

Visual recovery following open globe injury with initial no light perception

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Background: The purpose of this study was to analyze eyes presenting with no light perception (NLP) after open globe injury (OGI) to determine visual outcomes and prognostic indicators for visual recovery.

Methods: The records of consecutive patients with at least 6 months of follow-up presenting with OGI and NLP to a single institution between January 1, 2003 and December 31, 2013 were reviewed for demographics, ophthalmic history, context and characteristics of injury, ocular examination findings, surgical interventions, and follow-up visual acuity. Unpaired *t*-tests and Fisher's Exact tests were used for statistical analysis.

Results: Twenty-five patients met our inclusion criteria. The mean age was 50.4 ± 25.5 (range 8–91) years. Four patients (16%) regained vision (hand motion in three patients and light perception in one patient) while 21 patients (84%) remained with NLP or had a prosthesis at final follow-up. Fourteen eyes (56%) were enucleated; nine (36%) were secondary enucleations. Although the sample sizes were small, neither ocular trauma score nor wound size was found to predict visual recovery.

Conclusion: Four patients regained some vision after presenting with NLP due to OGI. These findings suggest that, in select cases, physicians should discuss the possibility of regaining some vision.

Keywords: no light perception, open globe injury, visual recovery, vitreoretinal surgery

Introduction

Open globe injuries (OGIs), defined as full-thickness wounds of the eye wall,¹ are estimated to occur at a rate of 3.5 per 100,000 persons per year worldwide.² Similar estimates are found in the USA.^{3–5} Patients who initially present with no light perception (NLP) vision are at risk for poor visual outcomes,^{6–10} and primary enucleation of these eyes is considered to mitigate the risk of sympathetic ophthalmia and to reduce pain.^{10–13}

Arguing against primary enucleation of OGIs with initial NLP, however, are reports demonstrating improved vision following primary closure and possible subsequent vitreoretinal surgery.^{6,14–20} To date, few studies have attempted to identify prognostic indicators for visual outcomes in patients with OGI presenting with NLP. These factors include age,²¹ mechanism and type of injury,^{22–24} presence of a relative afferent pupillary defect (RAPD),^{14,25} size and location of the wound,^{14,16,23} retinal detachment (RD),^{14,15,23} ciliary body or choroidal damage,¹⁵ vitreous hemorrhage (VH),^{23,24,26} and time to intervention.^{6,22}

The recovery of visual perception in traumatized eyes with NLP can have profound functional and psychological implications for patients. Given the controversy concerning the management of eyes presenting with NLP after OGI, we present a study of 25 consecutive patients with initial NLP, four of whom regained vision

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following primary repair and subsequent vitreoretinal surgery. We describe the characteristics of injury, visual and anatomic outcomes, and attempt to identify predictors for visual improvement.

Methods

The study protocol was approved by the human investigations committee of the Yale University School of Medicine. A retrospective review of medical records was performed on patients with OGI and initial NLP vision who presented to Yale-New Haven Hospital between January 1, 2003 and December 31, 2013. Demographics, ophthalmic history, context and characteristics of injury, best-corrected visual acuity, and ocular examination findings at time of injury and after surgical intervention(s) were recorded for each patient. Unpaired two-tailed *t*-tests were utilized to determine whether ocular trauma score (OTS) and wound size were associated with visual recovery. Other possible predictor variables for prognosis included age, mechanism, and type of injury, RAPD, size and location of the wound, RD, choroidal damage, VH, and subsequent vitreoretinal surgical intervention. Outcomes included follow-up best-corrected visual acuity at 6 months, 1 year, and final follow-up.

Results

The inclusion criteria were met by 25 patients. The mean age ($\pm$ standard deviation) was 50.4 ± 25.5 (range 8–91) years, and eight patients (32%) were women. The left eye was involved in 17 of the cases (68%). Four patients (16%) were pseudophakic.

The subjects experienced ocular trauma in both the indoor (48%) and outdoor (52%) settings (Table 1). Materials of impact included shoes ($n=3$), bullets ($n=3$), windshields ($n=2$), bottles ($n=2$), and knives ($n=2$), among others. Approximately half of the patients suffered globe rupture, and the remainder experienced either perforation (20%) or penetration (28%). Only one patient had an intraocular foreign body, which was metallic and resulted in NLP.

Twenty-one patients (84%) remained with NLP or had a prosthesis at final follow-up, while four patients improved to light perception or hand motion (HM, Table 2). Mean final follow-up for all patients was 25.48 ± 18.2 (range 6–66) months. For the group that had light perception or better at final follow-up, the mean follow-up duration was 39 ± 28.8 months, while the mean for those who remained with NLP was 22.90 ± 15.2 months. There was no significant difference in follow-up duration between the two groups ($P=0.35$). The four patients with visual recovery after initial NLP are described thus:

Table 1 Characteristics of injury and ocular examination findings

	n (%) of total sample (total n=25)	Patients with final BCVA > NLP (n=4)
Location		
Indoor	12 (48)	3
Outdoor	13 (52)	1
Home	4 (16)	1
Outside the home/not specified	21 (84)	3
Mechanism of injury		
Penetration	7 (28)	1
Perforation	5 (20)	0
Rupture	13 (52)	3
Relative afferent pupillary defect	14 (56)	2
Hyphema	17 (68)	3
100% AC fill	16 (64)	3
50%–99% AC fill	1 (4)	0
<50% AC fill	0 (0)	0
360-degree subconjunctival hemorrhage	20 (80)	3
Iris injury	24 (96)	4
Lens injury	23 (92)	4
Traumatic cataract	9 (36)	2
Subluxation	11 (44)	1
Expulsed IOL	3 (12)	1
Periorbital ecchymosis/edema	19 (76)	3
Facial or lid laceration	13 (52)	1
Orbital fracture	15 (60)	1
Vitreous hemorrhage	25 (100)	4
Retinal detachment	23 (92)	3
Intraocular foreign body	1 (4)	0
Choroidal detachment/rupture	17 (68)	3
EOM dis-insertion or damage	9 (36)	0
Wound location		
Zone I	12 (48)	2
Zone II	18 (72)	3
Zone III	17 (68)	2
Wound characteristics		
Size >10 mm	20 (80)	3
Uveal prolapse	23 (92)	4
Vitreous prolapse	17 (68)	2
Surgery		
Ruptured globe repair	21 (84)	4
Primary enucleation	4 (16)	N/A

Abbreviations: BCVA, best-corrected visual acuity; NLP, no light perception; AC, anterior chamber; IOL, intraocular lens; EOM, extraocular muscle.

Patient 1

A 72-year-old Caucasian female with a history of Fuchs' dystrophy and prior penetrating keratoplasty suffered a dehiscence penetrating keratoplasty with an 8 mm wound (zone I) after blunt trauma from a plastic whiffle-ball during outdoor play with a grandchild. She presented with a traumatic cataract,

Table 2 Follow-up best-corrected visual acuity and complications

	n (%)
6-month BCVA (22 patients)	
• NLP/prosthesis	19 (86)
• LP	1 (5)
• HM	2 (9)
12-month BCVA (18 patients)	
• NLP/prosthesis	15 (83)
• LP	1 (6)
• HM	2 (11)
Final BCVA (25 patients)	
• NLP/prosthesis	21 (84)
• LP	1 (4)
• HM	3 (12)
Phthisis	12 (48)
Enucleation	14 (56)
Retinal detachment s/p treatment	24 (96)
PVR s/p treatment	7 (28)
Endophthalmitis	2 (8)

Abbreviations: BCVA, best-corrected visual acuity; NLP, no light perception; LP, light perception; HM, hand motion; PVR, proliferative vitreoretinopathy; s/p, status-post.

VH, and choroidal detachment. The wound was associated with uveal and vitreous prolapse. OTS was 26. The patient underwent globe repair with reapproximation of the corneal graft within 24 hours. Her postoperative course was complicated by failed corneal transplant, RD, and proliferative vitreoretinopathy (PVR). She underwent two subsequent vitrectomies and a repeat corneal transplant. Visual acuity at one year is HM.

Patient 2

A 58-year-old male patient with no significant ocular history suffered a ruptured globe with a 15 mm corneoscleral wound after blunt trauma from a punch during an assault. He presented with an RAPD in the affected eye, total hyphema, 360-degree subconjunctival hemorrhage, and subluxation of the natural lens. Posterior examination revealed VH, RD, and choroidal rupture. The wound extended to zone III (>5 mm from the limbus) with uveal prolapse. OTS was 16. The patient was taken for ruptured globe repair within 24 hours of injury. His postoperative course was complicated by a funnel RD and PVR, for which he underwent pars plana vitrectomy (PPV) with membrane peel and silicone oil. Visual acuity at 2 years is HM.

Patient 3

An 8-year-old Hispanic female with no significant ocular history suffered an open globe injury with a 25 mm corneoscleral wound (zone III) from a collision with a glass door at home.

She presented with total hyphema, uveal prolapse, 360-degree subconjunctival hemorrhage, traumatic cataract, periorbital swelling and ecchymosis, and adnexal injuries, including lid laceration and orbital fracture. Posterior examination revealed VH and RD. OTS was 26. She underwent ruptured globe repair within 24 hours, and her postoperative course was complicated by PVR, aphakia, corneal scar, and retinal incarceration. She underwent a combined scleral buckle and vitrectomy with pars plana lensectomy and silicone oil. Subsequently she received repeat vitrectomy with temporary keratoprosthesis, silicone oil, and penetrating keratoplasty. Her visual acuity at 5 years is light perception.

Patient 4

A 61-year-old female with no significant ocular history suffered an OGI with a 10 mm corneoscleral wound (zone II) with uveal and vitreous prolapse after blunt trauma from a fall while shopping. She presented with RAPD, total hyphema, 360-degree subconjunctival hemorrhage, expulsed natural lens, VH, and RD. OTS was 16. The patient was taken for open globe repair within 24 hours. Her postoperative course was complicated by hyphema rebleed, total RD, retinal incarceration, and PVR. She underwent anterior chamber washout with vitrectomy and silicone oil. Visual acuity at 5 years was HM.

Outcomes and characteristics

All four patients who regained vision required vitreoretinal surgery after primary closure. Patients who underwent PPV were more likely to regain vision than patients who did not undergo vitreoretinal surgery (odds ratio 123.5, 95% confidence interval 4.3–333.3, $P=0.0004$).

Five patients (20%) underwent primary enucleation for what were deemed unsalvageable injuries, three of whom had presented more than 24 hours from injury. All five patients who had primary enucleations had zone III injuries. Enucleation in the follow-up period was performed on an additional nine eyes for a total of 14 eyes (56%, Table 2). The most common indication for secondary enucleation was phthisis (Table 2). There were no cases of sympathetic ophthalmia. Two patients developed endophthalmitis, and all patients had received intravenous antibiotics at the time of primary intervention.

Ocular examination findings, including RAPD, hyphema, 360-degree subconjunctival hemorrhage, lens injury, and adnexal injury were not possible to establish as prognostic indicators due to the small sample sizes and heterogeneous types and causes of injury. Twenty-three of the 25 patients

Table 3 Ocular trauma score and wound size

	Ocular trauma score (mean $\pm$ SD)	Wound size, mm (mean $\pm$ SD)
All patients	16.7 $\pm$ 9.3	16.5 $\pm$ 7.6
Final BCVA > NLP	21 $\pm$ 5.8	14.5 $\pm$ 7.6
Final BCVA = NLP	16.15 $\pm$ 9.7	17 $\pm$ 7.7
	$P=0.20$	$P=0.58$

Abbreviations: BCVA, best-corrected visual acuity; NLP, no light perception; SD, standard deviation.

(92%) had a form of lens injury. Subluxation was most common (44%), followed by traumatic cataract (36%) and expelled intraocular lens (12%). VH was present in all 25 patients, and RD occurred in 84%. Choroidal detachment or rupture was observed in 17 patients (68%).

Twenty patients (80%) had wounds greater than 10 mm in size. The mean wound size for all patients was 16.52 $\pm$ 7.6 mm (Table 3). Mean OTS for all patients was 16.68 $\pm$ 9.3. Neither wound size nor OTS was found to predict visual recovery ($P=0.58$ and $P=0.20$, respectively), although the sample sizes were small for this comparison.

Discussion

Our study highlights four patients (16%) with OGI presenting with initial NLP who eventually improved to light perception ($n=1$) or HM ($n=3$) by final follow-up. No cases of sympathetic ophthalmia occurred in our study, with previous estimations ranging from 0.28% to 1.9% in OGIs.^{12,15,27,28}

In the previous reports of visual recovery following OGI and initial NLP,^{6,14–18,20,23} the proportion of patients with visual recovery compared with those remaining with NLP has varied widely. In a retrospective review, Salehi-Had et al reported 12 of 57 eyes with visual recovery.⁶ Soni et al reported 17 of 73 (23%) with improvement to light perception or better, with HM being the most common visual outcome, as was the case in our study.¹⁶ One eye had improved to 20/100. Feng et al in an interventional case series involving 33 eyes found that 18 eyes (55%) recovered light perception or better, with five eyes having better than 20/200 vision.²³ Two additional case series have reported rates of 67% and 33%, with four eyes (14.8%) in the latter study regaining 20/50–20/200 vision.^{14,15} Vitreoretinal surgery has an established role in the subsequent care of penetrating ocular trauma involving the posterior segment and is utilized within 3–14 days of initial injury to prevent PVR.^{29–33} In our study, a total of five patients (20%) underwent PPV, four of whom recovered to light perception or better. Vitreoretinal surgery was significantly associated with improved vision at final follow-up ($P=0.0004$). All four patients who had improved visual outcomes had undergone

vitrectomy, while 20 of the remaining 21 patients had no subsequent vitreoretinal intervention. It is important to note, however, that only eyes that spontaneously recovered some vision underwent PPV. Thus, our findings cannot support a causal relationship between the intervention and visual outcome.

Similar results were reported in both studies by Feng et al: all patients received PPV, with visual recovery rates of 54.5% and 66.7%.^{15,23} Likewise, all 18 patients in a prospective interventional case series underwent vitrectomy, 16 of whom improved to at least light perception.¹⁸ Six eyes (33%) in that study achieved 20/200 or better final VA. Soni et al observed that 14 of 15 receiving PPV after primary open globe repair recovered to light perception or better.¹⁶ Similar to our study, eyes that underwent PPV compared with eyes without vitreoretinal intervention were significantly more likely to achieve visual recovery (odds ratio 256.7; 95% confidence interval 24.8–2,659.3).¹⁶ Salehi-Had et al reported that all eyes without vitreoretinal intervention remained NLP or experienced phthisis within 7 months, whereas five of the eight patients (62.5%) who had vitreoretinal surgery experienced improved vision ranging from HM to 20/70.⁶ However, the argument can be made that vitreoretinal surgery following primary open globe repair is reserved only for eyes clinically deemed to have visual potential, while eyes with anticipated final NLP are observed or undergo secondary enucleation. For this reason, each case must be handled with clinical judgment, with an alertness to the evidence for visual recovery following vitreoretinal intervention in appropriate candidates. To identify these candidates, we initially sought to perform Fisher's Exact tests on initial examination findings and *t*-tests (unpaired and two-tailed *t*-tests) on wound size and OTS, but the small sample sizes and the heterogeneity of the types and causes of injuries precluded meaningful statistical comparisons. However, larger samples in the literature identify age, mechanism and type of injury, RAPD, size and location of the wound, RD, ciliary body or choroidal damage, VH, and time to intervention as having significant associations with visual outcomes.^{6,14–16,21–26}

An additional limitation to retrospective studies of OGI with NLP is visual acuity testing, which by its nature requires subjective input and effort both from patients and examiners, and thus can be unreliable in the setting of severe significant media opacity or altered mental status.³⁴

Nevertheless, our findings support the limited but existing evidence for visual recovery following cases of OGI with initial NLP. Several studies have also variously described the toll of enucleation, which can have profound psychological

as well as physical consequences.^{35–37} Reports in the literature show that a significant proportion of anophthalmic patients can experience depression, anxiety, or stress compared with the normal population, and may also report lower health-related quality of life.^{38–40} Moreover, chronic pain due to diverse causes ranging from dryness to infection and inflammation, such as in giant papillary conjunctivitis, has been associated with prosthetic eyes.^{41–44} Phantom eye pain, estimated to occur in up to as many as 28% of anophthalmic patients, is a particularly challenging form of chronic pain, and permanent pain relief is often reported to occur in less than 10% of all patients.^{36,45,46}

In conclusion, in the absence of an obviously unsalvageable case such as optic nerve avulsion, primary open globe repair with possible subsequent vitreoretinal intervention in appropriate cases is recommended to offer the best possible visual outcome for the patient, with the resultant psychological and functional benefits of even minimal visual restoration.

Disclosure

The authors report no conflicts of interest in this work.

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