Anatomical and functional outcomes in contusion injuries of posterior segment

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Abstract

Purpose To evaluate the clinical features, and anatomical and visual outcomes in patients with closed-globe contusion injury involving the posterior segment.

Methods Retrospective review of posterior segment contusion injuries admitted to our tertiary referral center.

Results In all, 115 patients (115 eyes) with complete data were reviewed. Surgery had been performed in 79 (69%) patients. The mean follow-up period was 6 months (range, 2–34 months). Retinal detachment, in 31% of eyes, was the most frequently encountered posterior segment pathology. The presence of retinal detachment was associated with poor visual outcome ($<20/100$), ($P < 0.001$).

Coexisting (five patients, 4%) and postoperative proliferative vitreoretinopathy (PVR) (two patients, 2%) was the main cause of failure in these cases. A significant positive correlation was obtained between initial and final visual acuity levels in both the medical treatment group and the surgical treatment group ($P < 0.05$). The presenting visual acuity of $<20/400$ was associated with poor visual outcome ($P < 0.05$ for both groups). Poor visual outcome in 13 patients with successful repair of retinal detachment was due to the macular lesions and the optic atrophy.

Conclusion Retinal detachment was the most frequently encountered posterior segment pathology subsequent to closed-globe contusion injuries. In addition to macular scarring and optic nerve damage, development of PVR has prognostic significance in these eyes.

Eye (2011) 25, 1050–1056; doi:10.1038/eye.2011.118; published online 27 May 2011

Keywords: closed-globe injury; contusion; ocular trauma; vitreoretinal surgery

Introduction

The term ‘contusion’ is used to describe closed-globe injury, which is not associated with full-thickness corneal and/or scleral wounds and is mostly caused by blunt objects, but rarely by sharp objects.¹ Contusion injuries are caused by various factors: most occur during daily activities. Depending on the impact site and the severity of the injury, blunt objects affect ocular tissues through two types of injury mechanism: (1) direct lacerations on the impact site, mostly on the outer coat of the globe (ie, the cornea and the sclera); and (2) indirect lacerations in the inner layers of the globe (ie, the choroid and the retina) including the optic nerve. The contusion type of injury affecting the posterior segment has been a matter of interest among ophthalmologists for decades, due to related poor visual outcome.^{2,3}

In this study, we aimed to evaluate clinical features, visual outcomes, and prognostic factors in our patients with contusion injury involving the posterior segment.

Materials and methods

The charts of patients admitted to our tertiary referral center for contusion-type closed-globe injury during the period from January 2003 to June 2008 were reviewed. The information gathered from the patient record included: (1) age, (2) gender, (3) cause of the injury, (4) associated ocular findings (including those observed during the operation), (5) follow-up time, (6) laboratory findings (including ultrasonography/computerized tomography in cases with suspicion of intraocular or intraorbital foreign body), and (7) intervention(s) (including observation).

Visual acuities were grouped into five categories: (1) 20/40 or better, (2) 20/50–20/100,

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Received: 31 August 2010
 Accepted in revised form: 4 April 2011
 Published online: 27 May 2011

This study has been presented at the Ocular Trauma Congress (Argentina, 2010)

(3) 20/200–20/400, (4) sensitivity to hand movement and light perception, and (5) no light perception (NLP). The patient records lacking sufficient details on the follow-up course (≥ 2 months) and patients with a medical history of ocular surgery were excluded from the study. The main outcome measures were functional and anatomical outcomes. Final visual acuity of $<20/100$ was considered to be poor visual outcome.

Statistical analysis was performed using SPSS, version 10.0 (SPSS, Chicago, IL, USA). Chi-squared test (χ^2) or Fisher's exact test was used to determine whether differences were statistically significant. Spearman's rank-order test was used for the correlation of categorical variables. The McNemar test was used to evaluate the differences between initial and final visual acuities.

Results

In all, 115 eyes of 115 cases with contusion injury involving the posterior segment and complete data for evaluation were studied. Mean age of the patients, including 102 (89%) men and 13 (11%) women, was 26 ± 14 years (range, 3–80 years). In total, 80% of patients (92 patients) were between the ages of 19–30 years old. Mean follow-up was 6 ± 5 months (range, 2–34 months). The majority of cases were work-related injuries (26%), followed by assault-related injuries (19%) and sports-related injuries (18%). The patients' demographic characteristics and causes of injury are listed in Table 1. The mean time for presentation to the hospital was 25 days (range, 1–480 days) after the injury. Three cases (3%) were also associated with lamellar laceration including scleral laceration in two cases and corneoscleral

laceration in one case. Surgical treatment was performed in 79 (69%) cases and medical treatment (including only clinical observation) was performed in 36 (31%) cases.

The flow chart described in Figure 1 was followed in the management of posterior segment contusion injuries.

Clinical findings in posterior segment contusion injuries

Presenting visual acuities were 20/40 or better in 26 (23%) eyes, 20/50–20/100 in 31 (27%) eyes, 20/200–20/400 in 25 (22%) eyes, hand movement and light perception in 30 (26%) eyes, and NLP in 3 (3%) eyes. The optic nerve avulsion in two eyes and the choroidal detachment associated with vitreous hemorrhage in one eye seemed to be responsible for NLP in these cases. Distribution of the posterior and anterior segment findings is given in Table 2.

Among the posterior segment pathologies developed in contusion injury, retinal detachment, found in 36 cases (31%), was the most frequent. In half of the cases (58 eyes), posterior segment pathologies were accompanied by at least one of the anterior segment pathologies, including hyphema, iridodialysis, cataract, and lens subluxation. Hyphema in 33 (29%) eyes was the most frequently encountered pathology, followed by cataract in 24 (21%) eyes. The frequency of associated anterior segment pathologies was similar between surgically and medically treated contusion injuries (51 vs 50%, χ^2 , $P = 0.950$).

Anatomical results in the surgically treated contusion injuries

Among surgically treated 79 (69%) eyes, 53 (67%) underwent vitreoretinal surgical interventions. Retinal detachment was the main indication in 36 (46%) eyes, of which 22 (61%) had macula-off retinal detachment. Dense vitreous hemorrhage in seven (11%) cases and proliferative vitreoretinopathy (PVR) in five (8%) cases were the significant findings in this surgically treated group. In eyes with retinal detachment, retinal breaks of different shapes (irregular, horse-shoe, and operculated) were observed in 21 (33%) eyes during preoperative and intraoperative examinations. In addition, retinal dialysis was detected in 10 (16%) eyes and giant retinal tear was detected in five (8%) eyes.

All surgical procedures mentioned in this study were performed by the same surgeons (GS, AHD, and FCE). All surgical attempts had been discussed collectively before the surgery. The surgeons followed the strategy defined preoperatively and recorded any alterations implemented intraoperatively. Pars plana vitrectomy (PPV) was the preferred surgical technique in cases with retinal tear complicated by dense vitreous hemorrhage

Table 1 Demographic features of the patients and causes of contusion injury

Number of patients	115
Gender (male/female)	102/13
Mean age (range)	26 (3–80)
Age range	
0–18	7
19–30	92
31–45	5
>45	11
Mean follow-up time (months)	6
Causes of injury	
Work related	30
Assault	22
Sports related	21
Explosive devices	16
Home accident	13
Vehicle accident	3
Other accidental injuries	10

Figure 1 The management flow chart for posterior segment contusion injuries. LPC, laser photocoagulation.

Table 2 Distribution of the posterior and anterior segment pathologies in eyes with contusion injury^a

	Number of eyes
<i>Posterior segment</i>	
Retinal detachment	36
Comotio retinae	24
Vitreous hemorrhage alone	23
Retinal breaks without retinal detachment	15
Retinal–subretinal hemorrhage	7
Proliferative vitreoretinopathy	5
Epiretinal membrane	4
Choroidal rupture	6
Optic nerve avulsion	2
Macular hole	1
Choroidal detachment	1
<i>Anterior segment</i>	
Hyphema	33
Cataract	24
Zonular dialysis	8
Angle recession	6
Iridodialysis	6
Lamellar laceration	5

^aSome eyes had more than one ocular findings in anterior and posterior segment.

or PVR; otherwise, scleral buckling (either segmental or encircling) was performed in well-defined anteriorly located tears, not complicated by media opacities. Clear lens extraction was performed in cases in which complete vitreous base dissection failed during the operation. Scleral buckling procedures were also added

in PVR cases with large and irregular retinal breaks extending to the vitreous base. Silicone oil was selected for intraocular tamponade; otherwise, perfluoropropane (C3F8) gas was injected. Silicone oil extraction was performed at least 2 months after surgery. In one case with giant retinal tear leading to phthisis, silicone oil was used as a permanent tamponade.

In cases with retinal detachment, PPV had been selected as a primary procedure in 17 (47%) eyes. Scleral buckling procedure was combined with PPV using an encircling silicone band or a segmental silicone sponge in 13 (36%) eyes. Other vitreoretinal surgical maneuvers such as membranectomy, retinotomy, and even retinectomy were performed to attach the retina. Pars plana lensectomy was also required in eight eyes during the same surgery. Silicone oil tamponade had been performed in 23 (64%) eyes and C3F8 in 7 (19%) eyes. Mean time to silicone oil extraction was 4 months (range, 2–7 months) after surgery.

Retinal detachment was repaired with scleral buckling alone in six (17%) eyes, including four eyes with encircling band and two eyes with segmental buckling. Sterile air injection was performed in one eye with encircling buckle, and supplemental sterile air injection and argon laser retinopexy for unstable tear were required in one eye with a segmental buckle. Retinal attachment was achieved in all patients that underwent scleral buckling alone.

Retinal attachment was achieved in 25 of 36 eyes (69%) after primary vitreoretinal surgery. Retinal detachment recurred after silicone oil removal in nine eyes and

absorption of C3F8 in two eyes. In these 11 cases, primarily treated by PPV or combined surgery, at least one or more additional vitreoretinal intervention was performed (range, 1–4). At the final examination, 29 of 36 eyes (81%) had attached retina (23 of the 30 eyes treated by PPV or combined surgery and six eyes treated by scleral buckle alone). Five of the seven eyes with surgical failure had retinal detachment due to PVR (three eyes with preoperative and two eyes with postoperative PVR), and two eyes with complications caused by giant retinal tear required additional vitreoretinal surgical procedures. Two of the seven eyes with surgical failure subsequently became phthisical and lost light perception.

Among surgically treated eyes, 17 (22%) were without retinal detachment. PPV was indicated in 15 (19%) eyes with dense vitreous hemorrhage (obscuring fundus details throughout the follow-up period of at least 15 days), in one eye with a macular hole, and in one eye with an epiretinal membrane. At the postoperative period, partial closure was noted in a case of macular hole. No additional surgery was performed in these cases, except trabeculectomy for two cases with uncontrollable intraocular pressure spikes. Cataract extraction and intraocular lens implantation were performed in six eyes (8%). Five cases (6%), four cases injured by explosive devices and one case injured by a sharp object were surgically explored through a 360° conjunctival peritomy. In all five cases with suspicion of occult penetrating globe injuries, surgical exploration was required to make a definite diagnosis and to repair of partial thickness corneoscleral laceration or to remove foreign bodies from conjunctiva and Tenon's capsule. Three of four patients injured by explosive devices also had open-globe injury in their fellow eyes.

Laser photocoagulation to the retinal laceration site was performed in 15 (19%) of the patients. Six (40%) of these 15 cases had associated vitreous hemorrhage, and three (20%) had choroidal rupture. There was no epimacular membrane formation or tears at the edge of the laceration, leading to retinal detachment in these eyes treated with laser photocoagulation at presentation.

Anatomical results in the medically treated contusion injuries

Medical treatment including observation was performed for 36 (31%) eyes. In this group of patients, the most common posterior segment pathology was commotio retina in 24 eyes (67%), followed by subretinal hemorrhage in seven (19%) eyes, choroidal rupture in three (8%) eyes, and optic nerve avulsion in two (6%) eyes (Table 2). High-dose corticosteroid therapy (1000 mg per day) had been performed in two cases with optic nerve avulsion. All other cases were treated symptomatically with anti-inflammatory agents, including corticosteroids for optic nerve avulsion, or observed regularly. In a patient presented with submacular hemorrhage, macular hole developed at 1-month follow-up. Macular hole surgery was not performed because of the patient refused surgical treatment.

Functional results in contusion injury

Visual outcomes obtained in the surgical and the medical treatment groups are presented in Table 3. Visual acuity levels were unchanged in 59 (51%) cases, increased in 52 (45%) cases, and decreased in 4 (4%) cases. In all, 32% of the surgically treated and 69% of the non-surgically treated patients had 20/40 or better final visual acuity. The increase in visual acuity was statistically significant in both surgical and non-surgical treatment groups (McNemar test, $P=0.002$ and $P<0.001$, respectively). There were 27 (34%) eyes from the surgical treatment group and 6 (17%) eyes from the medical treatment group with poor outcomes ($<20/100$) (χ^2 , $P=0.054$).

In surgically treated eyes, vitreous hemorrhage and anterior segment pathologies had no relation to poor visual outcome (χ^2 , $P=0.157$, $P=0.876$, respectively); however, retinal detachment was associated with poor visual outcome (χ^2 , $P<0.001$).

In 10 of 30 (33%) cases treated either with PPV or PPV combined with scleral buckling for retinal detachment, final acuity levels were 20/100 or better and there was no

Table 3 Presenting and final visual acuity levels in surgical treatment and medical treatment groups

Visual acuity level	Surgical treatment group, n = 79 (69%)		Medical treatment group, n = 36 (31%)		Total, n = 115	
	Presenting VA	Final VA	Presenting VA	Final VA	Presenting VA	Final VA
$\geq 20/40$	13	25	13	25	26	50
20/50–20/100	22	27	9	5	31	32
20/200–20/400	17	16	8	4	25	20
CF to LP	26	9	4	0	30	9
NLP	1	2	2	2	3	4

Abbreviations: CF, counting finger; LP, light perception; NLP, no light perception; VA, visual acuity.

Table 4 Causes of poor visual outcome (<20/100) in surgical treatment and medical treatment groups

	Surgical treatment group		Medical treatment group
	RD	Non-RD	
Preoperative PVR	3		
Postoperative PVR	2		
Macular scarring	6	3	
Complicated giant retinal tear	2		
Optic atrophy	3	2	2
Macular scarring with optic atrophy	4		
Cystoid macular edema		1	
Optic nerve avulsion			2
Choroidal rupture			1
Macular hole		1	1

Abbreviations: PVR, proliferative vitreoretinopathy; RD, retinal detachment.

difference between the groups (PPV *vs* combined surgery) (Fisher's exact test, $P = 0.440$). All six eyes treated with scleral buckling alone had visual acuity of 20/100 or better, including 20/40 or more in four eyes at the final examination. Except for the seven patients with surgical failure (five cases with PVR and two cases with complicated giant retinal tear), poor outcome in cases with attached retinas was caused by macular scarring in six (9%) eyes, optic atrophy in three (5%) eyes, and macular scarring with optic atrophy in four (6%) eyes.

Poor visual outcome was related with macular scar in three eyes, optic atrophy in two eyes, macular hole in one eye (partial closure was obtained after surgery), and cystoid macular edema in one eye in those patients in the surgically treated group without retinal detachment (Table 4).

No surgical treatment had been attempted in eyes with NLP from optic nerve avulsion (two eyes), traumatic optic atrophy (two eyes), choroidal rupture extending through the macula (one eye), or macular hole (one eye) (Table 4).

Overall, categorical distribution of initial and final visual acuities in the groups showed positive correlation, which was statistically significant (Spearman's $\rho = 0.685$, $P < 0.001$). Also, initial visual acuity of <20/400 in the groups was associated with poor visual outcome (χ^2 , $P < 0.001$ for the surgical treatment group; Fisher's exact test, $P = 0.045$ for the medical treatment group). Contusion injuries due to explosives, which accounted for 14% of cases, had no significant relation to poor visual outcome (Fisher's exact test, $P = 0.389$).

Discussion

This study describes clinical features and visual outcomes of 115 cases with contusion injuries in the

posterior segment. Heterogeneity of the injuries, a well-known feature, considerably limited comparison and evaluation of the series. Similar to previous studies, most patients in this series were male patients and young.⁴⁻⁷ As in our cases, contusion was typically caused by working conditions, assault, sports, and routine daily activities. In contrast to other series, explosives used in terrorist acts caused 14% of the cases with contusion.

Patients were admitted to our hospital up to 25 days after the injury, and only 20% of the cases had been presented to our hospital within 24 h. Therefore, early ocular findings, including the presence or absence of a relative afferent pupillary defect, were not evaluated in most of the cases and injuries were not classified according to the criteria of the Ocular Trauma Classification Group.⁸

Retinal detachment, found in almost one-third of the cases, comprised the most frequent indication for surgery in our cases. Archer and Canavan⁹ have shown that contusion injuries in the retina and the choroid were associated with retinal detachment in 9% of cases. Kuhn and co-workers² indicated that the rate of development of retinal detachment increases to 16% when it is complicated by vitreous hemorrhage. It seems that our cases without retinal detachment had been treated at primary care centers at the time of presentation; however, those with probability of poor visual outcome due to retinal detachment at presentation, and those who developed retinal detachment later, had been referred to our tertiary referral center for treatment.

As indicated, contusion injury represents the most important cause of traumatic retinal detachment.¹⁰ Weidenthal and Schepens¹¹ showed that blunt trauma causes retinal break and dialysis by expanding laterally at the equatorial zone and exerting traction at the vitreous base. In general, these breaks happen when sclera, rather than the anterior pole of the globe, was struck. Anterior segment involvement is rare in this type of closed-globe injury.¹² Our experience with contusion injury supports the notion that in contusion-type trauma, although the initial damage may seem minimal, the consequences are typically not. Complications may include retinal detachment, even years after the surgery.^{9,13} When the possibility of penetrating injury has been eliminated, it is essential to carry out a thorough retinal examination by indirect ophthalmoscopy. When details of the retina were obscured, B-mode ultrasonography was necessary for preoperative evaluation of contusion injury. In contusion-type injury, appropriately timed vitrectomy is crucial when vitreous hemorrhage is present.¹⁴

In our study group, retinal attachment was achieved in 69% of cases after primary vitreoretinal surgery. When clinical characteristics of the series were considered,

our series was comparable to that investigated by Ersanli *et al*,¹⁵ in which retinal detachment was repaired successfully in 70% of cases. Previous studies favor scleral buckling to prevent postoperative retinal detachment.^{16,17} Hermesen,¹⁸ however, observed a higher recurrence rate, and suggested restriction of the indications in scleral buckling surgery. Ersanli *et al*¹⁵ reported that the scleral buckling procedure might not be necessary for all cases undergoing vitreoretinal surgery for retinal detachment due to closed-globe injury. The authors also highlighted the risk of globe rupture due to scleral atrophy in cases with tight scleral buckling during reoperation.¹⁵ We noted no significant difference in poor visual outcomes between PPV and combined surgery ($P = 0.440$). There is no doubt that heterogeneity in ocular trauma mechanisms, surgical techniques, and prognostic variables affects the final visual outcome considerably. The fact that no case in our series developed recurrences when scleral buckling was performed in isolation renders this technique the treatment of choice in closed-globe injury. Sheard *et al*¹⁹ have found that use of scleral buckling as a primary treatment of traumatic retinal detachment during childhood achieved anatomical success in 71% of cases and visual success of 6/60 or more in 89% of cases. We obtained visual success of 20/100 or more in all cases, including 20/40 or more in four (57%) cases treated with scleral buckling alone. On the other hand, patients who underwent successful retinal detachment surgery with scleral buckling alone were not complicated by dense cataract, giant retinal tear, massive vitreous hemorrhage, or PVR.

Although it has some role in the development of PVR in contusion injury, vitreous hemorrhage seems to be a strong predictor of PVR, especially in cases with full-thickness scleral lacerations such as penetration and rupture.²⁰ In our series, retinal detachment surgery was performed in five cases with PVR and seven cases with vitreous hemorrhage. We could not determine whether the cases with PVR in the preoperative period had associated vitreous hemorrhage; however, we observed that two cases without vitreous hemorrhage developed PVR after retinal detachment surgery. We failed to achieve anatomical success in these seven eyes with PVR and complicated giant retinal tear, and two of them developed phthisis bulbi without LP. Silicone oil remained in one eye complicated by a giant retinal tear.

Comotio retina is one of the posterior segment pathologies related to contusion-type ocular traumas. In Eagling's prospective series including 108 cases of blunt ocular trauma, commotio retina affecting the macula was found in 30 cases (28%), 12 of whom (40%) had various degrees of visual loss and two of them had severe visual loss ($<20/100$).¹² In our study, commotio retina or

related posterior segment changes, such as retinal/subretinal hemorrhages, were noted in 30% of the cases. Four eyes, two with choroidal rupture under the macula and two with submacular hemorrhagic scar, yielded poor visual outcomes.

In this study, two patients who presented with NLP were diagnosed with optic nerve avulsion and received high-dose corticosteroid treatment. However, the visual acuity did not improve in both patients. The use of high-dose corticosteroids in the management of optic nerve avulsion remains controversial.^{21,22} In a series reported by Foster *et al*,²² visual outcome in patients with optic nerve avulsion was found to be only dependent on initial visual acuity after injury. In such patients diagnosed with complete optic nerve avulsion, high-dose corticosteroid treatment appears not to be effective in treatment of this condition.

In closed-globe injuries, postoperative visual acuity level has been reported to be closely associated with preoperative visual acuity level, namely, severity of the injury.^{14,19,23,24} We found a strong positive correlation ($P < 0.001$) between initial and final visual acuities. Presenting visual acuity of 20/400 or less was predictive of poor visual outcome, especially in the surgical treatment group ($P < 0.001$ and $P = 0.042$ for surgical treatment and medical treatment groups, respectively).

When compared with open-globe injuries, the incidence of closed-globe injury due to an explosive event is rare.^{25,26} In this study, 16 cases (14%) had contusion injury due to explosive materials used in terrorist acts. Contrary to those reported in Sobaci *et al*'s²⁷ series with open-globe injury from the same hospital, contusion injuries from explosives had favorable visual outcomes in this series of closed-globe injury ($P = 0.389$). In evaluation of this type of ocular injuries, surgical exploration should be considered to exclude a scleral laceration and possible penetrating injury.

This study has some limitations due to the retrospective design. Because the study group was mostly composed of referred patients requiring vitreoretinal surgery, the distribution of the posterior segment pathologies related to ocular contusion is likely to be affected. Another limitation of the study was the relatively short follow-up period; patients who received medical treatment or underwent observation without treatment could not be evaluated in terms of long-term complications.

In conclusion, contusion injuries of posterior segment might have potentially devastating visual results because the development of macular scar and optic atrophy is not rare, and retinal detachment is found in a considerable number of patients, who may develop PVR. The severity of contusion injury may predict final visual outcome.

Summary

What was known before

- PVR is one of the common causes of surgical failure in patients with penetrating ocular injuries.

What this study adds

- In this study, we aimed to report anatomical and functional outcomes in a series of patients with posterior segment contusion injuries. The development of PVR was found to be prognostic in contusion-type closed-globe injuries.

Conflict of interest

The authors declare no conflict of interest.

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