Prognostic Factors in Open Eye Injury Managed with Vitrectomy: Retrospective Study

Mojca Globočnik Petrović, Xhevat Lumi, Brigita Dmovšek Olup
Eye Clinic, University Medical Centre Ljubljana, Ljubljana, Slovenia

Aim. To evaluate surgery results and establish prognostic factors that predicted final functional (good or poor vision) and anatomic (final retinal detachment) outcome in open eye injury involving the posterior segment managed with pars plana vitrectomy.

Methods. Medical records of 52 consecutive patients with open eye injury involving the posterior segment were retrospectively reviewed. Specific variables of a system for classifying mechanical injuries of the eye were analyzed: the type of injury (defined by the mechanism of injury), grade of injury (defined by initial visual acuity), zone of injury (defined by the location of the wound), and relative afferent pupillary defect. Additional variables, such as wound length, retinal detachment, endophthalmitis, and timing of vitrectomy, were also included in the analysis. Final visual outcome and retinal attachment rate were recorded. Data were analyzed with chi-square test, univariate analysis for predictors, and multivariate logistic regression analysis.

Results. After a mean follow up of 20.0±10.5 months, 50% of eyes achieved visual acuity 0.5 or better, 27% of eyes achieved visual acuity 0.1 or worse, and 10% of eyes had final retinal detachment. According to univariate analysis results, the following parameters were predictors of good vision (visual acuity ≥ 0.5 in comparison with visual acuity < 0.5): grade of injury (p = 0.008), zone of injury (p = 0.01), afferent pupillary response (p < 0.001), wound length (p = 0.002), and initial retinal detachment (p = 0.009). The predictors of poor vision (visual acuity ≤ 0.1 in comparison with visual acuity > 0.1) were zone of injury (p < 0.001), relative afferent pupillary defect (p < 0.001), wound length (p = 0.002), and initial retinal detachment (p < 0.001). Relative afferent pupillary defect (p = 0.003) and initial retinal detachment (p < 0.001) were predictors of final retinal detachment with proliferative vitreoretinopathy. However, multivariate logistic regression analyses revealed that relative afferent pupillary defect was the only significant factor for poor visual acuity (odds ratio, 10.3; 95% confidence interval, 1.1-92; p = 0.04). On the other hand, none of the variables was a significant independent predictor for either good visual acuity or final retinal detachment.

Conclusion. Half of the eyes with a good final visual outcome in our study were successfully managed with pars plana vitrectomy for open eye injury after trauma. The classification system may become a useful prognostic tool for visual outcome in posterior segment ocular injuries managed with vitrectomy. Relative afferent pupillary defect as a functional test is a good predictor for visual outcome.

Key words: eye injuries; prognosis; retinal detachment; treatment outcome; visual acuity; vitrectomy

Ocular trauma is a leading cause of visual impairment in children and young adults (1). Severe ocular trauma involves the posterior segment of the eye. Management of open globe injury involving the posterior segment has benefited from the advances in understanding of the pathophysiology of ocular trauma and proliferative vitreoretinopathy, clinical studies identifying prognostic factors related to the outcome after ocular trauma, and development of new surgical approaches. After the development of vitrectomy, previously unsalvageable traumatized eyes could be repaired with better anatomic and functional success (2-5). Vitrectomy allows the reconstruction of the posterior segment, clears vitreous opacity (6), controls the healing response (7,8), and prevents phthisis (8).

Vitrectomy should be performed within 14 days after ocular trauma (9). With early vitrectomy performed in the first four days, retinal tears and detachment can be treated and fibrocellular proliferation can be prevented. The disadvantages are higher risk of bleeding, wound leakage, and increased difficulty to detach the posterior hyaloid and control suprachoroidal hemorrhage and bad visualization. There are two strong indications for delayed vitrectomy performed within 5-14 days after trauma: choroidal hemorrhage (10,11) and large posterior wound in perforating open globe injury (12). For severe trauma with extensive damage to the eye, early vitrectomy can alter the prognosis. Early vitrectomy can lower the probability of proliferative vitreoretinopathy and retinal detachment, which are frequent in severe trauma (4,13).
Birmingham Eye Trauma Terminology encourages the use of standardized eye injury terminology, which permits an unambiguous interpretation of findings (14). Rupture is a full-thickness wound of the eye wall, caused by a blunt object. Penetrating injury implies a full-thickness entrance wound, and an entrance and exit wound of the eye defines perforating injury. A sharp object can cause both of them. Intraocular foreign body injury has retained foreign object in the eye.

A system for classifying mechanical injuries of the eye is based on anatomic and physiologic variables that have prognostic value for visual outcome in ocular injuries (15-17). The classification includes the minimum number of prognostic features that are descriptive of the injury at initial examination, type of injury defined by the mechanism of injury, grade of injury defined by visual acuity, zone of injury defined by the location of the wound, and relative afferent pupillary defect.

The purpose of this study was to determine the prognostic significance of classification system variables in terms of the outcome of pars plana vitrectomy in eyes with open globe injury involving the posterior segment. We also analyzed whether the non-classification system variables (posttraumatic endophthalmitis, retinal detachment, wound length, and timing of pars plana vitrectomy) could affect the prognosis, which is defined by the final functional (good vs poor vision) and anatomic outcome (final retinal detachment with proliferative vitreoretinopathy).

Patients and Methods

Patients

We retrospectively reviewed the medical records of the 64 patients (65 eyes) with open globe injury managed with pars plana vitrectomy at the Eye Clinic University Medical Center in Ljubljana between May 2000 and May 2003. The clinical features included age, sex, type of injury defined by the mechanism of injury, grade of injury (grade, 1-5) defined by visual acuity, zone of injury (I-III) defined by the location of the wound, presence of relative afferent pupillary defect, wound length (<10 vs >10 mm), presence of retinal detachment, presence of endophthalmitis, and timing of vitrectomy (performed 1-4 days, 5-14 days, or over 14 days after trauma). Final visual outcome and retinal attachment rate were considered. Exclusion criteria were the missing characteristics, inadequate follow up (less than 6 months), and poor visual acuity before trauma. Thirteen eyes were excluded from study: in 10 eyes the data for a relative afferent pupillary defect was missing, in one the follow up was shorter than 6 months, and in two cases the visual acuity before trauma was poor.

The final study sample included 52 eyes of 51 patients. Only one patient was female. The median age of patients was 29.5 years (range, 5-67 years). The follow-up ranged from 6 months to 3.5 years (mean±SD, 20.0±10.5 months).

Evaluation of Injuries

Birmingham Eye Trauma Terminology was used for the classification of eye injury (14). Type, grade, zone of injury, and a relative afferent pupillary defect were defined as prognostic factors by using a system for the classifying mechanical injuries of the eye (Table 1). Other prognostic factors, such as retinal detachment, endophthalmitis, wound length, and timing of pars plana vitrectomy were also evaluated.

Main Outcome Measures

Final clinical outcomes were defined as good visual acuity (0.5 or better), poor visual acuity (0.1 or less), and retinal detachment with proliferative vitreoretinopathy after at least 6 months of follow up.

Statistical Analysis

Data were analyzed first to assess bivariate relationships between potential predictors and visual acuity outcomes. Chi-square test was used for categorical data analysis. For each clinical factor, a p-value was determined. Multiple logistic analysis was performed to determine the combinations of clinical factors related to ocular trauma that predict the final outcome of visual acuity and retinal detachment. The multivariate model included factors found by univariate analyzes to be significant predictors of final visual outcome and final retinal detachment (p<0.01, univariate analysis). Statistical analysis was performed by using the SPSS package for Windows, Version 11 (SPSS Inc., Chicago, IL, USA).

Results

Good visual outcome (visual acuity 0.5 or better) was achieved in half of the patients, and poor visual outcome (visual acuity 0.1 or less) in 27 % of the patients. Predictive factors of good and poor visual acuity and retinal detachment with proliferative vitreoretinopathy were grouped into functional and anatomic outcome categories, respectively (Table 2). Univariate analysis showed that the grade of injury (p=0.008), zone of injury (p=0.001), afferent pupillary response (p<0.001), wound length (p=0.002), and initial retinal detachment (p=0.009) were the predictors of good vision (visual acuity ≥0.5 compared with visual acuity <0.5). The predictors of poor vision (visual acuity ≤0.1 compared with visual acuity >0.1), according to the univariate analysis, were the zone of injury (p<0.001), relative afferent pupillary defect (p<0.001), wound length (p<0.002), and initial retinal detachment (p<0.001). Univariate analysis also revealed relative afferent pupillary defect (p=0.003) and initial retinal detachment (p=0.001) as the predictors of final retinal detachment with proliferative vitreoretinopathy.

Type of injury, early pars plana vitrectomy, and endophthalmitis were not demonstrated to be predictors of visual outcome (Table 2). The probability of

<table>
<thead>
<tr>
<th>Type</th>
<th>No. of patients (n=52)</th>
</tr>
</thead>
<tbody>
<tr>
<td>rupture</td>
<td>11</td>
</tr>
<tr>
<td>penetrating</td>
<td>23</td>
</tr>
<tr>
<td>intraocular foreign body</td>
<td>7</td>
</tr>
<tr>
<td>perforating</td>
<td>3</td>
</tr>
<tr>
<td>mixed</td>
<td>0</td>
</tr>
<tr>
<td>Grade (visual acuity):</td>
<td></td>
</tr>
<tr>
<td>1 (&gt;0.50)</td>
<td>11</td>
</tr>
<tr>
<td>2 (0.40-0.20)</td>
<td>7</td>
</tr>
<tr>
<td>3 (0.19-0.025)</td>
<td>4</td>
</tr>
<tr>
<td>4 (0.02-light perception)</td>
<td>30</td>
</tr>
<tr>
<td>5 (no light perception)</td>
<td>30</td>
</tr>
<tr>
<td>Zone:</td>
<td></td>
</tr>
<tr>
<td>I (isolated to cornea)</td>
<td>22</td>
</tr>
<tr>
<td>II (limbus to a point 5 mm posterior into the sclera)</td>
<td>23</td>
</tr>
<tr>
<td>III (posterior to the anterior 5 mm of sclera)</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pupil (relative afferent pupillary defect in the affected eye):</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>positive (present)</td>
<td>16</td>
</tr>
<tr>
<td>negative (absent)</td>
<td>36</td>
</tr>
</tbody>
</table>
A good visual outcome was the highest in eyes with intraocular foreign body injury, whereas perforating ocular injury had the worse prognosis; 3 eyes (75%) with perforating ocular injury had poor visual outcome (Fig. 1). Early pars plana vitrectomy (within 4 days), which was performed in more than half of the eyes, was not a statistically significant predictor of good visual acuity. Endophthalmitis was present in 4 eyes: 3 had intraocular foreign body and one eye suffered penetrating trauma. Two eyes with endophthalmitis had good visual outcome.

For final retinal detachment, relative afferent pupillary defect and (initial) retinal detachment were included in the logistic regression model. Neither variable was demonstrated to be a significant predictor of final retinal detachment with proliferative vitreoretinopathy.

![Figure 1](image_url)
Discussion

Using the system for classifying mechanical injuries of the eye (15), we found that the relative afferent pupillary defect was the only independent predictor of poor visual outcome in posterior segment trauma managed with pars plana vitrectomy. It is well known that the type of injury affects visual prognosis (1,4,5,12,16-19). Visual acuity 0.5 or better after intraocular foreign body injury was achieved in 66% of patients in our study, which is comparable to results from other studies (20-22). Visual acuity 0.5 or better after penetrating trauma was achieved in 40% of our patients, which is lower percentage than that reported by other authors (23,24). However, visual acuity 0.5 or better after a rupture in our study was 33%, which is more than double percentage reported by Pieramici et al (5). Final visual acuity better than 0.2 after perforating injury achieved in 25% of our patients was lower than that reported in another study (12). Type of injury was not a predictor of visual outcome in our study. We believe that by increasing the number of cases in our study, the type of injury might become a predictor of outcome.

Grade of injury (initial visual acuity) is usually a strong predictor in open eye injury (1,16-19,25-28). Patients with grade 1 (initial visual acuity, 0.5 and better) had good visual outcome; 91% of these patients achieved ultimate good visual acuity. Thirty (58%) of our patients had grade 4 (initial visual acuity, 0.02 – light perception), 33% of those patients had good visual outcome, and 40% had poor visual outcome. Good initial visual acuity undoubtedly has a good prognosis, but poor initial visual acuity did not correlate with poor visual outcome, which means that with vitrectomy the prognosis in a group of patients with lower initial visual acuity could be improved.

It is well known in the open eye injury that the more posterior the wound, the worse the prognosis (4,5,16-19,26,29). Wound location in the zones I and II in an open eye injury do not extend into the retina, and the visual prognosis can be better. All the patients with good visual outcome in our study had wound location in the zones I and II. Six of the seven eyes in our study with wound location in the zone III had poor visual outcome.

Relative afferent pupillary defect is a strong predictor of poor visual outcome in the eye trauma (4,5,16-18,25), and remains as such after vitrectomy of traumatized eyes (30). All 16 patients with relative afferent pupillary defect and only 3 of the 36 patients with normal pupillary response had poor visual outcome in our study. The identification of relative afferent pupillary defect is based on a functional test. To assess this functional test, a patient should be binocular or at least one pupil must have an intact efferent pathway. The presence of relative afferent pupillary defect indicates a significant injury of the retina or optic nerve and is a valuable predictor.

Retinal detachment occurring immediately after the eye trauma is a rare and serious complication of eye injury and has a poor prognosis for successful outcome (25,29). More commonly, an open eye injury initiates and propagates retinal detachment because of proliferative vitreoretinopathy later on (7,8,31). None of our patients with the initial retinal detachment had good final visual acuity. All our patients with initial retinal detachment had relative afferent pupillary defect, which could be a predictor for retinal detachment and poor visual outcome.

We did not find endophthalmitis to be a predictor for the outcome. Better visual acuity outcome in patients with endophthalmitis is associated with better presenting visual acuity, infection with nonvirulent organism, and absence of retinal detachment (32-34).

We have demonstrated that the wound length is an important predictor of final visual acuity, which is in agreement with previous studies (1,4,26).

Proper timing of vitrectomy is very important in functional and anatomic prognosis. After severe trauma, the probability of retinal detachment with proliferative vitreoretinopathy is extremely high (13,35), but may be diminished with early vitrectomy. In our study, 82% of eyes treated with early vitrectomy had a good visual outcome. Although early vitrectomy did not appear to be a statistically significant prognostic variable for good visual outcome, we observed the trend towards it.

Univariate analysis showed a relative afferent pupillary defect and initial retinal detachment to be predictors of final retinal detachment; multivariate analysis, however, failed to confirm these findings. The discrepancy between the results provided by univariate and multivariate analyses might be due to a small number of cases with final retinal detachment. In general, the limitations of our study were a small study sample and an unequal distribution of cases according to the type of injury.

In conclusion, the goal of vitrectomy after open globe trauma is not just an anatomic reconstruction, but also restoration of useful vision to the patient. Our results are in concordance with the findings of previous studies, but this is the first study that tested the prognostic significance of the classification system variables in the eyes with open globe injury involving the posterior segment managed with pars plana vitrectomy. The classification system variables, especially the relative afferent pupillary defect, are important predictors of visual outcome. We believe that some additional variables like wound length and timing of pars plana vitrectomy, especially in severe trauma, may also affect the prognosis.

References


Received: December 16, 2003
Accepted: March 29, 2004

Correspondence to:
Mojca Globočnik Petrovič
Eye Clinic
Ljubljana University Medical Center
Zaloška 29a
1000 Ljubljana, Slovenia
mojca.globočnik@kclj.si