The effect of intraocular pressure on visual field after trabeculectomy in patients with primary open angle glaucoma

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Purpose: To compare the mean intraocular pressure (IOP), peak IOP and percentage reduction in IOP in the first five years following trabeculectomy between the patients with progressed visual field loss and the patients with stable visual fields.

Material and methods: Thirty-six eyes of 36 patients were followed for five years after their first trabeculectomy with tonometry and automated perimetry (Octopus 500EZ, program G1). The rate of change of the visual field was measured by linear regression analysis of the mean sensitivity value (dB) of each field test versus time (month). Based on the statistical significance of the slope of the regression line (Spearman p value of the correlation coefficient less than 0.05), patients were divided into two groups: with significant negative slope of the regression line (group with progressed visual field loss) and with non-significant slope of the regression line (group with stable visual field). The mean IOP and percentage of IOP reduction at the end of each of the first five years after surgery were compared between the group with progressed field loss and group with stable fields by using Mann-Whitney U test.

Results: Patients with progressed visual field loss had higher mean IOP, higher peak IOP and less reduction in pressure after the operation than patients with stable visual field. The mean IOP at end of the two year postoperative period was significantly higher in patients with progressed visual field loss (21.98±3.35mmHg) than in those with stable fields (17.48±4.80mmHg). The mean percentage reduction in IOP at the end of two year postoperative period was significantly less in patients that showed progression of field loss (21.84%) than in those with stable fields (41.0%). Conclusion: Prognosis for further field loss seems to be better if postoperative pressure is at lower levels and greater percent reduction of IOP is obtained after surgery. The data that predict better prognosis is the mean postoperative IOP value of approximately 18mmHg or less resulting from at least 35% of IOP reduction.

Key words: glaucoma, trabeculectomy, visual field

INTRODUCTION.

Trabeculectomy is considered as successful and relatively safe surgical procedure in the treatment of glaucoma. The majority of ophthalmic surgeons decide to treat glaucoma surgically when the maximum medical therapy has failed, e.g. when medications become incapable of lowering intraocular pressure (IOP) below satisfactory level and/or to stop progression of visual field and optic disc changes. There are also ophthalmologists who decide in favor of operation before all possibilities for medical treatment have been exhausted. The rationale for early surgical intervention, would be in avoidance of the side effects that accompany long-term medical treatment, which primarily manifest in decreased perfusion of the optic nerve head. The success of the trabeculectomy is usually estimated by its ability to reduce IOP. However, the basic principles of both surgical as well as medical therapy lay on the assumption that IOP lowering will protect visual field from further deterioration, or at least slow its progression. We made an attempt to answer the question whether surgically lowered IOP can stabilize visual function and reverse the chronic progressive disease course.

MATERIAL AND METHODS.

Prospective study was conveyed on patients with primary open-angle glaucoma who had their first trabeculectomy without antimetabolites. To qualify for this study all patients had to satisfy the following conditions:
TABLE 1
COMPARISON OF CHARACTERISTICS BETWEEN THE GROUP WITH PROGRESSIVE VISUAL FIELD AND THE GROUP WITH STABLE VISUAL FIELD

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Visual field progressed</th>
<th>Visual field stable</th>
<th>Probability p</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of patients (%)</td>
<td>9 (25%)</td>
<td>27 (75%)</td>
<td>NS</td>
</tr>
<tr>
<td>No of eyes (%)</td>
<td>9 (25%)</td>
<td>27 (75%)</td>
<td>NS</td>
</tr>
<tr>
<td>Age*, years (range)</td>
<td>50.0 +/- 17.74 (30-63)</td>
<td>53.69 +/- 16.93 (30-77)</td>
<td>NS</td>
</tr>
<tr>
<td>MND Man:Woman</td>
<td>4:5</td>
<td>15:12</td>
<td>NS</td>
</tr>
<tr>
<td>Family history of glaucoma, positive</td>
<td>1</td>
<td>6</td>
<td>NS</td>
</tr>
<tr>
<td>Postoperative follow-up*, months (range)</td>
<td>51.89 +/- 10.93 (30-69)</td>
<td>47.41 +/- 14.35 (22-74)</td>
<td>NS</td>
</tr>
<tr>
<td>Visual acuity*</td>
<td>0.96 ± 0.13</td>
<td>0.95 ± 0.10</td>
<td>NS</td>
</tr>
<tr>
<td>Preoperative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postoperative</td>
<td>0.84 ± 0.27</td>
<td>0.83 ± 0.24</td>
<td>NS</td>
</tr>
<tr>
<td>Preoperative refractive error*</td>
<td>-0.33 ± 1.19</td>
<td>-0.27 ± 1.53</td>
<td>NS</td>
</tr>
<tr>
<td>Preoperative mean sensitivity* (MS, dB), (range)</td>
<td>13.94 ± 6.53 (18-45)</td>
<td>14.45 ± 7.88 (18-60)</td>
<td>NS</td>
</tr>
<tr>
<td>Preoperative IOP*, mmHg (range)</td>
<td>29.0 ± 5.7 (18-45)</td>
<td>30.9 ± 9.0 (18-60)</td>
<td>NS</td>
</tr>
<tr>
<td>Preoperative No of visual fields*</td>
<td>7.56 ± 1.42</td>
<td>6.93 ± 1.80</td>
<td>NS</td>
</tr>
</tbody>
</table>

*Mean ± SD, IOP: intraocular pressure; NS: non significant

1. Confirmed diagnosis of primary open-angle glaucoma (IOP above 22 mmHg without therapy, gonioscopically open and wide anterior chamber angle, characteristic glaucomatous visual field defects and glaucomatous changes of the optic disc).
2. Best corrected visual acuity of at least 0.8 on Snellen chart both preoperatively and postoperatively.
3. Maximum correction of +3.0 D sph and astigmatism not exceeding + 1.0 D cyl, in order to avoid occurrence of refraction scotomas in visual field.
4. Papillary diameter of minimum 3 mm.
5. Transparent optic media and absence of other apparent pathologies that could cause visual field loss.
6. Good collaboration during visual field evaluation.
7. Prior completion of at least one computerized visual field examination for decreasing learning effect on peripheral results.
8. Less than 20% false negative and/ or less than 20% false positive answers in the catching trials on visual field examination.

In cases where both eyes were operated upon, the eye with longer follow-up period was included in the study. Study was conducted at the Clinic for Eye Diseases, Clinical Center of Serbia, from January 2003 to January 2010. In each case trabeculectomy was performed. All surgeries were performed by the first authors of this paper following the course of maximum tolerated medical treatment because of evidence of either progressive visual field or optic disc damage or high IOP. No major intra - and post - operative complications were encountered. None of the patients had undergone laser trabeculoplasty before the surgery. Minimum follow - up period after surgery was 22 months with at least one baseline preoperative visual field and at least 5 (five) visual fields available in postoperative period.

Visual field examination was performed on computerized perimeter Octopus 500EZ (Interzeag, Schlieren, Switzerland), using normal strategy of the program G1. The first postoperative visual field examination was done not earlier than 3 months after the operation. Data regarding the level of differential light sensitivity of each of 59 central test points from all visual fields were obtained after surgery. Test points on the periphery of visual field where not included in regression analysis. By eliminating these test points, which frequently show depressed sensitivity due to artefacts caused by correction lens or depressed eyelid, number of false positive visual field defects was decreased. Sensitivity of each visual field test point, expressed in dB units, was first entered into database and later analyzed using the statistical software program SPSS/PC. Sensitivity of each test points and mean sensitivity of the whole central visual field (MS) was compared with time (in months) elapsed since the beginning of the
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FIGURE 1.
FREQUENCY DISTRIBUTION OF MEAN POSTOPERATIVE INTRAOCULAR PRESSURE (IOP) IN THE GROUP WITH PROGRESSED VISUAL FIELD AND IN THE GROUP WITH STABLE VISUAL FIELD.

FIGURE 2.
FREQUENCY DISTRIBUTION OF PEAK POSTOPERATIVE INTRAOCULAR PRESSURE (IOP) IN THE GROUP WITH PROGRESSED VISUAL FIELD AND IN THE GROUP WITH STABLE VISUAL FIELD.

follow-up period by using the method of linear regression.

The slope of the regression line is a measure of the direction and rate of change of visual field over time, and can have positive or negative value. Positive slope indicates increase in sensitivity over time or improvement of visual field. Negative slope indicates decreased sensitivity over time or deterioration of visual field. We used the Spearman rank correlation coefficient and the Spearman probability p value to determine whether the slope, either positive or negative, is different from zero, regarding the fact that the differential sensitivity data do not follow normal (Gaussian) distribution of frequencies. The slope of the regression line is considered significant if the Spearman p value of the correlation coefficient of sensitivity values over time is less than 0.05. Based on the statistical significance of the slope of the regression line 36 patients were divided into two groups. The first group with significantly negative slope of the regression line was characterized as a group with progressed visual field loss and consisted of 9 patients (25%). The second group with non-significant slope of the regression line was characterized as a group with the stable visual field and consisted of 27 patients (75%). Groups where compared by demographic and ocular characteristics, including the values of IOP and quantitative characteristics of optic disc.

Intracocular pressure measurement was performed on Goldmann type appplanation tonometer during each patient visit. Average values were calculated from all IOP measurements done preoperatively while the patient was under maximum medical therapy, and postoperatively. The peak IOP values were noted under the same conditions. In cases where successful IOP control was not obtained after a single operation patients received additional medical therapy. In none of cases was trabeculectomy repeated or any other additional anti-glaucoma surgery performed. Antifibrotic agents were not applied during the operation nor postoperatively.

For statistical analysis non-parametric Mann Whitney U test was used to test for a significant difference in the frequency distribution of variables in the group with progressed visual field loss and the group with stable visual fields. Discrete variables were compared with chi-square test (X², Fisher exact test). Probability (p) value of less than 0.05 was considered significant. The statistical tests were performed using SPSS PC statistical software program.

RESULTS

The current study group included group of 9 patients (9 eyes) with progressed visual field loss and a group of 27 patients (27 eyes) with stable visual field following the operation. Table 1, presents the characteristics of each group of patients. There were no statistically significant differences among these two groups in relation to sex, age, family history of glaucoma and the length of preoperative medical treatment. The mean postoperative follow-up periods for two groups were similar: 51.8±10.93 months (approximately 4 years) for group with progressed visual field loss as compared to 47.4±14.35 months (approximately 4 years) for group with stable visual field. Difference in visual acuity before the operation as well as after the operation (at the last follow-up visit) between the study groups was insignificant. Both groups showed decrease in visual acuity after the operation for approximately 1 line on Snellen chart. Refractive error before the operation did not show any significant difference among the groups. Preoperative mean visual field sensitivity (MS) was almost the same in both groups and an average preoperative IOP value of about 30 mmHg was present in both groups. An average number of visual field examinations performed postoperatively did not differ between groups. The slope of the regression line of mean sensitivity was -0.12±0.10 dB/months in the group with progressed visual field loss as compared to 0.00±0.12 dB/months in the group with stable visual field (Table 1).
Graph analysis of the distribution of mean IOP (Figure 1) and distribution of peak IOP after surgery (Figure 2) disclose significant data. Eyes with mean IOP of 20 mmHg or higher, during the postoperative follow-up period, had progressive visual field changes (Figure 1). Conversely, eyes with mean IOP of 19 mmHg or less remained stable. Only 14.8% of eyes with average IOP above 19 mmHg had stable visual fields after the operation (Figure 1). Additionally, patients who had a peak IOP of 20 mmHg or higher did show progression of visual field loss and 88% of patients with progressed visual field loss had peak IOP of 24 mmHg or higher (Figure 2). The mean values of IOP and percentage of reduction in IOP at the end of each of the first five years postoperatively were compared between the group with progressed visual field loss and the group with stable visual field. The mean postoperative IOP value did not exceed the upper limit of "normal" IOP of 22 mmHg in either group, however IOP values were consistently higher in the group of patients with progressed visual field loss (Figure 3). Statistically significant difference between the groups regarding mean IOP values was noted during the second and the third year postoperatively. At the end of the two year postoperative period, for example, mean IOP was significantly lower in patients with stable visual field (17.48±4.80 mmHg) than in those who showed progression of visual field loss (21.98±3.38 mmHg) (Figure 3). The mean IOP for the whole 5 year period in the group with stable visual field was 17.77±3.47 mmHg, whereas in the group with progressed visual field loss was 21.88±1.19 mmHg. The mean of the percentage reduction in IOP following the operation in comparison to initial preoperative value was calculated using the formula: (postoperative IOP minus initial preoperative IOP x 100 divided by initial preoperative IOP). The mean of the percentage reduction in IOP following the operation was lower in eyes with progressed visual field loss than in eyes with stable visual fields, particularly during the second and third year after surgery (p < 0.05) (Figure 4). The mean of the percentage reduction in IOP at end of the two year postoperative period was 41.00% in patients with stable visual fields whereas in patients with field loss was 21.84%. The average magnitude of IOP reduction in the whole 5 year period following the operation in group with stable visual fields was much greater (35.02%) than in the group with progressed visual field loss (23.3%).

**DISCUSSION**

The effect of trabeculectomy on the level of IOP in the first five years after surgery was satisfactory in general, if we define success as IOP less than 22 mmHg, considering our findings of mean IOP below this value in most of our patients. However, even though the IOP was in the majority of patients "normalized", significant decrease in visual field sensitivity was noted in 9 eyes (25% of cases). Such frequency of progressive loss of visual field in the first five years following operation lies in the middle of frequencies range presented in literature which spans from the earliest studies on trabeculectomy to AGIS. The conclusion of Advanced Glaucoma Intervention Study was that low intraocular pressure is associated with reduced progression of visual field defect, supporting evidence from earlier studies of a protective role for low intraocular pressure in visual field deterioration. As for other glaucoma types, the results are not so consistent. According to the results of Shigeeda T and co-workers trabeculectomy in patients with progressive normotensive glaucoma was statistically associated with slowing further progression of visual field damage. The progression, however, did not completely stop over the 6-year postoperative follow-up period. Bertran and colleagues also studied the rates of visual field progression before and after trabeculectomy in
a similar sample size study as ours, and concluded that trabeculectomy Trabeculectomy significantly decreased the rates of visual field deterioration.

The results of our study are in agreement with the results of Kotecha and Mahdavi, indicating that approximately one third of eyes continued to display glaucomatous progression after trabeculectomy. In our study out of 36 tested subjects, 9 patients have shown progressed visual field deterioration after trabeculectomy was performed.

The question arises whether some clinical elements could have prognostic value regarding the course of disease following surgery, in other words, which parameters could separate the eyes with tendency for deterioration of visual field, from those with stabilized visual field after operation? Retrospective analysis of our results has led us to the conclusion that the higher values of IOP after operation in addition to lower degree of IOP reduction in regard to preoperative values, discloses the cases with unfavorable prognosis. Several other authors also share our opinion that lowering of IOP has favorable effect on the course of glaucoma.

According to our results, the data that predicts better prognosis is the mean postoperative IOP value of approximately 18 mmHg resulting from 35% of IOP reduction relative to preoperative level. Better prognosis does not always imply stopping, but merely slowing of visual field deterioration. This data refutes the opinion, still present in common practice, about a "cured" glaucoma when the IOP values remain in "normal range". Even in cases were target IOP was reached perimetry may disclose occurrence of de novo visual field defects and indicate inadequate IOP level. Possibility of additional medical anti-glaucoma treatment should then be considered.

Higher degree of glaucomatous damage carries the greater risk for progressive loss. The patients with advanced stage of glaucoma are in greater danger from further progression of the disease than the patients with initial stage of glaucoma. Reports have been made on progressive damage in cases of advanced glaucoma even after significant operative reduction of IOP was accomplished.

CONCLUSION

The results of our study show that the prognosis for further field loss after trabeculectomy seems to be better if postoperative pressure is at lower levels and greater percent reduction of IOP is obtained after surgery. The data that predict better prognosis is the mean postoperative IOP value of approximately 18 mmHg or less resulting from at least 35% of IOP reduction.

SUMMARY

EFEKAT INTRAOKULARNOG PRITISKA NA VIDNO POLJE NAKON TRABEKULEKTOMIJE KOD PACIJENATA SA PRIMARNIM GLAUKOMOM OTVORENOG UGLA

Cilj rada: Utvrditi da li se razlikuje visina intraokularnog pritiska između pacijenata koji su pet godina nakon trabekulektomije imali stabilno vidno polje i pacijenata koji su u istom vremenskom periodu ispoljili progressiju ispada.

Materijal i metodi rada: Kod 36 pacijenata pet godina posle trabekulektomije meren je nivo promene analizom linearnih regresije prošetnih senzitivnosti vidnog polja (dB) u mesećima. Na osnovu statističke značajnosti nagiba linije regresije (Spearman r koeficijent korelacije < 0.05), pacijenti su podešeni u grupu sa progressijom i grupu sa stabilnim vidnim poljem.

Rezultati: Pacijenti sa progressijom imali su više prosečan, viši maksimalni intraokularni pritisak i manji stepen redukcije pritiska.

Zaključak: Prognoza daljeg napredovanja promena u vidnom polju bolja je ukoliko se postigne proseći postoperativni pritisak 18 mmHg ili niz i redukcija pritiska od najmanje 35% u odnosu na preoperativnu vrednost.

Ključne reči: glaukom, trabekulektomija, vidno polje

REFERENCES

