BACKGROUND

Early detection and management of glaucoma can reduce the visual morbidity. As the population-based screening programs were not cost effective because of low prevalence of glaucoma in general population, this study was aimed at screening by the comprehensive eye checkup at hospital attending patients for any possibility of developing glaucoma in future and if detected to evaluate the extent of damage suffered at initial diagnosis and to provide treatment.

MATERIALS AND METHODS

A cross-sectional survey conducted on participants aging 40 years or older attending eye department from March 2013 to February 2014. All were subjected to a pre-structured questionnaires. Data on demographics collected besides screening and evaluating each patient for glaucoma by extensive comprehensive eye checkup. The results were analysed.

RESULTS

924 patients participated in this study from urban and semi-urban areas having similar ethnicity. The mean age was 52 (range 28 – 76 yrs.); 146 (15.8%) were labelled as glaucoma suspects. Optic nerve head changes of glaucoma suspects were noted and correlated with visual field defects and intraocular pressure; 28 (3.03%) were detected to have various types of glaucoma.

CONCLUSION

Comprehensive eye checkup to screen glaucoma in hospital attending patients proved a good measure to detect and manage glaucoma at the earliest as is shown in result of this study; 3.03% were detected with various types of glaucoma, of which 1.62% had POAG. All patients were managed conservatively and surgically as per need. Proper training of optometrists will also be an effective step in early detection, management and preventing this blinding disease.

KEYWORDS

Screening, Evaluation, Intraocular Pressure (IOP), Primary Open Angle Glaucoma (POAG), Primary Angle Closure Glaucoma (PACG), Glaucoma Suspects, Automated Perimetry, Optical Coherence Tomography (OCT).


BACKGROUND

Glaucoma is an extremely serious illness from social standpoint and consistently is the 2nd leading cause of blindness in the world.1 Glaucoma is a group of conditions defined by a progressive optic neuropathy accompanied by visual field changes with raised intraocular pressure being an important risk factor. Raised IOP being a defining characteristic for glaucoma has been almost universally discarded as some patients presented with glaucoma, have IOP within the normal range.2 The estimated prevalence of glaucoma worldwide was 60.5 million in 2010 and is expected to increase to 79.6 million by 2020. Of these, 74% will have Open Angle Glaucoma (OAG). Women comprised 55% of OAG and 70% of Angle Closure Glaucoma (ACG) and 59% of all glaucoma in 2010. Asians contributing to 47.0% of those with glaucoma and 87.0% of those with ACG.3 All studies show increased prevalence of POAG with age. From 2010 to 2020, the most predictable change in the world-wide glaucoma will be its increase in India as population over 40 will increase.3 In population-based studies conducted at various regions of India, 11.2 million persons aged 40 yrs. and older had glaucoma. Primary open angle glaucoma is found in 6.48 million people and primary angle closure glaucoma in 2.54 million. Those in any form of primary angle closure disease could be approximately 27.6 million persons. Secondary glaucoma could affect 2.28 million people.4 The number of bilaterally blind will rise from 8.4 million in 2010 to 11.1

ABSTRACT


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millions in 2020. Of 12% of the world blindness, (4.4 million) was caused by glaucoma. Several population-based studies have been conducted at different zones of the country to estimate the prevalence as Andhra Pradesh Eye Disease Study (APEDS), Chennai Glaucoma Study (CGS), West Bengal Glaucoma Study (WBGS), Yellore Eye Study and Arvind Comprehensive Eye Survey (ACES). Having different methodologies, interpretation of those may differ from each other. Recently, to bring uniformity most of the studies are using the guidelines of International Society of Geographical and Epidemiological Ophthalmology (ISGEO) definitions for glaucoma, which suggested classification of glaucoma as per 3 levels of evidence as in category 1, structural and functional evidence (CDR or CDR asymmetry) > 97.5th percentile for normal population or a neuroretinal rim width reduced to < 0.1 CDR (between 11 to 1 o’clock or 5 to 7 o’clock) also showing a definite field defect consistent with glaucoma. Category 2 requires advanced structural damage (CDR or CDR asymmetry) > 99.5th percentile for the normal population) when subject does not satisfactorily have complete visual field loss. Both do not require IOP for diagnosis. Category 3 requires IOP ≥ 99.5th percentile for normal population and vision < 3/60 only if the optic disc is not seen and visual fields are not possible or has an evidence of glaucoma filtration surgery or glaucomatous visual morbidity. According to this categorization, all studies have relied on structural damage to optic nerve to diagnose glaucoma and most have not considered IOP for diagnosis.

Although, glaucoma is characterised by Optic Nerve Head damage, Visual field loss and raised intraocular pressure, there is no consensus definition for confirming diagnosis. Damage is irreversible, so early detection can prevent severe vision loss. Unfortunately, only-half of the prevalent cases of glaucoma have been identified in the United States due to at least 2 factors, firstly glaucoma being asymptomatic disease and secondly there is no single test to identify the people with glaucoma. Besides the people of African-Caribbean decent are up to eight times more likely to develop POAG, which appears 10 - 15 yrs. earlier than in any other ethnic group. High prevalence of narrow angle is seen in several East-Asian populations including those from Vietnam, Thailand, Burma and Chinese-Americans.

In March 2005, U.S. Preventive Services Task Force (USPSTF) recommendation for screening of glaucoma stated that there was insufficient evidence to recommend for or against screening adults for glaucoma as IOP measurement and ONH assessment have limited effectiveness as population-based screening tool. Also concluded that assessing visual field loss may be impractical for population-based studies due to challenge of instrument portability and being time consuming. With nearly 1/5th of population affected by glaucoma, being blind in one or both eyes and > 90% being unaware of their disease put the onus on a plausible way to screen for glaucoma in community.

MATERIALS AND METHODS
A cross-sectional study conducted with intention of screening and evaluation of hospital attending patients for glaucoma for a period of one year from March 2013 to February 2014. Patients selected were aged 40 yrs or older with various complaints and after obtaining their consent were subjected to pre-structured questionnaires. Socio-demographic details including age, gender, previous history of eye checkup, any family history of glaucoma, previous eye surgery or treatment were noted. Patients underwent an extensive comprehensive eye check-up including visual acuity, slit lamp examination along with assessment of depth of anterior chamber by Von Herrick’s method, tonometry, gonioscopy, direct ophthalmoscopy to assess the C:D and the status of neuroretinal rim or other evidences of glaucomatous changes, water drinking test and diurnal variation test, automated perimetry to assess the visual field damage and Optical Coherence Tomography (OCT) to reach to final conclusion in a few selected cases. Criteria for inclusion was- 1. All participants belonging to similar ethnicity, 2. All above 40 years age, 3. Some patients younger than 40 yrs. having optic nerve head changes were also included in the study for further screening and evaluation, 4. Patients of high risk groups for glaucoma (Diabetics, Hypertensives, Myopics) were also included in the study. Criteria for exclusion- 1. All those already diagnosed with glaucoma and are under treatment; 2. All those who refused to undergo complete investigations; 3. All secondary glaucomas. The diagnosis of glaucoma was made according to 3 levels of evidence as suggested by International Society of Geographical and Epidemiological Ophthalmology (ISGEO). The data was compiled for further analysis and those detected with glaucoma were managed accordingly.

RESULTS
924 patients participated in this study. The mean age being 52 (range- 28 and 76 years), Males- 55.3%, Females- 45.61%. Highest number of patients belonged to 41 to 60 years’ age group, i.e. 59.52% as evident from Chart 1; 602 (65.15%) patients belonged to general category and the rest were from high risk groups- Chart 2; 146 patients were labelled as glaucoma suspects. The different criteria taken up for glaucoma suspects are as shown in Table 1. Disease wise distribution of glaucoma suspects is shown in Table 2. Among them, hypertensives were found more susceptible for glaucoma. The optic nerve head changes observed in glaucoma suspects is as shown in Table 3. Majority (86.42%) had cup disc ratio of ≥ 0.6Of these suspects, only 51 patients underwent through the complete screening program as patients who had no positive outcome after water drinking tests and diurnal variation tests were not subjected further to automated perimetry or OCT. Only those patients who had strong evidence of glaucomatous optic disc but inconclusive evidence of visual field defects were subjected to OCT; 28 (3.03%) out of the complete study population of 924 were detected with various types of Glaucoma- Table 4; 11 (1.19%) patients...
labelled as strong suspects as in spite of an array of glaucomatous changes results of automated perimetry were inconclusive and they did not turn up for OCT. Those were advised to be on periodic followup. Here, it needs a special mention that during course of screening program, 11 patients, all above 60 yrs. of age were detected as known cases of glaucoma of various types and 5 of them having gross visual loss at least in one eye suggesting late or missed diagnosis and ignorance on the part of patients. Of those, 4 eyes had undergone trabeculectomy and 6 eyes had laser peripheral iridotomy with continued topical medication in some. Those patients were excluded from our study. A case of pigment dispersion with Krukenberg’s spindle with no evidence of glaucoma was noted and advised for further followup.

### Table 1. Criteria - Glaucoma Suspects (n = 146)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Number of Patients</th>
<th>N = (146) Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raised IOP</td>
<td>40</td>
<td>27.39</td>
</tr>
<tr>
<td>C. D &gt; .6 ≥</td>
<td>121</td>
<td>86.42</td>
</tr>
<tr>
<td>C.D - Difference of 0.2 ≥</td>
<td>58</td>
<td>39.42</td>
</tr>
<tr>
<td>Vertical C.D. 0.2 ≥</td>
<td>30</td>
<td>20.54</td>
</tr>
<tr>
<td>F/H of Glaucoma</td>
<td>10</td>
<td>6.84</td>
</tr>
<tr>
<td>Shallow - A.C.</td>
<td>15</td>
<td>10.27</td>
</tr>
</tbody>
</table>

### Table 2. Disease Wise Distribution

<table>
<thead>
<tr>
<th>Category</th>
<th>N = (146) Patients</th>
<th>N = (924) Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>94</td>
<td>10.17</td>
</tr>
<tr>
<td>Hypertensive</td>
<td>34</td>
<td>3.67</td>
</tr>
<tr>
<td>Diabetic</td>
<td>6</td>
<td>0.64</td>
</tr>
<tr>
<td>Combined (H + D)</td>
<td>10</td>
<td>1.08</td>
</tr>
<tr>
<td>Myopic</td>
<td>2</td>
<td>0.21</td>
</tr>
<tr>
<td>Total</td>
<td>146</td>
<td>15.8</td>
</tr>
</tbody>
</table>

### Table 3. Optic Nerve Head Changes in Glaucoma Suspects

<table>
<thead>
<tr>
<th>Criteria</th>
<th>N = (146) Patients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>C: D -&gt; 0.6 ≥</td>
<td>121</td>
<td>86.42</td>
</tr>
<tr>
<td>C:D -Difference of 0.2 ≥</td>
<td>58</td>
<td>39.42</td>
</tr>
<tr>
<td>Vertical C: D - 0.2 ≥</td>
<td>30</td>
<td>20.54</td>
</tr>
<tr>
<td>N.R.R.- Thinning</td>
<td>46</td>
<td>31.5</td>
</tr>
<tr>
<td>N.R.R.- Absent</td>
<td>6</td>
<td>4.1</td>
</tr>
<tr>
<td>Notching Superior Inferior</td>
<td>14.16</td>
<td>9.58, 10.95</td>
</tr>
<tr>
<td>Splinter Hmgs.</td>
<td>2</td>
<td>1.36</td>
</tr>
<tr>
<td>Peripapillary Hallow</td>
<td>6</td>
<td>4.10</td>
</tr>
<tr>
<td>Pallor</td>
<td>36</td>
<td>24.65</td>
</tr>
<tr>
<td>Vascular Changes</td>
<td>47</td>
<td>32.19</td>
</tr>
</tbody>
</table>

### Table 4. Glaucoma Detected (28/924)

<table>
<thead>
<tr>
<th>Category</th>
<th>N = (28) Glaucoma Patients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Open Angle Glaucoma</td>
<td>15</td>
<td>1.62</td>
</tr>
<tr>
<td>Normotensive Glaucoma</td>
<td>7</td>
<td>0.75</td>
</tr>
<tr>
<td>Creeping Angle Closure Glaucoma</td>
<td>4</td>
<td>0.43</td>
</tr>
<tr>
<td>Primary Narrow Angle Glaucoma</td>
<td>2</td>
<td>0.21</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>3.03</td>
</tr>
</tbody>
</table>
DISCUSSION

Glaucoma, being silently progressive in nature, patients often present late in the course of disease with irreversible damage. Early detection can prevent severe vision loss. Open Angle Glaucoma (OAG), the most common subtype of the disease affects more than 2.5 million people in United States with a mean age adjusted prevalence of 4.6% among American Africans and 1.6% in white people based on year 2000 estimates.16

Poor awareness and knowledge regarding the disease emphasises the need for proper screening of patients, specially in the hospital-based population as the population-based screening programs have been found to be difficult and controversial as discussed earlier.19,20

146 patients (15.8%) selected as glaucoma suspects as per criteria shown in Table 1. Of those, 60.2% were males and 39.72% were females. After undergoing a thorough comprehensive eye check-up, the no. of patients detected with glaucoma were 28 (3.03%), males were found to be affected more (2.5:1). The break-up is shown in Table 4. Prevalence of open angle glaucoma in the Indian population-based studies of Chennai Glaucoma Study group5-12 was found to be 1.62% to 3.51% in rural and urban cohort respectively, whereas in APEDS study5-8 also reported almost similar findings, i.e. 1.6% to 4% in rural and urban cohort respectively. Our finding of prevalence of primary open angle glaucoma in urban/semi-urban population was slightly on lower side, i.e. 15 (1.62%) and normotensive glaucoma was found in only 7 (0.75%). This lower incidence could be attributed to the fact that normotensive glaucoma patients have been categorised separately. Prevalence of POAG in ACES15 was reported as 1.7%. In this study, 19 (2.05%) patients were found to be ocular hypertensive in contrast to 0.42% in APEDS study and to some extent comparable to VES14 study report, i.e. 3.08%. In this study, 11 patients strongly suspected of glaucoma where automated perimetry result was found inconclusive, did not agree to undergo the OCT checkup and thus excluded which could have otherwise made a difference in overall prevalence of glaucoma. This apathy on the part of the patients suggests the reason of late diagnosis. The prevalence could be related to with age and also with gender as males were found to be affected more as in other studies.21 In this study, high-risk group of diabetics and hypertensives were included and was found that hypertensives were more prone for Open angle glaucoma.

6 (0.64%) patients having PACG of which 4 (0.43%) were labelled as creeping angle closure glaucoma, a variant of narrow angle glaucoma. Prevalence of PACG in VES study was found high, i.e. 4.32% compared to POAG (0.41%) and a female preponderance and diabetes and hypermetropia was noted to be associated in CGS. In present study, one patient of pseudo exfoliation was noted with creeping angle closure in contrast to open angle. The overall prevalence of angle closure glaucoma was found 26 (0.6%) in the Egna-Newmarkt Glaucoma Study, where 15 (0.34%) patients were of chronic angle closure cases.22 Creeping angle closure is one cause of primary angle closure, where an insidious and usually symptomless angle closure occurs. The disease closely resembles chronic simple glaucoma, but the outflow impairment is different.23

In this study 8 (28.57%) patients presented with blindness and were unaware of the term glaucoma, of which 4 (14.28%) patients belonged to POAG and 4 (14.28%) patients were having PACG. B/L blindness was seen in 2 (7.14%) and unilocular blindness in other 6 (21.42%). In the combined cohorts of APEDS, bilateral blindness was seen in 20% and additional 28.7% had unilateral blindness and was much higher than that reported by CGS, which was 5.9% and 8.8% respectively. This level of high blindness reflects the high no. of undiagnosed disease, lack of awareness and asymptomatic nature of disease.

Optic disc changes are shown in Table 3. Optic nerve head topography is important for diagnosis and followup of glaucoma. Compared to visual field examination, topographic analysis of ONH may be more objective and less time consuming and these changes do occur earlier than visual field defects.24 Global topographic parameters like cup volume and rim area are reproducible and the results correlate significantly with functional indices of glaucomatous disease.25-27 However, the results show a large overlap between glaucomatous and normal eyes and can be well explained by the large normal variation of optic disc and cup size and shape.28 Sensitivity and specificity of structural optic disc parameters in chronic glaucoma was observed and found glaucomatous eyes had significantly larger cup areas, horizontal and vertical C/D ratios as well as smaller rim areas than normal eyes.29 This is similar to findings in the present study- Table 3. A generalised concentric expansion of the cup and also a change of optic cup configuration from horizontally oval to circular may be the earliest visible sign in glaucomatous eyes. Increased vertical elongation and/or asymmetrical expansion of the optic cup has been also described as the next clinical sign of glaucomatous disc changes.30 Increased vertical c/d ratio and asymmetry of cup was observed in 20.54% and 39.42% respectively of glaucoma suspects. Recognition of normal aging changes is fundamental to our understanding of diseases that have an age related incidence, such as glaucoma. There is a conflicting evidence in literature with respect to aging changes in optic disc cupping with some reporting an increase, others none and the same with neuroretinal rim.31 So, while selecting the glaucoma suspects these variables should be kept in mind as the older age group patients are being dealt with.

In this study the increased cup was found in 86.42% of those suspects, may be due to the elderly age group intentionally included in the study considered as high risk group.

The NRR thinning was observed in 31.5% of cases and absent in 4.1% of those suspects, which is quite valuable in assessing glaucomatous atrophy as the disc and cup size have a lot of individual variation as discussed earlier. Not much difference was found in superior/inferior notching of
rim. Splinter haemorrhages seen in 2 (7.14%) of the cases detected having glaucoma as has been reported in previous study done in India.\textsuperscript{32} Temporal pallor and vascular changes on the optic disc surface were noted as 24.65% and 32.19% respectively of glaucoma suspects. 

Optic nerve evaluation in glaucoma is very important as the structural changes precede functional changes. This parameter, unlike IOP does not fluctuate day-to-day or unlike visual fields is not dependent on patient cooperation. Therefore, it has the potential to be the most useful indicator of the disease or its progression. So, it needs to be done with great care and attention to detail. Though automated perimetry is vital in diagnosing and monitoring Glaucoma, it fails to detect visual field loss until 30% - 50% of the ganglion cells are lost. Therefore, raised IOP and automated perimetry has a poor sensitivity for diagnosis of early glaucoma.

According to OHTS (Ocular Hypertensive Treatment Study) at 60 months, the probability of developing glaucoma was 9.5% in observation group and 4.4% in the treatment group and without careful optic disc evaluation, one can miss 55% of glaucoma. Retinal nerve fibre layer analysis by OCT is useful as a baseline and follow-up tool for objective RNFL assessment in ocular hypertensive and glaucoma suspects with ONH changes. In glaucomatous patients, it can be a useful adjunct to perimetry when it is difficult to assess the progression and can prove handy in early detection of glaucoma. In this study, all the patients where the automated perimetry showed inconclusive result were subjected to OCT for final conclusion regarding diagnosis.

Primary open angle glaucoma was found in 3 hypertensive and 3 patients with a combined hypertension and diabetes in this study, i.e. 10.71% in each group. Diabetes and glaucoma have a common pathogenesis. The prevalence of glaucoma in diabetics was found 15.6% in a hospital-based study done in Maharashtra, India\textsuperscript{33} and found to be significantly associated with duration of disease. This prevalence is higher than our study, could be because of limited no. of diabetics included in this study.

Management

Despite continued advances in laser and surgical procedures, medical therapy still appears to be the primary means by which the intraocular pressure is controlled. Initial medical therapy has changed with the introduction of prostaglandin analogs, which are replacing β-blockers as the drug of first choice.\textsuperscript{34} Although, only one of them i.e. latanoprost has been approved for first line therapy\textsuperscript{35} in this study, patients diagnosed as POAG and NTG (Normotensive glaucoma) were started on prostaglandin analog Travoprost 0.004% once a day with good control and tolerance and no complaints of hyperaemia. Besides good IOP control, it also has a neuroprotective action by increasing optic nerve head perfusion. In 2 patients with advanced glaucoma, coming from a distant town, trabeculectomy was done with good control of IOP. Laser iridotomy was done in one patient of creeping angle closure glaucoma, but postoperative medical therapy with Travoprost was continued because of the advanced stage of disease in one eye. Two patients of PNAG were subjected to laser iridotomy as a prophylactic measure. After peripheral iridectomy, continued medical treatment may be needed, specially if necessary in cases of creeping angle closure glaucoma.\textsuperscript{23}

CONCLUSION

Glaucoma being an asymptomatic condition causing blindness insidiously, is a major cause of concern for visual health. As the population-based screening programs are quite cost effective and controversial due to lack of portability of diagnostic equipments, a comprehensive eye checkup in hospital attending patients are much of value in regard to early detection and management of glaucoma patients, as has been substantiated by this present study where prevalence of all types of Glaucoma was found to be 3.03% and POAG in 1.62% of hospital attending population. Here, it needs a special mention of proper training of optometrists for screening of glaucoma as an important step, as they are often the primary eye care provider. A constant effort to educate the patients to attend hospital for routine eye check-up can prove valuable in reducing the economical blindness thus caused.

REFERENCES