Comparison of Visual Field Defects Between Primary Open-Angle Glaucoma and Chronic Primary Angle-Closure Glaucoma in the Early or Moderate Stage of the Disease

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The visual field data (Humphrey C24-2) of early to moderate stage glaucoma between primary open-angle glaucoma (POAG) and chronic primary angle-closure glaucoma (PACG) patients was compared. Eleven POAG (11 eyes) and 14 chronic PACG patients (14 eyes) were matched with respect to age, sex, and disease severity. Although the mean deviation, pattern standard deviation, and short-term fluctuation were similar between the two groups, the mean corrected pattern standard deviation was higher in the POAG patients (p=0.048). When the numeric pattern deviation data (STATPAC II) was used for point-wise between-group comparisons, more depressed paracentral points were found in POAG patients. Different patterns were identified in visual field damages between the chronic PACG and POAG patients. The chronic PACG patients showed more generalized field loss than the POAG patients.

Key words: pattern deviation, primary angle-closure glaucoma, primary open-angle glaucoma, visual field

INTRODUCTION

It has been suggested that there is a close relationship between the morphology of the optic nerve head and functional changes, and that patients with different disc appearances show differences in the intraocular pressure (IOP) levels, visual field defect patterns, and pathogenesis.1-4 The pathophysiological process of optic nerve damage may not be identical between primary open-angle glaucoma (POAG) and chronic primary angle-closure glaucoma (PACG). When compared with POAG, chronic PACG is considered more likely to be caused by increased IOP.5 Moreover, previous studies show that the optic nerve damage in chronic PACG differs somewhat from that of the POAG (Unpublished data, Wang JJ, Hung PT, Yang C-H: Characteristic features of optic nerve damage in chronic primary angle-closure glaucoma, presented at the 1996 AAO annual meeting, Chicago, USA), and that peripapillary atrophy in PACG has a different relationship to the structural and functional optic disc changes than those in POAG.5

Although PACG patients are rarely encountered in Western countries, Quigley suggested that the prevalence of PACG and POAG might be similar worldwide.6 The reason is that the prevalence of
PACG in Asian patients is much higher than in Caucasians. Moreover, PACG is a more visually destructive form than POAG in Chinese (Unpublished data, Foster PJ, Oen FT, Machin D, Ng TP, Johnson GJ, Seah SK: The prevalence of glaucoma in Chinese Singaporeans, presented at the 1999 ARVO annual meeting, Ft Lauderdale, USA).

There are some comparative studies on visual field damages between POAG and normal-tension glaucoma (NTG), which suggest that the pathophysiological process may not be identical in POAG and NTG.\textsuperscript{7-10} However, there is a paucity of comparative studies on visual field changes between POAG and PACG patients.

**PATIENTS AND METHODS**

Patients who were diagnosed with chronic PACG or POAG at the Glaucoma Clinic of Korea University Guro Hospital, Seoul, Korea were included in this study. Chronic PACG patients were enrolled according to the Kim and Jung’s classification.\textsuperscript{11} That is, patients who had peripheral anterior synechia, an IOP greater than 21 mmHg, with or without a history of angle-closure attack, a glaucomatous optic nerve head and visual field defects were enrolled in this study. POAG was diagnosed according to the following criteria: open angle, glaucomatous optic nerve head damage, visual field defects, and an IOP greater than 21 mmHg. Patients with secondary glaucoma, NTG, previous ocular trauma, and previous cataract surgery were excluded. Visual field examinations were performed with the Humphrey Field Analyzer (program C24-2, Allergan Humphrey, San Leandro, CA, USA). Size III and white stimuli were used, and the results were analyzed with the STATPAC II program (Allergan Humphrey, San Leandro, CA, USA). Glaucomatous visual field defects were defined as follows: (1) a glaucoma hemifield test outside the normal limits on at least two fields; or (2) a cluster of 3 or more points in a location typical for glaucoma, all of which have a depressed pattern deviation plot at a p<5% level and 1 of which is depressed at a p<1% level on two consecutive fields.\textsuperscript{12} In chronic PACG patients, visual field examinations were carried out after normalizing the IOP and visual acuity, with minimal or no signs of corneal edema and an anteri- or chamber reaction following treatment including medication, laser iridotomy and trabeculectomy. All the eyes included in this study had reliable visual fields (fixation loss < 20%, false-positive or -negative responses <33%) and the pupil diameter was 3 mm or greater in all cases.

Fourteen eyes from 14 chronic PACG patients with early to moderate stage glaucoma (mean deviation, MD >-10 dB) were selected from our patient database that consisted of consecutive glaucoma patients who visited our clinic between March 1997 and February 1998. Subsequently, 11 eyes from 11 POAG patients matched to the PACG eyes with respect to age, sex, and severity of the disease were also selected. Patients who had a glaucomatous field defect with a mean deviation (MD) >-10 dB, corrected visual acuity >20/40, refractive errors between -6D and +3D, good reliability indices, stable baseline fields, and >55 years of age were included in this study. The data of the left eyes were converted to mirror images. Results of the second or third visual field examinations in each patient were then compared between the two groups by pointwise between-group comparisons using numeric pattern deviation (STATPAC II) data. Chi-square, Student’s t, and Mann-Whitney U tests were used to analyze the patient characteristics and visual field parameters. The statistical significance level was set at p<0.05.

**RESULTS**

The mean age was over sixty and there were more women in the study. However, there were no significant differences in age and sex distribution between the two groups. The maximum IOPs (the highest IOP during the follow-up period) were higher in chronic PACG patients (PACG group, 31.9±12.5 vs POAG group, 25.1±3.5 mmHg, p=0.048) and the mean IOP at the time of the visual field tests was higher in the POAG patients (PACG group, 17.2±5.5 vs POAG group, 22.5±4.8 mmHg, p=0.010) (Table 1). There were no significant differences in the MD, pattern standard deviation (PSD), and short-term fluctuation (SF) between the two groups. However, the mean corrected pattern standard deviation (CPSD) was higher in POAG patients (PACG group, 3.62±2.52 vs POAG group, 4.95±2.29 dB,
Table 1. Patient characteristics

<table>
<thead>
<tr>
<th></th>
<th>PACG (n=14) (Mean±SD)</th>
<th>POAG (n=11) (Mean±SD)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>65.4±7.7</td>
<td>67.7±6.0</td>
<td>0.428*</td>
</tr>
<tr>
<td>Male:female</td>
<td>2:12</td>
<td>4:7</td>
<td>0.406**</td>
</tr>
<tr>
<td>Maximum IOP (mmHg)</td>
<td>31.9±12.5</td>
<td>25.1±3.5</td>
<td>0.048*</td>
</tr>
<tr>
<td>IOP at VF testing (mmHg)</td>
<td>17.2±5.5</td>
<td>22.5±4.8</td>
<td>0.010*</td>
</tr>
</tbody>
</table>

PACG: primary angle-closure glaucoma, POAG: primary open-angle glaucoma, SD: standard deviation, IOP: intraocular pressure, VF: visual field, *: Student’s t-test, **: chi-square test

Table 2. Visual field global indices by the STATPAC II program (decibels)

<table>
<thead>
<tr>
<th></th>
<th>PACG (n=14) (Mean±SD)</th>
<th>POAG (n=11) (Mean±SD)</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD</td>
<td>-5.26±2.07</td>
<td>-6.17±1.80</td>
<td>0.250</td>
</tr>
<tr>
<td>PSD</td>
<td>4.55±2.25</td>
<td>5.59±2.17</td>
<td>0.171</td>
</tr>
<tr>
<td>SF</td>
<td>2.21±0.87</td>
<td>2.17±0.89</td>
<td>0.784</td>
</tr>
<tr>
<td>CPSD</td>
<td>3.62±2.52</td>
<td>4.95±2.29</td>
<td>0.048</td>
</tr>
</tbody>
</table>


Table 3. Test points where the differences in pattern deviation between the PACG and POAG group were statistically significant

<table>
<thead>
<tr>
<th>Deviation in decibels</th>
<th>PACG</th>
<th>POAG</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>P22</td>
<td>-4.00±7.78</td>
<td>-8.46±6.59</td>
<td>0.037</td>
</tr>
<tr>
<td>P23</td>
<td>-2.79±3.29</td>
<td>-6.27±4.27</td>
<td>0.039</td>
</tr>
<tr>
<td>P39</td>
<td>-2.57±5.56</td>
<td>-5.09±3.99</td>
<td>0.021</td>
</tr>
<tr>
<td>P40</td>
<td>-0.36±1.78</td>
<td>-3.64±6.92</td>
<td>0.009</td>
</tr>
<tr>
<td>P42</td>
<td>-0.43±1.79</td>
<td>-1.91±2.12</td>
<td>0.047</td>
</tr>
<tr>
<td>P48</td>
<td>-5.14±3.66</td>
<td>-2.00±2.86</td>
<td>0.036</td>
</tr>
</tbody>
</table>

PACG: primary angle-closure glaucoma, POAG: primary open-angle glaucoma, P: test points with the Humphrey field analyzer STATPAC II program (C24-2, See Fig.1), *: Mann-Whitney U test

p=0.048) (Table 2). When numeric pattern deviation data was used for point-wise between-group comparisons, the sensitivity losses (dB) were significantly greater at test points 22, 23, 39, 40 and 42 in the POAG patients than those of the chronic PACG patients (p<0.05). On the other hand, point 48 showed a greater sensitivity loss in chronic PACG patients than in POAG patients (p<0.05) (Fig. 1 and Table 3). That is, there were more depressed paracentral points in the POAG patients than in the PACG patients in the pattern deviation.

**DISCUSSION**

Visual field changes associated with acute primary angle-closure glaucoma usually show nonspecific
Fig. 1. Distribution of test points in the Humphrey STATPAC II program where the differences in pattern deviation were significant between the PACG and POAG groups. Squares with dark shadow, points 22, 23, 39, 40, and 42, represents those at which the deviation in decibels was greater in the POAG group, and point 48, a lightly shadowed square, represents the point at which deviation was greater in the PACG group. Black squares represent the blind spot.

generalized or upper field constriction. The early loss of central vision, enlargement of the blind spot, and nerve fiber bundle defects may be found. In chronic angle closure glaucoma, the visual field defects progress similarly to those seen in open-angle glaucoma.13

Although an increased IOP has been considered the major causative risk factor in POAG, vascular and other factors may influence the individual susceptibility to the optic nerve damage as well. It is reasonable to say that the NTG is influenced to a larger degree by the other factors than the IOP when compared to POAG patients. On the other hand, optic disk damage in eyes with chronic PACG and secondary glaucoma is considered more likely to be caused primarily by the increased IOP, because the disease process occurs in the chamber angle and the resultant increased IOP causes symptoms and signs in PACG and secondary glaucoma.

Caprioli et al reported that the IOPs were consistently higher in eyes with diffuse field loss compared to eyes with localized field loss.14 They hypothesized that the diffuse loss of visual field sensitivity from glaucoma is largely pressure depen-
dent, and may be secondary to diffuse axonal dysfunction leading to progressive concentric enlargement of the optic nerve cup and an evenly distributed thinning of the disk rim. Chauhan et al also suggested that glaucoma patients with lower IOPs have more localized damage than those with higher IOPs.15 Nicolela and Drance suggested that a generalized enlargement of the optic cup is probably a pressure-related optic disc change and supported the correlation between diffuse visual field loss and an elevated IOP.1

A high PSD indicates an irregular hill and may be due either to variability in the patient response or to actual field irregularities. CPSD is a PSD corrected for SF. Thus, a CPSD value represents the irregularity in the contour of the island of vision due to actual field loss.16 In this study population, the CPSD was statistically higher in POAG patients than in PACG patients (p=0.048). This is despite the similarity in SF between the two groups (p=0.784). These results suggest that chronic PACG patients had a more diffuse field loss than POAG patients.

POAG patients were also found to have more depressed paracentral points than PACG patients. When pattern deviation data was used for point-wise between-group comparisons, the sensitivity losses (dB) were significantly greater at test points 22, 23, 39, 40 and 42 in POAG patients than those of chronic PACG patients (p<0.05). On the other hand, only point 48 showed greater sensitivity loss in chronic PACG patients than POAG patients (p<0.05) (Fig. 1 and Table 3).

Our result supports the hypothesis that the pattern of visual field damages may be different between chronic PACG and POAG patients. The difference of the pattern of IOP changes, or the difference of the magnitude of the IOP elevation between the two groups may be responsible for the visual field difference. In this study, the maximum IOPs were higher in the PACG group. The mean IOP upon visual field examinations was lower in the PACG group than those in the POAG group (Table 1).

Perimetry is the standard psychophysical method for determining the extent of optic nerve damage in glaucoma evaluations. Significant field defects correlated with the increase in IOP and the visual field defects progressed relentlessly to end-stage glaucoma.17 In this study, a sophisticated instrument was
not used to measure optic disc damage, and the cup-to-disc ratio is not an excellent indicator of the severity of glaucoma, especially in the early stage. Therefore, the visual field severity rather than cup-to-disc ratio was adopted as a means of determining the disease severity. In addition, only eyes with early to moderate damage were included, because the visual field in advanced or end-stage disease is likely to be similar in all glaucoma patients. Furthermore, a diversity of the stages of visual field damage can influence the threshold measured at the target test point.

Although we carefully matched the study subjects between POAG and PACG including the disease severity (MD), there may be a selection bias. Moreover, the sample size was small, partly because there were very few chronic PACG patients who met all the inclusion criteria. Thus, further study is needed to confirm the different patterns of field defects between the two disease entities.

In conclusion, a different visual field loss pattern was found between POAG and PACG patients in this study. Chronic PACG appears to have diffuse visual field damage. Different patterns of IOP elevation between POAG and PACG may play a role in this difference in visual field loss.

REFERENCES