

Surgical Treatment of Severely Traumatized Eyes with No Light Perception

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Purpose: To evaluate the anatomical and functional outcomes of surgical intervention in severely traumatized eyes with no light perception (NLP).

Methods: In this prospective interventional case series, 18 eyes of 18 patients with severe ocular trauma whose vision was documented as NLP and with relative afferent pupillary defect (RAPD) of 3-4+ underwent deep vitrectomy and other necessary procedures once to three times.

Results: Vision was NLP in all eyes at the time of surgery which was performed 3-14 days after the initial trauma. During a mean follow up period of 20.5 ± 5.2 (range 11 to 49) months, except for one case of phthisis, other eyes achieved acceptable anatomic and functional outcomes. Postoperative vision was NLP in two eyes (11.1%), light perception in three eyes (16.7%), hand motions in four eyes (22.2%), counting fingers in three eyes (16.7%) and 20/200 or better in six eyes (33.3%).

Conclusion: Following eye trauma, NLP vision and RAPD of 3-4+ alone may not be an indication for enucleation. Performing exploratory surgery within 14 days after the injury may salvage the globe and improve vision; this approach may be more acceptable psychologically for patients and relatives.

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INTRODUCTION

Ocular trauma is an important cause of visual loss worldwide.¹ In the USA, approximately 2.5 million persons, particularly young individuals, sustain eye injuries per year of whom 50,000 develop significant visual loss.² Ocular trauma can be categorized into blunt, penetrating, perforating and associated with intraocular foreign body (IOFB).³ Trauma is classified as penetrating when the object enters a structure and perforating when the object enters from one side and passes through another. For instance, when an object passes through the cornea and enters the anterior chamber, the

trauma is considered perforating for the cornea but penetrating for the globe.⁴ Ocular trauma may lead to various forms of damage to different parts of the eye ranging from superficial abrasions to sight-threatening lesions.

Improvements in our knowledge of the pathophysiology and management of ocular trauma over the past 30 years together with advances in surgical instrumentation and techniques have improved the efficacy of vitreoretinal surgery in injured eyes. Achieving useful vision depends on several prognostic factors such as severity of the initial trauma, involved ocular structures, preoperative visual acuity and timely diagnosis and treatment.

Outcomes of early surgical management in injured eyes with light perception (LP) vision have been reported with different success rates, however no consensus exists on the surgical management of eyes with no light perception (NLP).⁵ In this report we describe the anatomical and functional outcomes of surgical intervention for traumatized eyes with NLP vision.

METHODS

This prospective interventional case series includes 18 eyes of 18 patients with severe trauma, NLP vision and relative afferent pupillary defect (RAPD) of 3-4+ at Nikookari Hospital, Tabriz, Iran from 2002 to 2005. After performing primary repair, NLP was confirmed on several occasions. All patients underwent a comprehensive ophthalmologic examination and were evaluated for the cause of trauma, type of injury, signs of endophthalmitis, presence of IOFB, hyphema, lens status, location and extent of laceration, retinal detachment, vitreous or choroidal hemorrhage, and tissue prolapse. Imaging studies such as ocular ultrasonography, orbital radiography and CT scan were performed as needed. After obtaining informed consent from patients or their guardians for possible enucleation, deep vitrectomy and other required procedures were performed.

Surgical Technique

All patients underwent standard three-port pars plana vitrectomy under general anesthesia. The lens was removed by pars plana lensectomy or extracapsular extraction in 11 eyes and through the limbus in two other eyes with lens dislocation into the vitreous cavity. Intraocular lens (IOL) implantation was not performed in any eye. A prophylactic band was sutured to the sclera in all eyes 9.5 and 10 mm posterior to the limbus in nasal and temporal quadrants, respectively. In eyes with retinal detachment, the following procedures were performed: scleral buckling and membrane

removal (12 eyes), retinotomy and retinectomy at the site of retinal incarceration (8 eyes), perfluorocarbon injection (12 eyes), SF₆ injection (5 eyes), silicone oil injection (13 eyes), iridoplasty (5 eyes), choroidal tap (3 eyes) and secondary repair of the laceration (2 eyes).

In cases with IOFB, after performing vitrectomy, an appropriate device was selected for IOFB removal depending on its magnetic property. Magnetic IOFBs were first separated from the retina and brought into the anterior vitreous using an intraocular magnet or a flute needle. Thereafter, the light probe sclerotomy was widened and the IOFB was grasped and removed using forceps. Large IOFBs were removed through a limbal incision. Non-magnetic IOFBs were separated from the retina by a flute needle and removed from the eye via the sclerotomy.

RESULTS

Overall 18 patients including 12 male (66.7%) and six female (33.3%) subjects with mean age of 28.4 ± 7.1 (range 3-65) years were operated and followed for a mean period of 20.5 ± 5.2 (range, 11 to 49) months. Most patients (72.2%) were less than 30 years of age. Visual acuity of the injured eye was NLP or LP at the time of admission; however all eyes had lost light perception at the time of vitrectomy. All eyes had RAPD of 4+ at the time of surgery. Vitrectomy was performed at a mean interval of 11.0 ± 2.3 (range 3-14) days after primary repair. Table 1 summarizes demographic and clinical characteristics of each patient and the involved eye.

Causes of ocular injury included car accidents (4 eyes), knife injury, work-related activities, explosions and fist trauma (each in two eyes); and needle trauma, blunt assault, gun shot (metallic pellet), wooden materials, and scissors (each in one eye).

Overall lacerations were detected in 17 eyes including corneal (8 eyes), corneal and scleral (7 eyes), limbal and corneal (one eye) and limbal (one eye) lacerations. The globe was intact in one eye of one patient in whom the orbit was fractured.

Table 1 Demographic and clinical characteristics

No	Sex	Age (yr)	Cause of trauma	Type of trauma	Site of injury	Extension of injury	Tissue prolapse	Lens status	Hyp. Hyph.	Vit Hx	RD	Endoph	IOFB	Initial VA	Type of surgery	Endolaser	Type of tamponade	IOFB removal	F/U (mon)	Post-op comp	Final BCVA
1	F	28	Fist	L	Under rectus muscles	8 mm	+	Sublux	+	+	+	-	-	NLP	Deep vitx, lenx, SB-band	+	Gas	-	48	-	20/200
2	M	23	Work related	P	Limbus	5 mm	+	Clear	-	+	-	-	+	NLP	Deep vitx, band	+	silicon	+	21	-	HM
3	F	37	Car accident	L	Sclera, Cornea	11 mm	+	Cat	+	+	-	-	-	NLP	Deep vitx, cat ex, SB-band	+	Silicon	-	49	-	20/300
4	M	8	Metallic pellet	L	Sclera, Under muscles	9 mm	+	Clear	-	+	+	+	+	NLP	Deep vitx, Lenx	+	Silicon	+	15	Phthisis	NLP
5	M	53	Wood	L	Limbus	6 mm	+	Cat	+	+	+	+	-	NLP	Deep vitx, cat ex, band	-	Gas	-	26	-	20/160
6	M	29	Car accident	L	Cornea, Sclera	10 mm	+	Sublux	-	+	-	-	-	NLP	Deep vitx, cat ex, band	+	Gas	-	18	Macular scar	20/400
7	M	11	Knife	P	Cornea, Sclera	13 mm	+	Cat	+	+	+	-	-	NLP	Deep vitx, lenx, band	+	Silicon	-	19	PVR, RD	HM
8	F	3	Scissor	P	Cornea, Sclera	16 mm	+	Cat	-	+	-	-	-	NLP	Deep vitx, lenx	+	Silicon	-	22	-	LP
9	M	25	Fist	L	Sclera, Under muscles	7 mm	+	Clear	+	+	-	-	-	LP	Deep vitx, band	+	Gas	-	19	-	20/160
10	F	25	Blunt assault	Blunt	Orbital fracture	-	+	Sublux	+	+	-	-	-	NLP	Deep vitx, lenx	+	Silicon	-	13	Optic nerve dissection	NLP
11	F	6	Needle trauma	P	Cornea	2 mm	+	Cat	-	+	+	-	-	NLP	Deep vitx, lenx	+	Silicon	-	17	PVR	HM
12	F	21	Knife	P	Cornea, sclera	16 mm	+	Cat	+	+	+	-	-	NLP	Deep vitx, lenx, band	+	Silicon	-	14	-	HM
13	M	23	Work Related	P	Sclera	5 mm	-	Cat	-	+	+	+	+	NLP	Deep vitx, lenx, band	+	Gas	-	25	-	LP
14	M	17	Explosion	P	Sclera	2-5 mm	-	Cat	-	+	-	-	+	NLP	Deep vitx, lenx, band	+	Silicon	+	20	-	20/200
15	M	65	Car accident	L	Cornea, sclera	10 mm	-	Aphasia	+	+	+	-	-	NLP	Deep vitx, band-SB	+	Silicon	-	29	-	20/200
16	M	55	Blunt assault	L	Cornea, sclera	19 mm	+	Aphasia	+	+	+	-	-	NLP	Deep vitx	+	Silicon	-	48	Giant retinal tear	20/100
17	M	39	Car accident	L	Sclera	12 mm	-	Clear	-	+	-	-	-	NLP	Deep vitx, lenx, band-SB	+	Silicon	-	12	-	LP
18	M	22	Explosion	P	Sclera	6 mm	-	Clear	-	+	+	+	+	NLP	Deep vitx, lenx, band	+	Silicon	+	11	-	20/400

Hyph., hyphema; Vit Hx, vitreous hemorrhage; RD, retinal detachment; Endoph, endophthalmitis; IOFB, intraocular foreign body; VA, visual acuity; F/U, follow-up; post-op comp, postoperative complications; BCVA, best-corrected visual acuity; F, female; M, male; L, laceration; P, perforation; Cat, cataract; Sublux, subluxated; NLP, no light perception; Lenx, lensectomy; Vitx, vitrectomy; ex, extract; SB, scleral buckling; PVR, proliferative vitreoretinopathy; HM, hand motion; LP, Light perception

The most prevalent finding following primary repair was severe vitreous hemorrhage in all eyes. Other findings included retinal detachment in 12 eyes (66.7%) which was associated with proliferative vitreoretinopathy in all cases; lens injury in 13 eyes (72.2%) including lens opacity (9 eyes), subluxation (two eyes) and dislocation into the vitreous cavity (two eyes); hyphema in 9 eyes (50%); IOFB in five eyes (27.8%) and endophthalmitis in four eyes (22.2%). Two eyes were rendered aphakic by the trauma, cataracts were extracted but IOL implantation was not performed in any eye.

Secondary measures for visual rehabilitation included secondary IOL implantation in six eyes and contact lens administration in two eyes. Vitrectomy was performed once in nine eyes, twice in seven eyes and three times in two eyes. The reason for repeat vitrectomy was retinal detachment associated with proliferative vitreoretinopathy.

Postoperative complications included macular scars in two eyes (11.1%), band keratopathy, strabismic amblyopia, extensive corneal scar and macular pucker, each in one eye (5.6%). Final visual acuity was NLP in one case due to optic nerve transection associated with an orbital fracture and in another case due to phthisis bulbi but improved to LP in three eyes, HM in four eyes, counting fingers in three eyes and $\geq 20/200$ in six other eyes (table 2).

Table 2 Final visual acuity

	No.	%
No light perception	2	11.1
Light perception	3	16.7
Hand motion	4	22.2
Counting fingers	3	16.7
20/200-20/100	6	33.3
Total	18	100

No significant association was observed between age, sex, type or location of injury, lens status, hyphema, endophthalmitis, IOFB or retinal detachment (RD) and final BCVA; however there was an association between mean number of vitrectomy procedures and final BCVA according to analysis of variances.

Eyes with final BCVA of LP had the largest number of operations (2.33 ± 0.58 times) followed by HM (2.30 ± 0.82 times), counting fingers (1.67 ± 0.58 times) and $\geq 20/200$ (1.14 ± 0.38 times).

DISCUSSION

Severe eye injuries such as large or posterior ruptures of the globe or those associated with evacuation of ocular contents including the retina may preclude anatomical repair rendering enucleation inevitable.^{6,7} In certain cases when the eye is visually lost despite all attempts and in the presence of risk factors for sympathetic ophthalmia, the eye may also be enucleated.⁶ Prior to deciding for enucleation in severely traumatized eyes with loss of light perception, reversible causes of profound visual impairment such as media opacity (e.g. corneal edema, hyphema, cataracts, vitreous hemorrhage), commotio retinae, retinal detachment associated with subretinal hemorrhage and even psychological factors leading to incorrect visual assessment should be excluded.⁵ Even in situations where enucleation seems inevitable, the ophthalmologist should discuss possible options with the patient before making a final decision. Most patients may prefer to retain the repaired eye because of the great psychological impact of enucleation.⁸

Before the advent of modern vitrectomy, all injured eyes with HM, LP or NLP vision had poor outcomes with any type of management and were therefore considered to entail the same visual prognoses.⁹ Improvements in our knowledge of the pathophysiology of eye trauma together with advances in diagnostic and therapeutic techniques have greatly improved the success rates of management for these eyes.¹⁰ Vitreoretinal microsurgery in particular has dramatically improved the prognosis of these eyes and offered a variety of measures to maintain or improve vision in injured eyes, however the general attitude toward surgical repair of traumatized eyes with no light perception has not changed much.¹¹

One should bear in mind that light perception is a subjective measure and not a

reliable test in the presence of severe media opacity even with the bright light of an indirect ophthalmoscope.¹² Although RAPD is a reliable sign of damage to the optic nerve or retina, it may be positive in the presence of severe hyphema or subretinal/vitreous hemorrhage and may disappear following resorption of the hemorrhage.¹³ Bright-light flash electroretinography (B-ERG) is an important measure for making a preoperative decision but this test was not accessible for evaluation of our patients. Although B-ERG and visual evoked potential (VEP) are used for more precise evaluation of visual potential, they are not completely reliable. A non-recordable B-ERG in the presence of dense vitreous hemorrhage does not necessarily indicate that visual potential is lost. It has been shown that both ERG and VEP are reduced in the presence of a dense vitreous hemorrhage.¹⁴ Ultrasonography is useful for diagnosing RD in eyes with media opacity, but it is sometimes difficult to differentiate a detached retina from blood clots in the vitreous cavity or membranes. Furthermore this test is not capable of providing information about the retina itself.^{12,14-16}

Generally speaking, there is no reliable indirect test to determine the necessity for enucleation or avoiding surgical intervention in recently injured eyes with severe media opacity.^{5,12-14} The only practical way may be direct observation of vital structures of the injured eye during surgical exploration. Clearing the hyphema and the vitreous hemorrhage together with cataract extraction during exploration may enable the surgeon to determine whether further surgery is warranted and to evaluate the visual prognosis.¹⁷

An indication for enucleation of an injured eye is the risk of sympathetic ophthalmia which may lead to bilateral blindness.⁶ This ominous complication is rare during the first two weeks after trauma; 65% of cases develop from two weeks to two months following injury.⁷ The actual rate of post-traumatic sympathetic ophthalmia is not clear and reported rates vary from 0.28% to 1.9%.^{5,9} These apparently low rates may indicate that surgical intervention

should not be abandoned; if exploratory surgery reveals total loss of vision, enucleation may be performed at the same session. Reparative surgery in an injured eye with NLP vision does not seem to increase the risk of sympathetic ophthalmia and modern surgical techniques have actually reduced this risk.^{8,17-19} Regarding the above, the patient may be the only one who can decide to undergo reparative surgery and accept the risk of sympathetic ophthalmia. The surgeon's role is to help the patient make the best decision in this regard.

There are limited studies on performing reparative surgery in severely injured eyes with NLP vision. In one study, 11 eyes with NLP vision underwent vitrectomy, of which seven achieved visual acuity of LP to 2/10 and four remained NLP.¹ Another study reported the results of reparative surgery on three injured eyes with NLP vision as follows: one achieved visual acuity of 20/300 after 52 months and the retina was attached in the presence of silicone oil. The second case achieved visual acuity of 20/100 six weeks postoperatively but developed severe proliferative vitreoretinopathy and RD 4 to 8 months thereafter and finally underwent enucleation. The third eye achieved visual acuity of 20/40 seven months after surgery with aphakic correction.⁵ According to the United States Eye Injury Registry, visual outcomes of reparative surgery on 28 injured eyes were as shown in table 3.⁶ Ebrahimi et al²⁰ from Farabi Hospital, Tehran, Iran reported the anatomical and visual outcomes of surgical repair on 12 injured eyes with RAPD 4+; 11 had successful results including visual acuity between HM and 6/10, attached retina and normal intraocular pressure (IOP). The anatomical and functional results in our study were very promising such that at final follow up, visual acuity improved in the majority of the eyes (88.9%); visual acuity $\geq 20/200$ was achieved in 33.3%; the retina was attached and IOP was normal in all cases except one phthisical eye.

In conclusion, the results of the current series indicate that absence of light perception or RAPD 3-4+ may not reflect the need for enu-

cleation and that the globe may be salvaged and even vision preserved by appropriate surgical intervention; therefore, primary enucleation should be avoided. It may be better to perform exploration and reparative surgery within two weeks after trauma. In the presence of favorable conditions of vital structures such as retina, optic nerve and ciliary body, definite reparative surgery may be performed; otherwise the eye should be enucleated to avoid the remote risk of sympathetic ophthalmia. Preservation of the globe may also have positive psychological impacts on the patient and his relatives.

Table 3 Visual outcomes of reparative surgery on 28 injured eyes according to the United States Eye Injury Registry⁶

Postoperative VA	No	%
Light perception	9	32.1
Hand motions	10	35.7
1/200-4/200	2	7.1
5/200-19/200	1	3.6
20/200-20/120	3	10.7
20/100-20/50	2	7.1
>20/40	1	3.6

VA, visual acuity

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