Surgical Outcomes after Vitrectomy in Severely Traumatized Eyes with No Light Perception and Flat ERG

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Abstract

***Purpose*:** To report visual outcomes of pars plana vitrectomy in severely traumatized eyes with no light perception (NLP) and flat electroretinography (ERG)

***Methods*:** We performed a prospective interventional study on 22 severely traumatized eyes with NLP, 4+ relative afferent pupillary defect (RAPD) and flat ERG.

***Results*:** One year after pars plana virectomy, 15 patients (68.18%) had NLP, six patients (27.27%) had light perception and one patient (4.54%) could count fingers at 70 cm. There was a significant improvement in final visual acuity (VA) (p=0.02). There was no significant association between mechanism of trauma, type or site of laceration, age, sex, ocular comorbidities, type of the surgery or mean number of vitrectomies and final VA.

***Conclusion*:** If the anatomical status of the eye permits (such as lack of optic nerve avulsion), and also in the presence of specific situations (as in one eyed patients), vitreoretinal surgery could be thought for the preserving at least some vision and also to conserve the appearance of the globe and to help the psychological state of the patient.

***Keywords*:** Vitrectomy, Electroretinography, Relative Afferent Pupillary Defect, Trauma, No light Perception, Flat ERG, Vitrectomy

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Introduction

Ocular trauma is an important leading cause of visual loss in the world. On the other hand the most common target is young people,[1,2] thus because of long time survival and great social role of this population, treatment and also rehabilitation seem to be compulsory.

According to Birmingham Eye Trauma Terminology (BETT) and the Ocular Trauma Classification Group,[2] ocular trauma is subdivided into open and closed globe injuries. Because of complex situations of the open globe injury, management of this condition seems to be very important, one of these complications is decision making about enucleation of a severely traumatized eye. There were different strategies about management of an eye with no light perception (NLP), and our concern has been the risk of sympathetic ophthalmia (SO) and on the other hand the trend toward salvage of these young eyes. One of the tests that could have a role in defining prognosis is electrophysiological testing.[3-5] In this article, we discuss the roles of bright flash electroretinograms (ERGs), in fact we performed vitreoretinal surgery in the cases of flat ERG and also 4+RAPD and to find out the visual outcomes.

Methods

We performed a prospective interventional study on severely traumatized eyes. All patients who had a history of penetrating trauma to the eye, underwent primary repair of their laceration and after primary repair of globe injury they underwent thorough ophthalmic examination. Traumatic and postoperative endophthalmitis cases were excluded from the study. Cases that seem to be inoperable during the operation were excluded. Twenty-two eyes from twenty-two patients enrolled in our study after exclusion of two cases with optic nerve avulsion (see below). Patients who had NLP after primary repair underwent bright flash ERG. NLP was defined as inability to perceive light in all four quadrants using an indirect ophthalmoscope, light turned on to full intensity and then focused through a 20 D lens in all quadrants. This was confirmed by two expert ophthalmologists (S.A.T. and M.M.). Patients that had NLP visual acuity (VA) and flat ERG enrolled in our study. All patients had NLP after primary repair and flat bright flash ERG. Demographic data including gender, age and type of trauma were recorded. Informed consent both for the study and vitrectomy and also for the enucleation (if the retinal or optic nerve status seemed inoperable) was obtained from the participants. All of them or their parents (for those under 18) were thoroughly informed about the prognosis and cost of the surgery. The research adhered to the tenets of the declaration of Helsinki and was approved by the institutional review board and Ethics Committee of the Tehran University of Medical Sciences. All patients underwent standard 3-ports pars plana vitrectomy by one surgeon. In the case of hazy media related to cataract, the patient underwent cataract surgery in association with pars plana vitrectomy (15 eyes). Six patients who did not have clear cornea for visualization of posterior segment during pars plana vitrectomy underwent penetrating keratoplasty combined with virectomy using a temporary keratoprosthesis. Reexamination of patients was done in one day, one week, one month, three months, six months and one year after surgery.

Bright flash electroretinography was performed for all patients according to the International Society of Clinical Electrophysiology and Vision (ISCEV) standards.[6] Patients were dark-adapted for at least one hour before the recording, and for each patient the pupil was dilated using a mixture of phenylephrine hydrochloride 2.5% and tropicamide 1% and the cornea was anesthetized using topical tetracaine 0.5%. Dark-adapted bright flash ERGs were recorded by the placement of a bipolar contact lens electrode on the cornea, using methylcellulose solution. A ground electrode also was attached. The outputs were recorded using a preamplifier connected to a personal computer with potential of saving electroretingrams. White light flashes of 10 ms duration delivered at a rate of once per two min, to reach a dark-adapted state between impulses.

To describe data we used frequency (percent), mean±SD, median, range and 95% confidence interval (95% CI). All statistical analysis was performed using SPSS software (Version 21.0, IBM Co., Chicago, IL, USA).

Results

Twenty-two eyes from twenty-two patients enrolled in our study after exclusion of two cases of optic nerve avulsion (see below). Traumatic and postoperative endophthalmitis cases were excluded from the study. Twenty-one patients (95.45%) were male and only one patient (4.55%) was female with a mean age of 26±5.3 (with a range of 7-46 years) (Table 1).

Eleven patients (50%) had full thickness corneal laceration and twenty patients (90.91%) had full thickness scleral laceration. (Nine of them had combined full thickness corneoscleral laceration). Three patients (13.63%) had intraocular foreign body. Two patients had optic nerve avulsion detected during vitrectomy.

After primary repair of laceration, 3-ports pars plana vitrectomy was performed in sixteen patients (72.73%) and six patients (27.27%) underwent penetrating keratoplasty combined with pars plana virectomy using a temporary keratoprosthesis in full-thickness keratoplasty failed in three of the six cases after one year of follow-up) (Table 2). Vitrectomy was performed after a period of 3-12 days for all patients with a mean of 8±3.3 days. All patients presented vitreous hemorrhage after primary repair. Fourteen patients (63.63%) had retinal detachment while four of them were associated with proliferative vitreoretinopathy (18.18%). Four cases had two consequtive vitrectomies and three cases had vitrectomy three times, the most common cause of repeated vitreoretinal surgery was proliferative vitreoretinopathy in six cases of 10 eyes (The others consisted of persistent vitreous hemorrhage and re-detachment of the retina).

One year after pars plana virectomy, fifteen patients (68.18%) had NLP, six patients (27.27%) had light perception with light projection in at least one quadrant (four patients had light projection perception in all quadrants) and one patient (4.54%) could count fingers at 70 cm.

In seventeen (77.27%) patients, globes were preserved but four patients (18.18%) became pre-phthisic (NLP with raised IOP) and one patient (4.54%) became phthisic (NLP with low IOP) (Table 3).

SO symptoms and signs were not observed in any eye. Comparison was done between the preoperative VA and the postoperative VA. We considered the best corrected visual acuity (BCVA) (according to the patient's discrimination in a distance of at least two feet) converted into log of the minimum angle of resolution (logMAR) units to provide a numeric scale of VA for purposes of SPSS analysis as shown in the table 4.[6,7] There was a statistically significant improvement in final VA (p=0.02). The other eye of one of the patients who obtained light perception after surgery was visually lost and phthisis from childhood. The patients who obtained light perception and the one whose vision reached counting finger had clinically significant improvement. Twenty-one other cases in our series had at least $^{20}/_{40}$ VA in their untraumatised eye. Despite performing such surgical procedures, all patients except one declared psychological satisfaction in the questionnaire distributed by a person who was not involved in the process of the diagnosis and treatment in the study.

There was no significant association between mechanism of trauma (blunt vs penetrating), type or site of laceration, age, sex, ocular comorbidities (hyphema, cataract, retinal detachment, IOFB), type of the surgery or mean number of vitrectomies and final VA.

Table 1. Preoperative data of the patients

Data	Number (percent)
Male/Female	21/1 (95.45%/4.55%)
OD/OS	12/10 (54.55%/45.45%)
Age group	
1-10 years old	4 (18.18%)
11-20 years old	6 (27.27%)
21-30 years old	7 (31.82%)
31-40 years old	3 (13.64%)
41-50 years old	2 (9.09%)
Type of trauma	
Full thickness corneal laceration	11 (50%)
Full thickness scleral laceration	20 (90.91%)
Optic nerve avulsion	2 (9.09%)
Intraocualr foreign body	3 (13.63%)

Table 2. Type of surgery

Surgery	Number (percent)
Pars plana vitrectomy	16 (72.73%)
Penetrating keratoplasty combined with pars plana virectomy using a temporary keratoprosthesis	6 (27.27%)
Total	22 (100%)

Table 3. One year follow-up results

Data	Number (percent)
Viual acuity	
No light perception	15 (68.18%)
Light perception	6 (27.27%)
counting fingers at 70 cm	1 (4.54%)
Globe preservation	
Preserved globe	17 (77.27%)
Pre-phthisic	4 (18.18%)
Phthisic	1 (4.54%)

Table 4. Visual acuity conversion chart

logMAR units	Visual acuity	logMAR units	Visual acuity
−0.60	20/80	−4.70	No light perception
−0.48	20/60	−3.70	Light perception
−0.40	20/50	−2.70	Hand motion
−0.30	20/40	−1.40	Finger counting
−0.18	20/30	−1.60	20/800
−0.10	20/25	−1.30	20/400
0.00	20/20	−1.00	20/200
+0.12	20/15	−0.70	20/100

logMAR: Logarithm of the minimum angle of resolution

Discussion

The risk of SO, which may lead to bilateral blindness may be an indication for enucleation of an injured eye. The incidence of SO after open globe injury is in the range of 0.14-0.5%. This complication is rare in the first two weeks after trauma.[1,2,8-11] Severely devastating globe injuries such as those associated with evacuation of ocular contents may actually preclude anatomical repair, making enucleation inevitable.[8,9,12] In other cases, the eye may also be enucleated because the eye is visually lost despite all attempts and in the presence of the risk for SO. However there are some studies indicating surgical treatment of these traumatized eyes to prevent enucleation in these situations and the reason may be related to reversible causes such as media opacity (vitreous hemorrhage, hyphema, cataract), commotio retinae, retinal detachments and even psychological factors precluding correct visual assessment.[13]

Some recent reports indicate that more aggressive surgical managements, such as vitrectomy, of severely traumatized eyes may be associated with a greater risk for SO.[10-15] Besides, the cost and time of hospitalization are other parameters that need special attention. Therefore, it is of great importance to decide which of these cases should undergo surgical treatment. Bright-light flash electroretinography is an important electrophysiological test for prognosis of the post operative state.[5] Bright-light flash electroretinography and visual-evoked potential are useful for evaluation of visual potential, but they are not completely reliable.

It has been shown that both electroretinography and visual evoked potential (VEPs) are reduced in the presence of a dense vitreous hemorrhage that is not an uncommon state in these situations.[16-18] Thus, a non-recordable bright light flash electroretinography may be seen in the presence of severe hazy media and may not necessarily indicate the loss of visual potential and subsequent amputation of the eye.

In the literature, we found no strict report to ensure us for enucleation or even avoiding surgical procedures in these situations. The only decision making solution may be attention to vital structures of the eye during surgery. During surgery, the surgeon can clear hazy media, hyphema, cataract and vitreous hemorrhage and can determine the viability of these traumatized eyes. There are some studies in the literature proposing the role of the vitrectomy on the improvement of visual prognosis; Salehi-Had et al recommended primary closure of open globe injury and close observation in the first week after trauma and prompt referral to a vitreoretinal specialist with experience in treating ocular trauma to identify secondary intervention in eyes that have potential for visual recovery.[19] Heidari et al proposed that an exploratory vitreoretinal surgery may have a role in salvaging these severely traumatized eyes and improving visual and psychological prognosis.[20] However we performed ERG for all of the patients and included eyes with flat bright flash ERG in the study, thus we investigated patients with low potential of VA, explaining why final VA in our study was not as good as previous studies?[21] All of the eyes underwent complete vitreoretinal surgeries instead of exploratory vitreoretinal surgeries. Although there was statistically significant improvement after vitreoretinal surgery, the result was practically important only in two cases, one of them gained VA of counting fingers and the other was a one eyed patient who gained LP which indicates the importance of vitreoretinal surgery in such eyes. Moreover, most of the eyes preserved an acceptable anatomical shape (Table 3). Enucleation may be psychologically devastating, so before performing such amputation,[22,23] we should rule out any hope to salvage the traumatized globe.

Conclusion

In the open globe injuries, the first priority is closure of the eye, and visual loss and 4+RAPD are not indication for enucleation. Moreover, flat bright flash ERG may be misleading, and thus although there is very low risk of SO if the anatomical status of the eye permits (such as lack of optic nerve avulsion), and also in the presence of specific situations (as in one eye patients), vitreoretinal surgery could be considered for preserving at least some vision or at least to preserve the appearance of the globe and to help to improve the psychological state of the patient. Finally, a larger clinical trial is mandatory to prove the benefit of such interventions.

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