Aim: 1) To study the visual field progression in patients with unilateral visual field loss due to POAG. 2) To determine the risk factors for progression.

Materials and Methods: 31 patients with POAG with unilateral field loss by Anderson’s criteria were followed up with Humphrey’s Field Analyzer. Variables noted were age, duration of disease, duration of follow up, number of visual fields, initial C: D ratio, mean IOP, MD [dB], PSD for both eyes and AGIS score for first affected eyes. The criteria for progression were modified from Anderson, after taking into account the initial AGIS score.

Results: Progression of the field loss was noted in 11 (35.48%) first affected eyes over an average period of 22.72 ± 10.22 months and three (9.67 %) fellow eyes over an average period of 19.33 ± 13.31 months. The duration of follow-up was found to be significantly associated with progression in first affected eyes and no variable was significant in case of fellow eyes. Risk of progression estimated by Kaplan-Meier survival analysis as 46.74% at 3 years for the first affected and 15.38% at 4 years for the fellow eyes.

Conclusion: The risk of progression of the field defect in the fellow eyes without field loss is low compared to that in the eyes with field loss. None of the variables investigated were found to be significantly associated with progression in the fellow eye.

Key words: POAG, FELLOW EYE, UNILATERAL FIELD LOSS

Introduction

Primary open angle glaucoma (POAG) is the common form of glaucoma, affecting 1 to 2% of the world population. 1 Our understanding of the pathophysiologic events that result in the optic atrophy and visual field loss is imperfect. POAG is a bilateral disease of adult onset1. In patients with visual field loss in one eye, the fellow eye is at high risk for developing visual field defects because the patients may have some systemic susceptibility factors. 2

We studied the progression of visual fields in POAG patients with unilateral field loss with automated perimetry. We also sought to identify any risk factors for progression.

Materials and Methods

Patients seen at the Out Patient Clinic of the Department
of Ophthalmology, from January 2000 to May 2005 were included in the study.

The inclusion criteria were:

1. Patients with Primary Open Angle Glaucoma.
2. The visual field of one eye abnormal by Anderson's criteria.
3. The visual field of contralateral eye not meeting Anderson's criteria.
4. Patients with a minimum follow-up of 1 year with Humphrey visual fields.

The exclusion criteria were:

1. Secondary glaucomas.
2. Visual field loss due to causes other than glaucoma.

Age and sex of the patient were noted. A detailed history and the presenting symptoms were recorded. The duration of the disease, treatment taken and history of any ocular surgeries were noted. Any history of trauma to the eye and history of medications like topical or systemic steroids were noted. Presence of systemic diseases like Diabetes Mellitus, Hypertension and Cardiovascular disease was noted. Family history of glaucoma was also noted.

Visual acuity and anterior segment findings including the presence of cataract, IOP, diurnal variation of IOP and gonioscopic findings were recorded. In fundus examination, cup: disc ratio and other glaucomatous changes like notching, peripapillary atrophy etc. were noted. Any other fundus abnormalities were also noted. HFA 30-2 SITA was done and HFA 10-2 was performed in patients field loss. Visual field data like mean deviation [MD] and pattern standard deviation [PSD] were recorded and the AGIS score of the visual field noted. The criteria used to determine the abnormality was the Anderson's criteria. A visual field test was considered abnormal if any two of the following three criteria were met on at least two consecutive visual field tests:

1) A Glaucoma Hemifield Test outside normal limits.
2) A cluster of three or more non-edge points in a location typical for glaucoma all of which are depressed on the pattern deviation plot at a p < 5 % level and one of which is depressed at a p < 1 % level.
3) A corrected pattern standard deviation p < 5 %.

Since in the SITA program the short-term fluctuation and the CPSD are not available the pattern standard deviation was substituted as criteria in making the diagnosis.

For abnormal visual fields, the criteria for progression were modified from Anderson, after taking into account the initial Advanced Glaucoma Intervention Study (AGIS) score, as done in a previous study by Chen and Park. This was done to compensate for the higher level of fluctuation seen in eyes with more advanced glaucomatous damage. For eyes with an initial AGIS score of 5 or less (mild visual loss by AGIS classification), the progression was defined as three adjacent points depressed 5 dB or more from the initial level of loss on the total deviation plot, with at least 1 point depressed 10 dB, on two consecutive fields. For eyes with an initial AGIS score of 6 or more, progression was defined as three adjacent points depressed 10 dB or more from the initial level of loss on the total deviation plot, on two consecutive fields.

Patients were followed up according to the severity of the glaucoma (every 3-6 months). During follow-up the medications used, visual acuity, IOP and cup: disc ratio were recorded. Visual fields were examined to assess progression in the affected eyes and development of field loss in the normal eyes. Time taken for visual field progression was also noted. In the normal eyes where there was no field loss, SWAP was done wherever possible.

The variables noted were age, duration of the disease in years, follow-up in months, number of visual fields, mean IOP, initial characteristics like cup: disc ratio, MD, PSD for both eyes and AGIS score for the first affected eye. The IOP's at the time of follow-ups were averaged to derive the mean IOP.

Variables were compared between the eyes with and without progression using independent samples two-tailed 't' test. The correlation between the progression of the field defect in the first affected and the fellow eyes was assessed by Spearman correlation. Kaplan-Meier survival analysis was used to estimate progression in first and fellow eyes. Cox proportional hazards regression analysis with forward stepwise variable selection was also used to evaluate variables for association with progression. A statistical spreadsheet software program was used for all calculations (SPSS 10.0).
Results

62 eyes of 31 patients with unilateral field loss from POAG who attended our hospital from January 2000 to February 2005 were studied.

The study group included 18 males and 13 females. Out of the 31 first-affected eyes, 18 were affected in the left eye and 13 in the right eye. Family history of glaucoma was present in one patient. Demographic data of the patients studied is given in Table 1.

Progression of field loss was noted in 11 (35.48 %) of 31 first affected eyes. The average time to progression was 22.72 ± 10.22 months.

Among the variables investigated the duration of follow-up (in months) was found to be significantly associated with progression (P = 0.015). Risk of progression estimated by Kaplan-Meier survival analysis was found to be 46.74 % at three years. The distribution of the IOP and C:D ratio in the first affected eyes is shown in chart 1 and 2. The difference between the variables of the progressing eyes and the stable eyes is given in Table 2.

Three out of 31 fellow eyes (9.67 %) were found to have progression of the visual field defect. The average time to progression was 19.33 ± 13.31 months. No significant differences were found between stable and progressing eyes among the variables investigated. Kaplan-Meier survival analysis estimated the risk of progression to be 15.38 % at four years. The distribution of the IOP and C:D ratio in the fellow eyes is shown in chart 3 and 4. The difference between the variables of the progressing eyes and the stable eyes is given in Table 3.

Table 1. Demographic Data and Characteristics of the Patients studied, expressed as Range (Mean + SD )

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Range</th>
<th>Mean (SD)</th>
</tr>
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<tbody>
<tr>
<td>Age (in years)</td>
<td>28-77</td>
<td>57.12 +/- 12.08</td>
</tr>
<tr>
<td>Duration of disease (years)</td>
<td>1-14</td>
<td>3.86 +/- 3.09</td>
</tr>
<tr>
<td>Follow-up (months)</td>
<td>12-50</td>
<td>28.19 +/- 10.43</td>
</tr>
<tr>
<td>Number of visual fields</td>
<td>2-12</td>
<td>5.7 +/- 2.5</td>
</tr>
<tr>
<td>Ocular Characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial C:D ratio</td>
<td>0.4-0.9</td>
<td>0.75 +/- 0.12</td>
</tr>
<tr>
<td>Mean IOP</td>
<td>10-30</td>
<td>16.37 +/- 4.2</td>
</tr>
<tr>
<td>Mean Deviation (dB)</td>
<td>-30.28 to -0.4</td>
<td>-10.72 +/- 10.03</td>
</tr>
<tr>
<td>PSD (dB)</td>
<td>2.53-16.68</td>
<td>8.09 +/- 4.5</td>
</tr>
<tr>
<td>AGIS Score</td>
<td>1-20</td>
<td>8.13 +/- 7.12</td>
</tr>
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</table>

Bilateral progression was noted in one patient (3.22 %). 18 patients (58.06 %) were stable bilaterally. The correlation between the visual field progression in the first affected and fellow eye was not significant (P=0.937).

The number of antiglaucoma drugs used in the first affected and fellow eyes is given in table 4. Nine patients did not receive treatment in the fellow eye. None of them had visual field progression in the same eye.
Three patients underwent combined surgery in the first affected eye. Four patients underwent trabeculectomy in both eyes. Five patients could discontinue antiglaucoma medication after the surgery. In two patients who underwent combined surgery, antiglaucoma medication was restarted, the reason being inadequate control of IOP in one and progression of visual field defect in the other patient.

Initial C: D ratio (P = 0.00), Mean Deviation (P = 0.00) and Pattern Standard Deviation (P = 0.00) were found to be significantly higher in the first affected eye when compared to the fellow eye.

Worsening of final central acuity by more than 2 lines was noted only in one of 62 eyes, which was a first affected eye.

**Discussion**

Previous studies regarding the incidence of visual field loss in the fellow eyes of POAG showed that the level of visual field loss was higher than that seen in patients with ocular hypertension.

Harbin et al reported that 9 of 21 (43 %) fellow eyes of patients with POAG developed glaucomatous visual field loss over 4.4 years. Kass et al found 9 of 31 (29 %) fellow eyes developed visual field loss over a 3 to 7 year period. Susanna et al calculated progression of 25 % over 5 years in fellow eyes with median follow up of 3 years. Olivius and Thorburn found 25 % of unilateral glaucoma becoming bilateral in five years. Chen and Park calculated the progression in fellow eyes to be 6.3 % over an average period of 37 ± 9 months. In another study by Chen PP and Bhandari, assessed the fellow eye prognosis in patients with severe visual field loss in one eye from chronic open angle glaucoma, and found that 6 of 36 fellow eyes (17 %) had significant visual field progression. In another study by Chen PP, he studied correlation of visual field progression between the two eyes of patients with open-angle glaucoma, and found that 24.3 % of the better eyes progressed. In our study, the fellow eye progression was found to be 9.67 % over an average time of

<table>
<thead>
<tr>
<th>Table 2. Variables in first- affected eyes with and without progression (Mean+- SD) and their association with progression of field defect (P value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>progressing eyes</td>
</tr>
<tr>
<td>age (years)</td>
</tr>
<tr>
<td>duration of disease (years)</td>
</tr>
<tr>
<td>follow-up (months)</td>
</tr>
<tr>
<td>cup: disc ratio</td>
</tr>
<tr>
<td>mean iop (mm hg)</td>
</tr>
<tr>
<td>mean deviation (db)</td>
</tr>
<tr>
<td>pattern SD (db)</td>
</tr>
<tr>
<td>agis score</td>
</tr>
</tbody>
</table>

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19.33 months, which is corresponding to Chen et al’s studies \(^6, 10, 11\). The older studies were based on Goldmann fields. The studies by Chen PP \(^6, 10, 11\) and our study were based on visual fields by Humphrey’s Field Analyser.

In the present study, risk of progression in the fellow eye estimated by Kaplan-Meier survival analysis was 15.38 % at 4 years. This was comparable with previous studies. Chen and Park \(^6\) estimated 7.2 % at 5 years; Chen and Bhandari \(^10\) 12.4 % at 5 years and Chen \(^11\) 33 % at 10 years.

In our study, the progression in the first affected eye was 35.48 % over an average period of 22.72 months. Hart and Becker \(^12\) showed that 73 % of their patients with glaucomatous visual field defects progressed during the course of their disease. In the study by Mikelberg et al \(^13\), 76 % patients showed progression during the follow-up period. Harbin et al \(^7\) found in his study of 21 patients with monocular field loss, that 16 of the 21 eyes (76.19 %) already had field loss, progressed over a period of 4.4 years. In recent studies, Chen and Park \(^6\) found progression of the first affected eyes in 21 % patients; Chen and Bhandari \(^10\) in 33 % and Chen PP \(^11\) in 35.5 % patients.

In our study, risk of progression of the first affected eye as estimated by Kaplan-Meier survival analysis was 46.74 % at 3 years, which was high compared to that estimated by Chen and Park \(^6\) (25 % at 5 years) and Chen \(^11\) (44 % at 10 years).

The higher incidence of progression compared to the previous studies may be partly due to differences in the patient populations like racial composition and educational level.

The number of untreated fellow eyes in this study (8 of 31 eyes, 25.81 %) was similar to that in the study by Kass et al \(^8\) (19 %) and Chen and Park \(^6\) (21 %). No progression was seen in untreated eyes, in all the three studies.

In our study, the severity of initial visual field loss was measured by AGIS score unlike older studies, which generally assessed severity of visual field loss by broad grading schemes. AGIS score of the initial visual field in the first affected eye was found not to be significantly associated with progression (\(P = 0.443\)) unlike Chen and Park’s study. Some studies have shown that visual field progression is more in patients with advanced visual field damage \(^9, 12-14\), some have found progression to be more likely in eyes with less damage \(^15\) and some have found progression unrelated to the initial level of damage \(^16\).

Previous studies have found the risk factors for progression in the fellow eyes to be elevated IOP \(^2, 7, 8\), larger cup/disc ratio\(^2\), and optic disc hemorrhage. \(^2\) In our study, no variables were found to be significantly associated with progression. Chen and Park \(^6\) noted a similar observation.

In our study, among the variables investigated, only the duration of follow-up (in months) was found to be significantly associated with progression (\(P = 0.15\)) in the first affected eyes. The more we follow up a patient,

### Table 3. Variables in fellow eyes with and without progression (Mean+/− SD) and their association with development of field defect (P value)

<table>
<thead>
<tr>
<th>Progressing eyes</th>
<th>Stable eyes</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>58.33 +/- 4.04</td>
<td>57 +/- 12.68</td>
</tr>
<tr>
<td>Duration of disease (years)</td>
<td>5.6 +/- 7.27</td>
<td>3.68 +/- 2.52</td>
</tr>
<tr>
<td>Follow-up (months)</td>
<td>22.66 +/- 10.26</td>
<td>28.7 +/- 10.46</td>
</tr>
<tr>
<td>Cup: Disc ratio</td>
<td>0.566 +/- 0.23</td>
<td>0.567 +/- 0.16</td>
</tr>
<tr>
<td>Mean IOP (mm Hg)</td>
<td>16.26 +/- 0.88</td>
<td>15.09 +/- 2.75</td>
</tr>
<tr>
<td>Mean deviation (dB)</td>
<td>-0.906 +/- 0.34</td>
<td>-0.71 +/- 0.32</td>
</tr>
<tr>
<td>Pattern SD (dB)</td>
<td>3.01 +/- 1.04</td>
<td>2.63 +/- 1.16</td>
</tr>
</tbody>
</table>

### Table 4 Medical and surgical treatment in the first affected and fellow eyes

<table>
<thead>
<tr>
<th>No. of eyes on 1 drug</th>
<th>No. of eyes on 2 drugs</th>
<th>No. of eyes on 3 drugs</th>
<th>No. of eyes not on treatment</th>
<th>No. of eyes which underwent surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>First affected eyes</td>
<td>12</td>
<td>7</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Fellow eyes</td>
<td>11</td>
<td>5</td>
<td>2</td>
<td>9</td>
</tr>
</tbody>
</table>
the more the chance for detecting progression. Some of the previous studies have found IOP \(^8,15,17-19\), cup: disc ratio \(^17,20-23\), systemic diseases like diabetes \(^24\), hypertension \(^25\) to be associated with progression and some studies have found them to be not significant \(^26-31\). The cup: disc ratio was found to be significantly high in the first affected eye than the fellow eye. But the initial cup: disc ratio was not found to be associated with the development of field loss in the fellow eye. This may mean that other patient related factors (like decreased blood velocity in retrobulbar vessels) \(^32\) may be contributing to development of field loss.

**Conclusion**

The fellow eyes of patients with initially unilateral field loss were found to be at high risk for developing visual field defects in previous studies \(^2,7,8,33\). The risk of development of visual field loss in the fellow eyes was found to be significantly higher than that in ocular hypertension. This led to the current practice patterns of treating both the eyes in POAG, even if one eye has high IOP and field loss and the other eye has only high IOP and no field loss.

Recent studies \(^6,10,11\) have shown that the risk of development of field loss in the fellow eye is low. This improved prognosis may be due to the current practice patterns.

Our study confirms that the risk of progression in fellow eyes without field loss is low compared to that in the eyes with field loss. So the presence of field loss is a risk factor for further progression. The progression was not associated with the severity of initial field loss measured by AGIS score. There was no correlation between the progression of the field defect between the two eyes. None of the variables investigated were found to be significantly associated with progression in the fellow eye. In the first affected eye only the duration of follow up was found to be significantly associated with progression.

**References**


