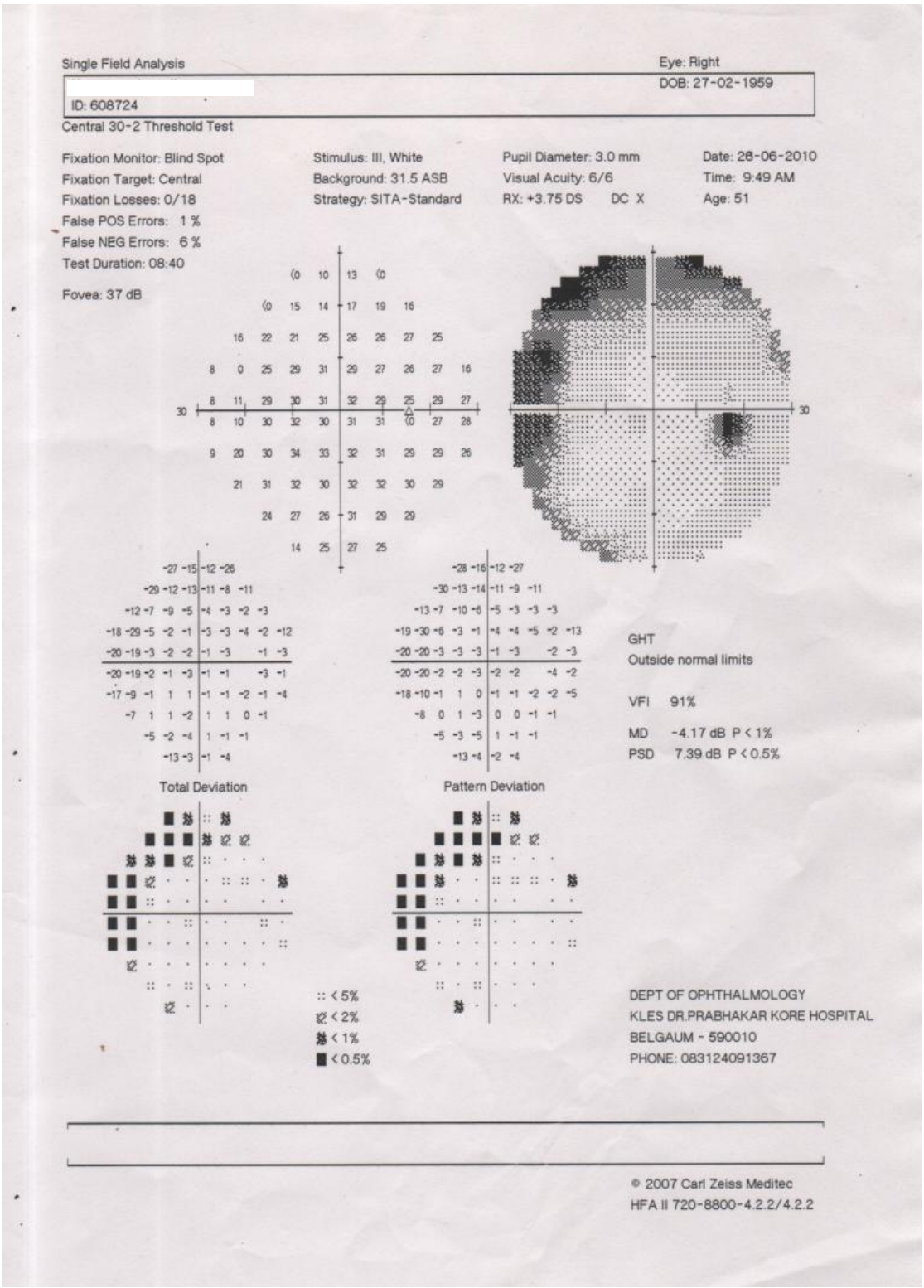
1. SINGLE FIELD ANALYSIS PRINT OUT OF 30-2 SITA STANDARD SHOWING NORMAL VISUAL FIELD



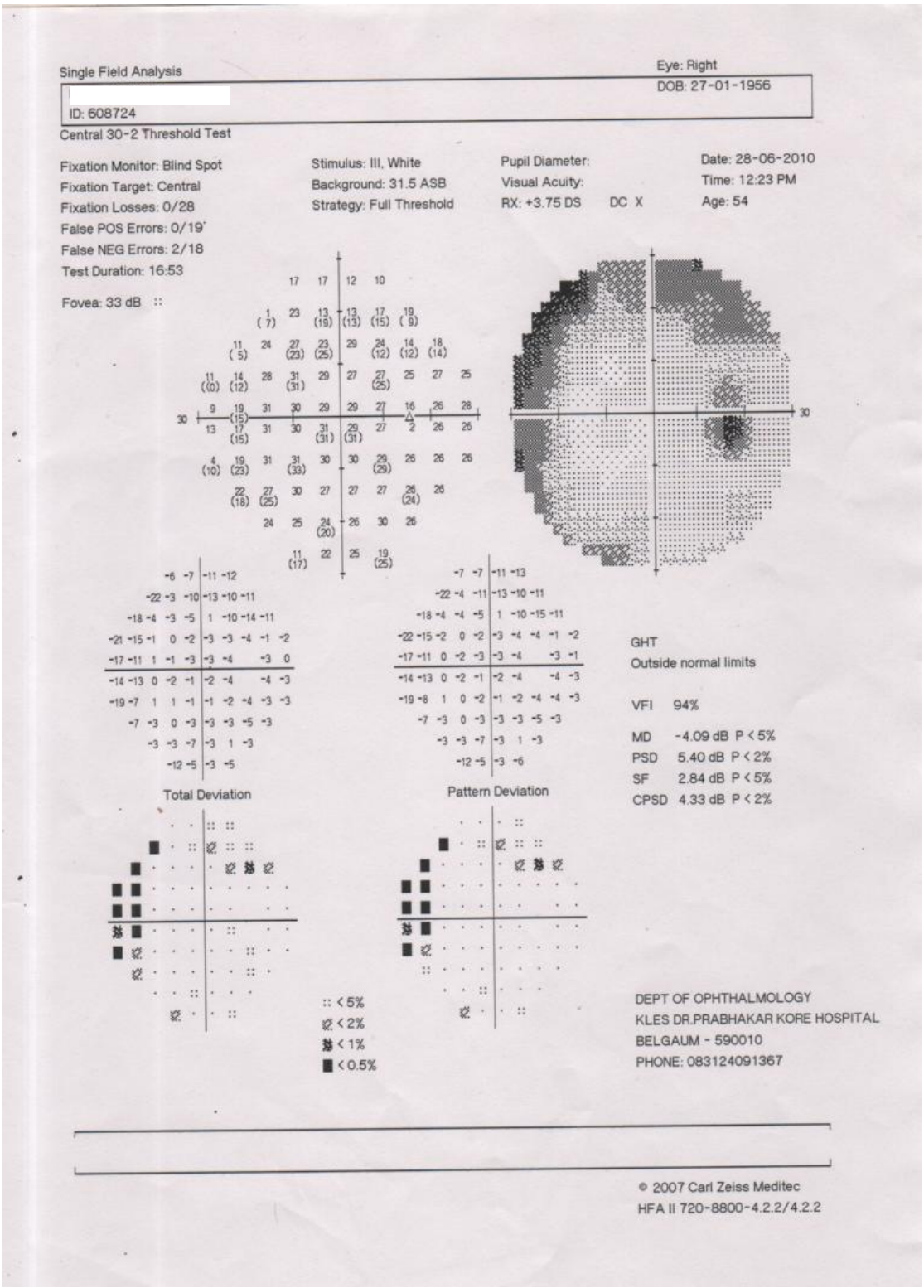
2.SINGLE FIELD ANALYSIS PRINT OUT OF 30-2 FULL THRESHOLD SHOWING NORMAL VISUAL FIELD



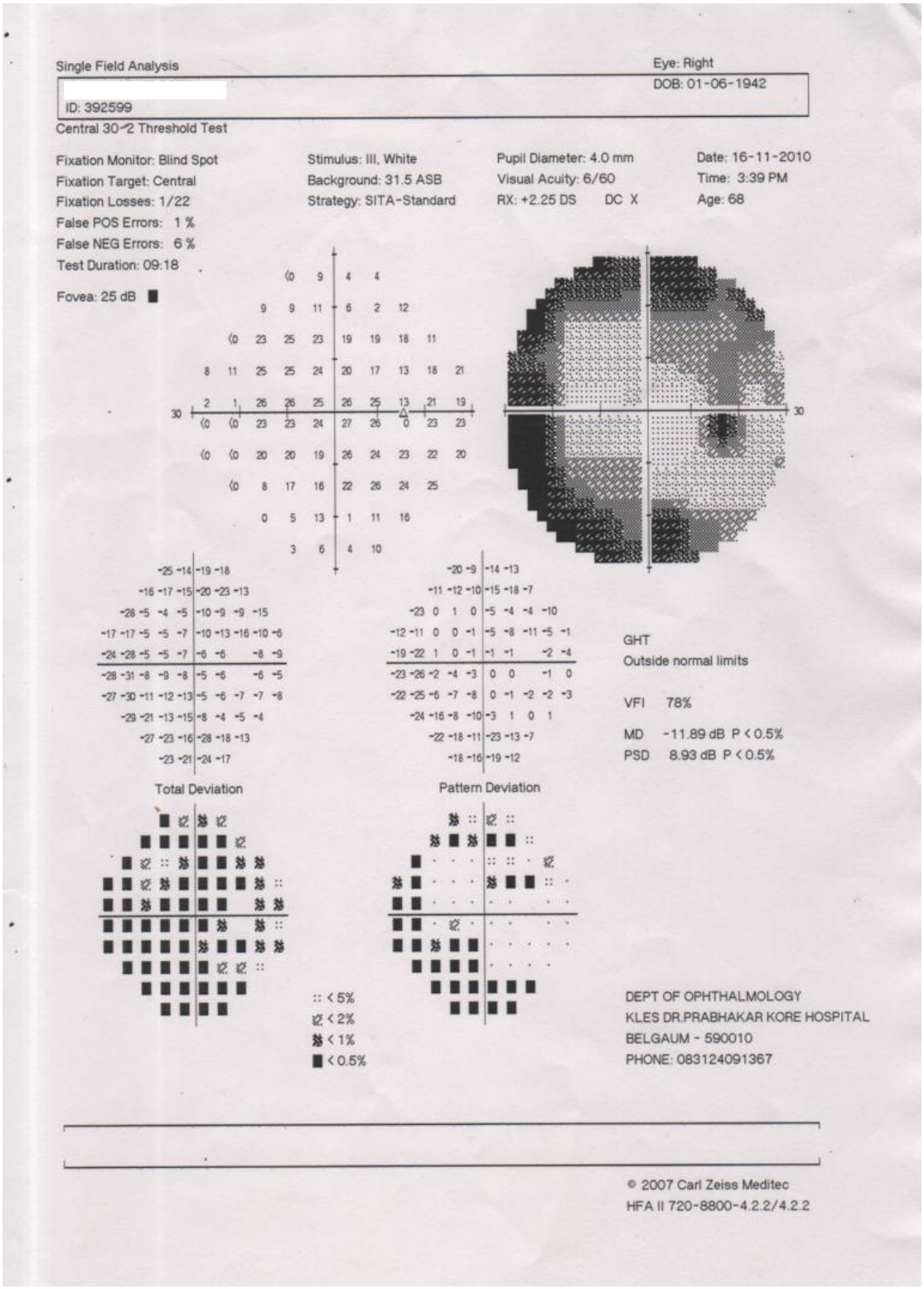
3.SINGLE FIELD ANALYSIS PRINT OUT OF 30-2 SITA STANDARD SHOWING MILD VISUAL FIELD DEFECT



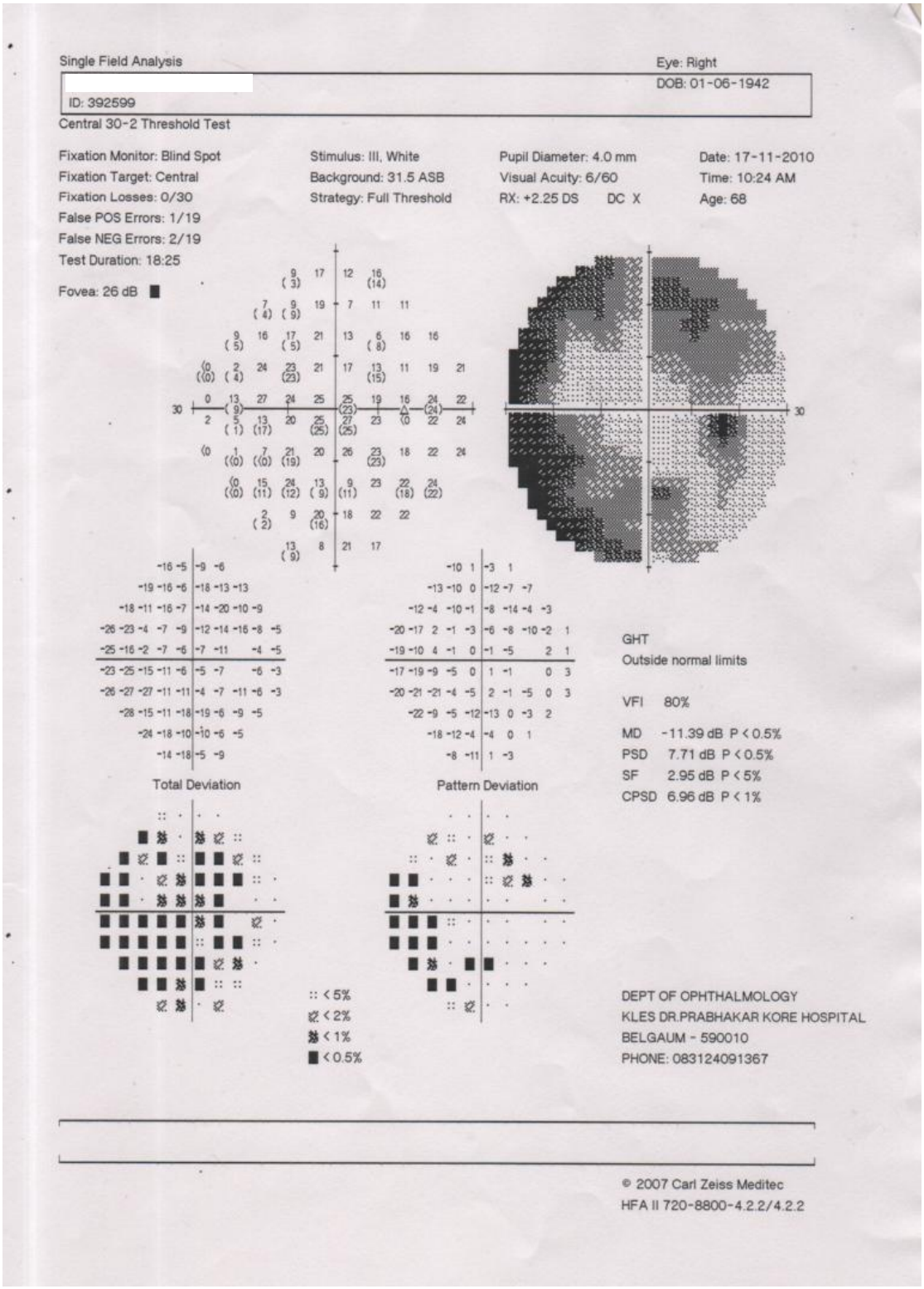
4.SINGLE FIELD ANALYSIS PRINT OUT OF 30-2 FULL THRESHOLD SHOWING MILD VISUAL FIELD DEFECT



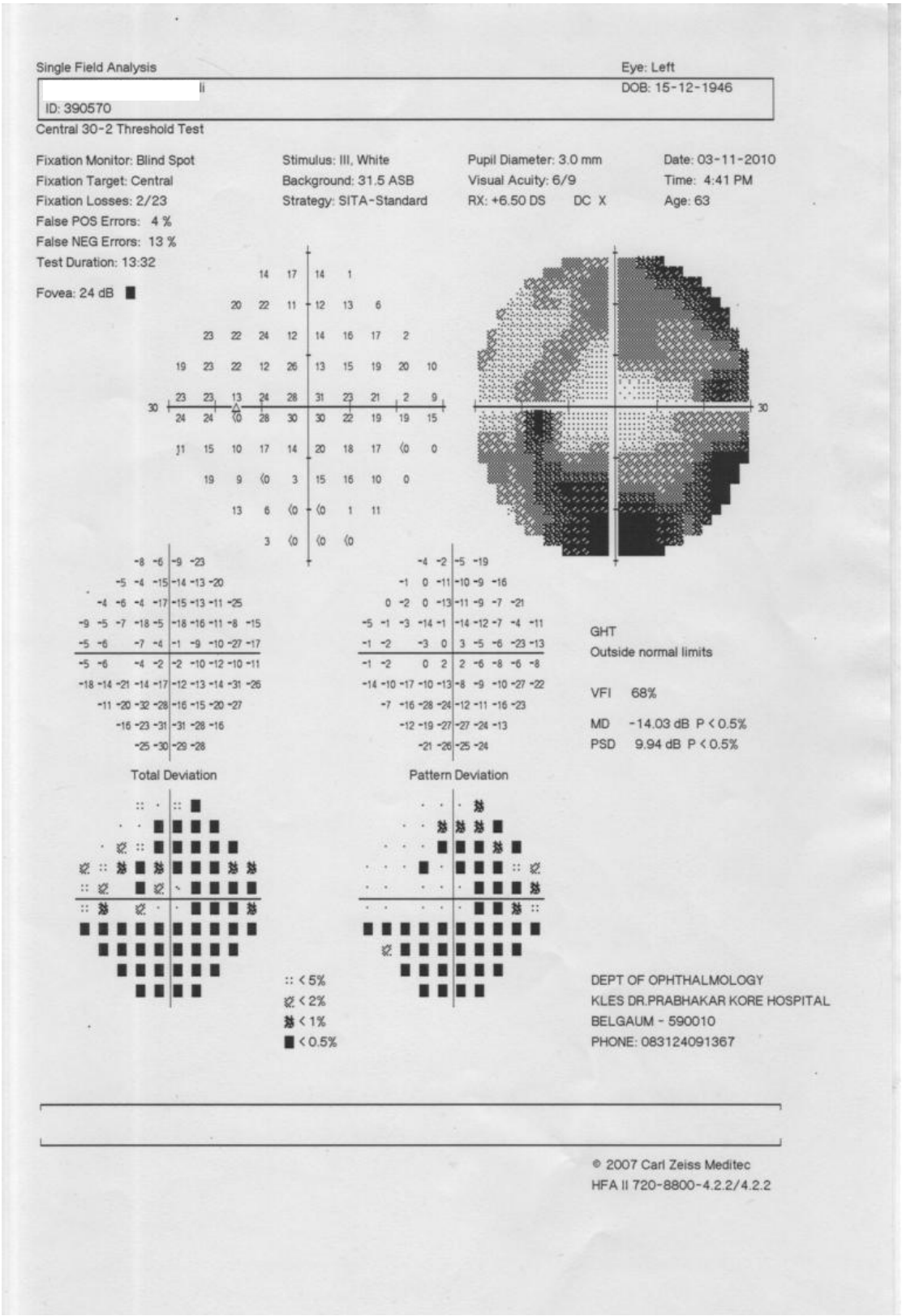
5.SINGLE FIELD ANALYSIS PRINT OUT OF 30-2 SITA STANDARD SHOWING MODERATE VISUAL FIELD DEFECT (SUPERIOR ARCUATE SCOTOMA)



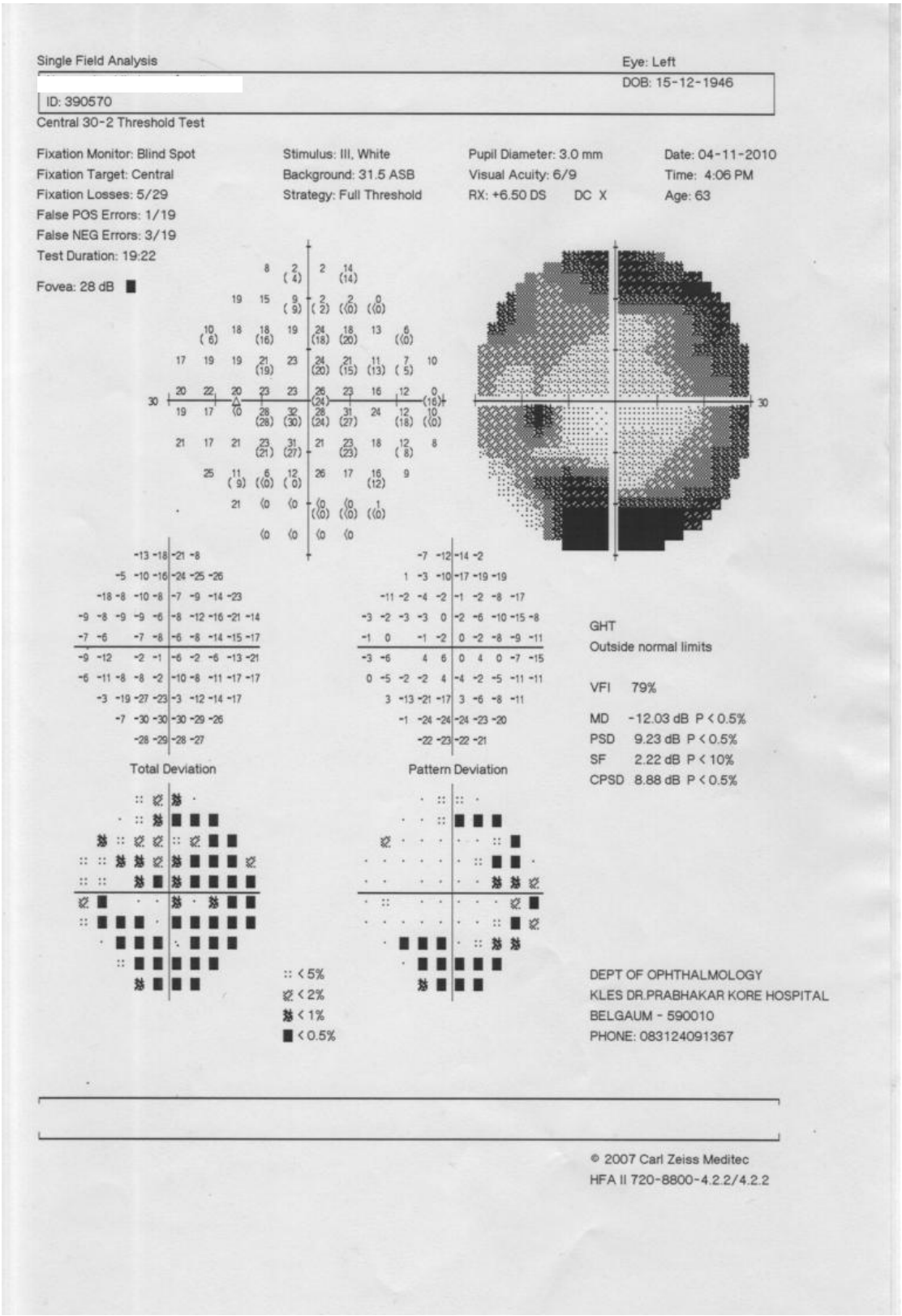
6.SINGLE FIELD ANALYSIS PRINT OUT OF 30-2 FULL THRESHOLD SHOWING MODERATE VISUAL FIELD DEFECT (SUPERIOR ARCUATE SCOTOMA)



7.SINGLE FIELD ANALYSIS PRINT OUT OF 30-2 SITA STANDARD SHOWING SEVERE VISUAL FIELD DEFECT (DOUBLE ARCUATE SCOTOMA)



8.SINGLE FIELD ANALYSIS PRINT OUT OF 30-2 FULL THRESHOLD SHOWING SEVERE VISUAL FIELD DEFECT (DOUBLE ARCUATE SCOTOMA)



ANNEXURE – V: MASTER CHART

SI NO	OP/IP no	AGE	SEX	EYE	F/HO	DM	HTN	smoking	RE re	LE re	RE IOP mm Hg	LE IOP mm Hg	RE C : D	LE C : D	RE PPA	LE PPA	FT GHT	SS GHT	FT CPSD p	SITA PSD p	cluster of 3 points <%%	cluster of 3 points < 5%	FT MD (dB)	FT MD(dB)	SS MD (dB)	SS MD(dB)	FT PDP	SS PDP	FT PSD (dB)	SS PSD (dB)	FT SENSITIVITY IN CENTRAL 5	SS SENSITIVITY IN CENTRAL 5	FT S & I	SS S & I	FT TIME	SS TIME	visual field defect (FT)	visual field defect (SS)	HAP FT	HAP SS
1	821050	63	M	RE	Y	A	P	Y	m	m	29	28	0.8	0.8	P	P	O	O	> 5%	> 5%	P	P	-25.1	> -12	-20.65	> -12	3	3	8.69	13.59	III	II	ii	ii	13.21	6.43	P	P	severe	severe
2	354646	70	M	LE	N	P	P	Y	e	e	32	29	0.7	0.8	P	P	O	O	> 5%	> 5%	P	P	-6.71	> -6	-19.06	> -12	1	3	13.49	15.2	I	II	i	ii	15.42	7.89	P	P	severe	severe
3	1268965	62	M	LE	N	A	A	Y	m	m	27	29	0.8	0.7	P	P	O	O	> 5%	> 5%	P	P	-27.7	> -12	-27.47	> -12	2	2	14.02	12.77	III	I	i	i	14.34	8.01	P	P	severe	severe
4	1307294	77	M	LE	N	P	P	N	e	e	31	28	0.9	0.7	P	P	O	O	> 5%	> 5%	P	P	-11.18	> -6	-5.79	< -6	2	1	8.57	10.11	I	I	i	i	19.55	10.21	P	P	Mode rate	Mode rate
5	359605	71	M	LE	N	A	A	Y	h	h	27	26	0.7	0.7	A	A	O	O	> 5%	> 5%	P	P	-11.84	> -6	-11.65	> -6	2	2	12.68	14.27	I	I	i	i	17.24	8.74	P	P	Mode rate	Mode rate
6	1325772	51	F	LE	N	A	P	N	m	m	28	28	0.8	0.7	P	A	O	O	> 5%	> 5%	P	P	-11.47	> -6	-5.98	> -6	2	1	15.05	16.05	I	I	i	i	12.03	5.89	P	P	moderat e	mild
7	1317075	61	M	RE	N	A	A	Y	e	e	21	20	0.4	0.3	A	A	W	W	< 5%	< 5%	A	A	-1.6	<-6	-1.63	< -6	1	1	7.9	5.25	I	I	i	i	15.25	8.12	A	A	no defect	no defect
8	586962	71	F	LE	N	A	P	N	h	h	28	29	0.8	0.9	A	P	O	O	> 5%	> 5%	P	P	-28.79	> -12	-29.59	> -12	3	3	6.36	5.8	III	III	iii	iii	7.54	6.34	P	P	severe	severe
9	784161	60	F	RE	N	A	A	N	m	m	27	26	0.7	0.8	P	P	O	O	> 5%	> 5%	P	P	-11.56	> -6	-19.49	> -12	2	3	13.25	12.53	I	I	i	i	16.16	7.89	P	P	Mode rate	severe
10	633624	76	M	LE	N	P	P	Y	e	e	26	29	0.7	0.9	P	P	O	O	> 5%	> 5%	P	P	-26.45	> -12	-24.32	> -12	3	3	14.21	12.76	II	II	ii	ii	12.41	7.12	P	P	severe	severe
11	371255	64	M	RE	N	A	P	Y	m	m	32	28	0.9	0.7	P	P	O	O	> 5%	> 5%	P	P	-19.46	> -12	-11.98	> -6	3	2	9.61	8.89	I	II	i	i	16.25	8.44	P	P	severe	Mode rate

12	608724	51	F	RE	N	P	A	N	h	h	22	21	0.4	0.3	A	A	W	W	< 5%	< 5%	A	A	-4.09	< -6	-4.17	< -6	1	1	5.4	7.39	I	I	i	i	16.53	8.4	A	A	no defect	no defect
13	1300978	50	M	RE	N	A	A	Y	m	m	28	27	0.7	0.8	P	P	O	O	> 5%	> 5%	P	P	-11.86	> -6	-5.98	> -6	2	2	11.29	12.92	I	I	i	i	18.1	9.25	P	P	Mode rate	mild
14	1317080	83	M	RE	N	P	P	Y	m	m	27	26	0.9	0.7	P	P	O	O	> 5%	> 5%	P	P	-20.63	> -12	-21.2	> -12	3	3	9.17	8.31	III	III	ii	iii	16.43	7.23	P	P	severe	severe
15	792099	45	M	RE	N	A	A	Y	e	e	28	29	0.7	0.9	P	P	O	O	> 5%	> 5%	P	P	-21.26	> -12	-18.64	> -12	3	3	13.5	14.75	II	II	ii	ii	11.2	6.32	P	P	severe	severe
16	1169308	51	M	RE	N	P	P	Y	m	m	31	30	0.9	0.9	A	P	O	O	> 5%	> 5%	P	P	-29.39	>-12	-29.4	> -12	3	3	4.59	6.31	III	III	iii	iii	11.07	6.54	P	P	severe	severe
17	373427	71	M	LE	N	A	P	Y	e	e	33	31	0.9	0.9	P	P	O	O	> 5%	> 5%	P	P	-28.03	>-12	-30.08	> -12	3	3	7.26	5.79	III	III	iii	iii	9.05	6.21	P	P	severe	severe
18	1381014	65	M	RE	N	P	A	Y	e	e	31	42	0.7	0.7	P	P	W	W	< 5%	< 5%	A	A	-5.77	<-6	-5.1	< -6	1	1	8.59	12.18	I	I	i	i	18.51	9.31	A	A	no defect	no defect
19	1383152	70	F	RE	N	A	P	N	m	m	30	26	0.8	0.7	A	A	O	O	> 5%	> 5%	P	P	-24.74	>-12	-20.08	> -12	3	3	6.52	5.5	III	III	ii	ii	9.35	6.14	P	P	severe	severe
20	1391688	71	M	RE	Y	A	A	Y	e	e	29	26	0.8	0.7	P	P	O	O	> 5%	> 5%	P	P	-29.1	> -12	-30.23	> -12	3	3	5.67	5.54	III	III	iii	iii	7.31	5.48	P	P	severe	severe
21	1395967	65	M	LE	N	A	P	N	m	m	26	29	0.6	0.8	A	A	O	O	> 5%	> 5%	P	P	-5.83	<-6	-5.76	< -6	1	1	11.86	12.83	I	I	i	i	17.58	8.25	P	P	mild	mild
22	1394866	70	M	RE	N	P	P	Y	h	h	28	31	0.7	0.9	P	P	O	O	> 5%	> 5%	P	P	-23.43	> -12	-24.55	> -12	3	3	8.26	9.69	II	II	ii	ii	10.27	6.54	P	P	severe	severe
23	386910	64	M	LE	N	A	A	Y	m	m	27	33	0.6	0.8	P	P	O	O	> 5%	> 5%	P	P	-25.25	> -12	-25.99	>-12	3	3	9	9.06	III	III	iii	iii	11.57	6.72	P	P	severe	severe
24	1005732	71	M	LE	N	A	P	Y	e	e	26	26	0.7	0.7	P	P	O	O	> 5%	> 5%	P	P	-5.18	< -6	-5.28	< -6	1	1	8.88	9.59	I	I	i	i	17.22	8.24	P	P	mild	mild
25	1410511	73	M	LE	Y	P	P	Y	m	m	26	29	0.5	0.8	P	P	O	O	> 5%	> 5%	P	P	-23.98	> -12	-25.22	> -12	3	3	11.09	11.08	III	III	iii	iii	12.5	7.12	P	P	severe	severe
26	937518	60	M	LE	N	A	A	N	e	e	26	27	0.7	0.9	P	P	W	W	> 5%	> 5%	A	A	-5.42	< -6	-3.6	< -6	1	1	6.14	3.71	I	I	i	i	15.3	7.43	A	A	no defect	no defect
27	1422661	70	F	LE	N	A	P	N	m	m	28	29	0.8	0.8	A	A	O	O	> 5%	> 5%	P	P	-19.84	> -12	-19.26	> -12	3	3	10.51	12.35	III	III	ii	ii	14.17	6.89	P	P	severe	severe
28	1420976	60	F	RE	N	A	A	N	h	h	28	31	0.9	0.7	P	P	O	O	> 5%	> 5%	P	P	-20.03	> -12	-18.79	> -12	3	2	10.56	12.64	I	I	i	i	17.49	9.56	P	P	severe	severe
29	1417797	74	M	RE	Y	P	A	Y	m	m	27	29	0.8	0.9	A	P	O	O	> 5%	> 5%	P	P	-21.64	> -12	-21.87	> -12	3	3	9.43	9.42	III	III	ii	ii	10.56	6.78	P	P	severe	severe

30	825962	51	F	LE	N	A	P	N	m	m	22	24	0.4	0.5	A	A	W	W	< 5%	< 5%	A	A	-3.73	< -6	-3.59	< -6	1	1	5.15	7.12	I	I	i	i	19.02	9.33	A	A	no defect	no defect
31	390570	65	F	LE	N	P	A	N	m	m	28	29	0.7	0.9	P	P	O	O	> 5%	> 5%	P	P	-5.86	< -6	-5.98	< -6	1	2	9.23	9.94	I	I	i	i	19.22	13.32	P	P	mild	Mode rate
32	392599	62	M	LE	N	A	A	Y	h	h	29	30	0.8	0.8	P	A	O	O	> 5%	> 5%	P	P	-5.11	< -6	-5.88	< -6	1	1	8.01	4.74	I	I	i	i	19.34	9.05	P	P	mild	mild
33	1062877	80	M	LE	N	A	P	Y	e	e	30	31	0.9	0.9	P	P	O	O	> 5%	> 5%	P	P	-28.61	> -12	-30.27	> -12	3	3	6.46	5.45	III	III	iii	iii	10.02	6.45	P	P	severe	severe
34	1046261	51	F	RE	N	A	A	N	m	m	28	26	0.8	0.7	A	A	O	O	> 5%	> 5%	P	P	-22.31	> -12	-24.44	> -12	3	3	9.26	8.95	I	I	i	i	14.32	7.89	P	P	severe	severe
35	1474454	45	F	RE	N	P	A	N	e	e	26	22	0.6	0.4	A	A	W	W	> 5%	> 5%	A	A	-5.78	< -6	-5.51	< -6	1	1	5.84	5.52	I	I	i	i	19.26	10.38	A	A	no defect	no defect
36	1488675	75	M	LE	N	A	P	Y	h	h	27	26	0.7	0.6	P	P	O	O	< 5%	< 5%	P	P	-27.82	> -12	-28.41	> -12	3	3	9.56	9.12	II	II	iii	iii	12.24	7.14	P	P	severe	severe
37	4995266	70	M	RE	N	A	A	Y	m	m	29	27	0.8	0.7	A	A	O	O	> 5%	> 5%	P	P	-21.92	> -12	-23.86	> -12	3	3	13.21	12.41	III	III	iii	iii	15.32	6.98	P	P	severe	severe
38	1584855	73	F	RE	Y	A	P	N	m	m	22	21	0.4	0.4	A	A	W	W	< 5%	< 5%	A	A	-5.79	< -6	-5.81	< -6	1	1	6.21	5.41	I	I	i	i	14.21	8.67	A	A	no defect	no defect
39	1604911	59	M	LE	N	P	P	Y	h	h	26	26	0.6	0.6	A	A	W	W	< 5%	< 5%	A	A	-5.04	< -6	-5.54	< -6	1	1	7.36	6.87	I	I	i	i	12.46	7.15	A	A	no defect	no defect
40	1611412	52	M	LE	N	A	A	Y	e	e	21	22	0.4	0.4	A	A	W	W	< 5%	< 5%	A	A	-1.43	< -6	-1.35	< -6	1	1	3.01	2.69	I	I	i	i	10.02	6.58	A	A	no defect	no defect
41	1621512	65	F	RE	N	P	P	N	m	m	22	22	0.5	0.4	A	A	W	W	< 5%	< 5%	A	A	0.04	< -6	0.07	< -6	1	1	1.53	1.93	I	I	i	i	12.43	6.48	A	A	no defect	no defect
42	1078959	76	M	RE	N	P	A	Y	h	h	28	26	0.8	0.7	P	P	O	O	> 5%	> 5%	P	P	-26.45	> -12	-27.26	> -12	3	3	9.21	8.27	III	III	iii	iii	10.21	6.21	P	P	severe	severe
43	830062	53	M	LE	Y	A	P	Y	m	m	37	26	0.9	0.7	P	P	W	W	< 5%	< 5%	A	A	-5.16	< -6	-5.23	< -6	1	1	13.01	12.71	I	I	i	i	12.01	6.87	A	A	no defect	no defect
44	588713	74	M	LE	N	A	A	N	h	h	24	26	0.3	0.4	A	A	W	W	< 5%	< 5%	A	A	-4.43	< -6	-4.68	< -6	1	1	6.32	5.84	I	I	i	i	12.02	7.24	A	A	no defect	no defect
45	1682591	69	F	LE	N	A	P	N	m	m	22	40	0.4	0.9	A	A	O	O	> 5%	> 5%	P	P	-11.59	> -6	-11.96	> -6	2	2	12.39	11.39	I	I	i	i	14.31	7.65	P	P	Mode rate	Mode rate

46	785703	66	M	LE	N	A	A	Y	h	h	27	29	0.9	0.8	P	P	W	W	< 5%	< 5%	A	A	-5.24	> -6	-5.33	< 0.6	1	1	12.04	10.77	I	I	i	i	10.34	6.42	A	A	no defect	no defect
47	1694160	62	M	LE	N	A	P	Y	e	e	28	28	0.8	0.9	A	A	O	O	> 5%	> 5%	P	P	-20.4	> -12	-21.32	> -12	3	3	11.72	10.09	III	III	iii	iii	17.51	9.54	P	P	severe	severe
48	1676706	76	M	RE	Y	P	A	Y	h	h	29	27	0.7	0.8	P	P	O	O	> 5%	> 5%	P	P	-26.81	> -12	-25.96	> -12	3	3	6.87	11.09	III	III	iii	ii	11.22	7.97	P	P	severe	severe
49	425384	67	M	RE	N	A	A	Y	m	m	26	27	0.7	0.6	A	A	W	W	< 5%	< 5%	A	A	-4.76	< -6	-5.84	< -6	1	1	16.12	15.42	I	I	i	i	14.32	6.95	A	A	no defect	no defect
50	1233112	42	M	LE	Y	A	P	N	h	h	26	28	0.7	0.8	A	A	W	W	< 5%	< 5%	A	A	-5.76	< -6	-5.89	< -6	1	1	3.25	3.15	I	I	i	i	15.49	7.54	A	A	no defect	no defect
51	1611412	71	F	RE	N	P	A	N	h	h	21	24	0.4	0.3	P	P	W	W	< 5%	< 5%	A	A	-2.01	< -6	-2.08	< -6	1	1	2.56	2.74	I	I	i	i	12.45	6.53	A	A	no defect	no defect
52	717916	56	F	RE	Y	A	P	N	h	h	20	22	0.6	0.6	P	P	W	W	< 5%	< 5%	A	A	-0.19	< -6	-1.16	< -6	1	1	1.59	1.7	I	I	i	i	12.46	6.5	A	A	no defect	no defect
53	1301589	55	M	RE	Y	P	A	Y	m	m	29	28	0.7	0.8	A	A	O	O	> 5%	> 5%	P	P	-5.62	< -6	-11.89	> -6	1	2	12.4	10.19	I	I	i	i	15.38	7.41	P	P	mild	Mode rate
54	1303797	60	M	RE	N	A	P	Y	e	e	27	26	0.6	0.6	A	A	W	O	< 5%	< 5%	P	P	-5.3	< -6	-5.63	< -6	2	1	3.57	7.76	I	I	i	i	18.23	8.97	A	P	no defect	mild
55	1277333	65	F	RE	N	A	A	Y	m	m	29	27	0.8	0.8	P	P	O	O	> 5 %	> 5 %	P	P	-5.78	< -6	-5.82	< -6	1	1	10.35	10.24	I	I	i	i	18.02	10.12	P	P	mild	Mode rate
56	1276599	54	M	LE	Y	P	P	Y	e	e	24	24	0.5	0.3	P	P	B	W	< 5%	< 5%	P	A	-3.53	< -6	-4.36	< -6	1	1	2.92	2.5	I	I	i	i	15.59	8.58	P	A	mild	no defect
57	1063769	62	F	LE	Y	A	A	N	m	m	26	27	0.6	0.8	P	P	O	O	> 5%	> 5%	P	P	-5.21	< -6	-5.97	< -6	1	1	7.6	5.75	I	I	i	i	20.57	9.98	P	P	mild	mild
58	1218531	60	M	LE	N	P	P	Y	m	m	26	28	0.6	0.8	P	A	O	O	> 5%	> 5%	P	P	-18.72	> -12	-18.86	> -12	2	2	9.61	3.67	I	I	i	i	13.54	6.78	P	P	severe	Mode rate
59	1534199	41	M	RE	Y	A	P	Y	e	e	22	24	0.3	0.4	A	A	B	W	< 5%	< 5%	P	A	-4.63	< -6	-4.23	< -6	1	1	3.25	3.15	I	I	i	i	15.49	7.54	P	A	mild	no defect
60	359328	71	F	RE	Y	A	A	N	m	m	28	29	0.8	0.7	P	P	O	O	< 5%	< 5%	P	P	-5.98	< -6	-5.92	< -6	1	1	10.43	10.3	I	I	i	i	18.95	9.87	P	P	mild	mild

ABBREVIATIONS AND KEY FOR MASTER CHART

A- Absent

B - Borderline

C : D - Cup : Disc

DH – Disc hemorrhage

DM – Diabetes Mellitus

e - emmetropia

FT - Full Threshold

GHT - Glaucoma Hemifield Test

HAP - Hodapp Anderson Parrish

h - hypermetropia

HTN – Hypertension

I – Inferior

IOP - Intra Ocular Pressure

LE - Left Eye

M – Male

m - myopia

MD - Mean Deviation

n – Notching

N – No

O - Outside normal limits

P - Present

PDP - Pattern Deviation Plot

PPA - Peripapillary Atrophy

PSD - Pattern Standard Deviation

RE - Right Eye

re - refractive error

S – Superior

SS - SITA Standard

W - Within normal limits

Y - Yes

1- <25% points depressed below 5% level

<15% points depressed below 1% level

2- >25% points depressed below 5% level

<25% points depressed below 1% level

3- >50% points depressed below 5% level

>25% points depressed below 1% level

I - No point within the central 5^0 with sensitivity less than 15dB

II - No point within the central 5^0 with sensitivity less than 0dB

III - Any point within the central 5^0 with sensitivity less than 0dB

i - No hemifield containing a point(s) with sensitivity less than 15dB within 5^0 fixation.

ii - Only one hemifield containing a point(s) with sensitivity less than 15dB within 5^0 fixation.

iii - Both hemifield containing a point(s) with sensitivity less than 15dB within 5^0 fixation.