Long-term results of 360A° scleral buckling and vitrectomy with silicone oil tamponade for management of gunshot-perforating ocular injury

HH Ghoraba¹, AF Ellakwa², AA Ghali³
 and HM Abdel Fattah⁴

Abstract

Purpose This is a retrospective consecutive study to assess the long-term results of combined scleral buckling and pars plana vitrectomy (PPV) with silicone oil for the management of perforating ocular injury caused by gunshots.

Methods Data were gathered from medical records of patients who underwent scleral buckling and PPV with silicone oil 2 weeks after primary repair elsewhere, in Magrabi eye center (Tanta, Egypt), from June 2005 to May 2010.

Results The evaluated group consisted of 49 cases, out of which 26 cases presented with gunshot injury. Twenty-two were male (84.62%) and four were female (15.38%), with a mean age of 27.19 ± 12.7 years. The follow-up ranged from 12 to 72 months, with a mean period of 32.04 ± 8.9 months. The *t*-test was used to determine the visual outcome and main prognostic factors. Visual acuity improved in 22 of 26 eyes (76.92%), was unchanged in 4 eyes (15.38%), and worsened in 2 eyes (6.69%). Ten eyes (38.46%) achieved visual acuity between (20/40) and (20/100), and eight eyes (30.76%) had visual acuity between (20/200) and (20/400). The 18 eyes (69.23%) with visual acuity better than counting fingers (CF) had an attached retina with no signs of active proliferation after removal of the silicone oil.

Conclusion POI due to gunshot is usually a terminal event for the eye. Eyes with perforating injury can be saved and may attain useful vision after performance of combined scleral buckling and PPV with

silicone oil tamponade. The final visual outcome depends on the macular or the optic nerve involvement and the final retinal stability, and phthisis bulbi can also be prevented.

Eye (2012) 26, 1318–1323; doi:10.1038/eye.2012.150; published online 3 August 2012

Keywords: gunshots; perforating injury; scleral buckle; silicone oil; trauma; vitrectomy

Introduction

Trauma can result in a highly diverse range of ophthalmic injury, leading to the difficulty of comparison between individual cases.¹ A perforating injury refers to an ocular injury with an entry and exit wound. The term perforating injury has replaced double-penetrating injury because the latter term, while descriptively correct, is not adequately specific as it may also be used to describe wounds caused by two foreign bodies that enter but do not exit the globe.²

Penetrating and perforating injuries involving the posterior segment of the globe often result in severe visual loss and carry a worse prognosis than blunt traumas, especially in young adults or children and if associated with an intraocular foreign body (IOFB). Visual loss results both from the initial effects of the injury and from delayed effects of intraocular cellular proliferation.^{3,4}

Benson and Machemer relate the high failure rate in the treatment of perforating injuries to an increased fibroblastic tissue response, but

¹Tanta University, Magrabi Eye Hospital, Tanta, Egypt

²Department of Ophthalmology, Menoufiya University, Shebin Elkom, Egypt

³Alazhar University, Damietta, Egypt

⁴Banha Teaching Hospital, Magrabi Eye hospital, Tanta, Egypt

Correspondence: AF Ellakwa, Department of Ophthalmology, Menoufiya University-Egypt, Ebn Rawaha Street, Building No. 2—in front of police club, Shebin Elkom, Menoufiya 12345, Egypt
 Tel: +20 1005288543;
 Fax: +20 482232521.
 E-mail: ellakwa@yahoo.com

Received: 13 July 2011
 Accepted in revised form: 1 May 2012
 Published online: 3 August 2012

Conway and Michels noted that the prognosis is worse when vitreous haemorrhage accompanies perforating injuries.^{5,6}

The introduction of pars plana vitrectomy (PPV) and subsequent improvements in associated instrumentation has increased the treatment options for trauma cases.⁷ At the same time, improvements in the understanding of pathological mechanisms have resulted from the study of animal models. These two factors have helped save many eyes that would have previously been enucleated.¹

Histological studies showed the important role of blood in creating a posterior vitreous detachment (PVD) after about a week of the injury. Proliferation of cells on the surface of the retina and vitreous subsequently leads to tractional retinal detachment, which usually occurs after 6 weeks. These findings were consistent with histological studies of human eyes enucleated after trauma.^{8,9}

The placement of an encircling scleral buckle has been advocated on the basis that complete removal of the vitreous base is not possible and the remaining tissue may contract leading to tractional retinal detachment or retinal breaks, particularly if haemorrhage occurs. The rationale of encirclement is to reduce the circumference of the vitreous base and thereby relieve traction on the peripheral retina.^{1,10}

The goal of our study is to examine how advanced microsurgical techniques can optimize the management of perforating ocular injuries.

Patients and methods

A retrospective consecutive series of all patients with perforating eye injuries caused by gunshot, in the period between June 2005 and May 2010, was evaluated.

Exclusion criteria

Cases with no light perception (LP), cases with the presence of IOFB, and cases with follow-up period <1 year after the last surgical intervention were excluded from the study.

For all cases, primary repair was performed elsewhere.

Preoperative evaluation included the following: age; sex of the patients; causes of the injury; preoperative VA; pupillary reaction, intraocular pressure (IOP); iris and lens status; vitreous haemorrhage; and entrance wound site.

Fundus photography was not feasible in most of the cases because of haemorrhage. Ultrasound was performed routinely. CT was performed in every case to confirm the site of the gunshot and for medico-legal purposes.

In all cases, surgery was performed after the second week of trauma by one surgeon (HG), under general anaesthesia. All patients underwent the following surgical steps: A scleral band (240) was secured in the

four quadrants with one 5-0 stitch polyester; a sleeve was used in the upper nasal quadrant. A twenty-gauge micro-vitreoretinal blade was used for the three sclerotomies at 3.5 mm from limbus. An infusion cannula was fixated by a 7-0 vicryl suture. Core vitrectomy was started with creation of PVD as a standard step; pars plana lensectomy was performed if the lens was affected or was preventing good visualization. Perfluorocarbon (PFC) liquid was used to flatten the retina if detached, support the retina during manipulation, and to drain supra-choroidal haemorrhage if present. Vitrectomy was completed from the posterior to the anterior part as much as possible. Care was given to the exit site by thorough shaving of the exit site. After tightening the buckle, laser was applied over the equatorial area and around any retinal tear and especially around the exit site. Six o'clock peripheral iridotomy was performed in aphakic cases. After air-PFC exchange, silicone oil 5000 centistokes was injected manually through the upper sclerotomy. Sclerotomies were closed after the removal of infusion cannula using 7-0 vicryl suture. Conjunctiva was closed by 7-0 vicryl. Subconjunctival injection of Garamycin and Dexamethasone was administered. All patients received a combined topical antibiotic and corticosteroid drop five times per day for 1 week, and then the dose was reduced gradually over the next week, as well as topical atropine drop three times per day for 2 weeks; topical anti-glaucoma medications were used according to the level of IOP.

Postoperatively, the patients were examined on the first day, first week, first month, and then every 6 weeks through the follow-up period. Silicone oil was removed after 1 year when retinal stability was seen. After the silicone oil removal, follow-up of the patients was scheduled on the first day, first week, first month, and every 2 months for at least 1 year after the operation.

Fundus photography was done postoperatively for some cases

Case 1:

Figure 1a: 1 week post surgery.

Figure 1b: 4 months post surgery.

Figure 1c: 38 months after Trauma, 18 Months Post SOR with BCVA 20/30.

Case 2:

Figure 2a: 1 day post surgery.

Figure 2b: 4 Months post surgery.

Figure 2c: 72 Months after trauma, 36 Months post SOR with BCVA 20/40.

Figure 1 Case 1: (a) one week post surgery. (b) 4 months post surgery. (c) 38 months after trauma (18 months post SOR) with BCVA 20/30.

Figure 2 Case 2: (a) one day post surgery. (b) 4 months post surgery. (c) 72 months after trauma (36 months post SOR) with BCVA 20/40.

Figure 3 Case 3: (a) Exit Site with retinal incarceration 4 days post surgery. (b) 6 months post surgery. (c) 12 months post surgery with BCVA 20/100. (d) 36 months after trauma (16 months post SOR) with BCVA 20/30. (e) Exit site 36 months after trauma, 16 months post SOR.

Case 3:

Figure 3a: Exit Site with retinal incarceration 4 days post surgery.

Figure 3b: 6 months post surgery.

Figure 3c: 12 months post surgery with BCVA 20/100.

Figure 3d: 36 months after trauma, 16 months post SOR with BCVA 20/30.

Figure 3e: Exit site 36 months after trauma, 16 months post SOR.

Results were collected and tabulated. Data were analyzed using the Statistical Package for the Social Sciences (SPSS for Windows version 19.0, IBM, Chicago, IL, USA).

Results

From June 2005 until May 2010, we received 46 patients suffering from injuries of gunshot. Three of them had bilateral injury. Twenty-three cases were excluded out of the 49 eyes (14 eyes were excluded due to no light perception at their presentation and only followed up and end by phthisis bulbi. Thirty-five cases were operated. Two cases had IOFB and were excluded from the study. Seven cases did not complete the 1-year follow-up after the last surgical interference and were excluded from the study). (Table 1). The remaining 26 eyes are analysed. The age ranged from 11 to 58 years, the mean age was 27.19 ± 12.7 years; 84.6% were male and 15.4% were female. The follow-up period ranged from 12 to 72 months (mean $\pm$ SD 32.04 ± 8.9 months). The preoperative BCVA was as follows: CF, 4 eyes

(15.38%); hand motion (HM), 20 eyes (76.9%); and LP, 2 eyes (7.69%).

Visual acuity improved in 18 of 26 eyes (69.23%), was unchanged in 4 eyes (15.38%), and worsened in 4 eyes (15.38%). Ten eyes (38.46%) achieved visual acuity between (20/40) and (20/100), and eight eyes (30.77%) had visual acuity between (20/200) and (20/400). The 18 eyes (69.23%) with visual acuity better than CF had an attached retina with no signs of active proliferation after successful removal of silicone oil. Poor visual acuity (CF or less) was observed in eight eyes (30.77%) because of proliferative tissue response of different degrees, of which four eyes (15.38%) failed to gain useful vision (HM, LP and NLP) (Table 2).

With regard to intra-operative retinal status, six eyes (23.08%) showed retinal detachment, four eyes (15.38%) showed retinal incarceration, and four eyes (15.38%) showed sub-macular haemorrhage; intra-operative PVD

was found in 20 cases, whereas the other six cases it was induced during surgery (Table 3).

With regard to gunshot entrance wound site, for two eyes (7.69%) it was corneal, one eye (3.84%) limbal, and 23 eyes (88.46%) scleral (Table 4).

The exit sites were as follows: 21 eyes (80.76%), extra-macular; 3 eyes (11.53%), paramacular; 2 eyes (7.69%), macular and optic disc (Table 4).

With regard to postoperative complications, four eyes (15.38%) had additional vitrectomy with silicone oil exchange because of re-proliferation. Relaxing retinotomy was performed in two of them and epiretinal membranes (ERM) were peeled in three eyes. Sub-retinal silicone oil was observed in two eyes (7.69%) and removed through 90 degree retinotomy. Glaucoma developed in two eyes (7.96%) and was controlled with anti-glaucoma medications. Cataract developed in 13 of 18 phakic eyes (73%) and was managed during silicone oil removal by phacoemulsification with or without PC IOL. Silicone oil was not removed in seven eyes (26.92%) because of extensive proliferation leading to retinal instability (5 eyes) or hypotony (2 eyes). Corneal scarring developed in two eyes (7.69%) (Table 5).

The postoperative retinal status at the last visit was as follows: flat retina was observed in 18 eyes (69.23%), extensive proliferation in 4 eyes (15.38%), sub-macular fibrosis in 3 eyes (11.53%), ERM in 3 eyes

Table 1 Distribution of eyes with gunshot with double perforation

Total no	49
Nonoperated (NLP)	14
Operated eyes (PPV + SB + Sil Oil)	35
Excluded eyes	9
IOFB	2
<1 year follow-up	7
Studied eyes with >1 year follow-up	26

Table 2 Postoperative BCVA (20 feet) at the last follow-up

Final BCVA	No.	Percentage (%)
20/40	2	7.69
20/50	5	19.23
20/80	1	3.84
20/100	2	7.69
20/200	2	7.69
20/400	6	23.07
CF	4	15.38
HM	2	7.69
LP	1	3.84
NLP	1	3.84

Table 3 Intra-operative retinal status in the studied eyes with >1 year follow-up (26 cases)

Intra-operative retinal status	No.	Percentage (%)
Retinal detachment	6	23.08
Retinal incarceration	4	15.38
Sub-macular haemorrhage	4	15.38
Presence of PVD	20	77

Table 4 Gunshot entrance and exit wound site

Entrance site	No.	%	Exit location	No.	Percentage (%)
Corneal	2	7.69%	Extra-macular	21	80.76
Limbal	1	3.84%	Paramacular	3	11.53
Scleral	23	88.46%	Macular or ON	2	7.69

Table 5 Postoperative complications and retinal status at the last visit

	No.	Percentage (%)
Complications		
Extensive proliferation	7	26.92
Hypotony	2	7.69
Retinal instability	5	19.23
Cataract	13	73
Glaucoma	2	7.69
Sub-retinal silicone oil	2	7.69
Corneal scar	2	7.69
Retinal status at last visit		
Flat retina	18	69.23
Extensive proliferation	4	15.38
Sub-macular fibrosis	3	11.53
ERM	3	11.53
Macular dragging	4	15.38

(11.53%), and macular dragging in 4 eyes (15.38%) (Table 5).

Endophthalmitis was not seen in any eye during the follow-up period. No eye of the operated group suffered from phthisis bulbi.

Discussion

We report that a series of 49 eyes of 46 patients presented with perforating eye injuries caused by gunshots. Fourteen patients were not operated because of the absence of LP. The other cases (35 cases) were operated. Nine cases were excluded because of IOFB (2 cases) or <1 year of follow-up after the last surgical interference (7 cases).

It is difficult to compare our results with other studies, because there is no standardized approach to management. Clinically, it was demonstrated that perforating injuries have a significantly worse prognosis than blunt or sharp penetrating injuries.¹⁰ In our study, visual acuity improved in 18 of 26 eyes (69.23%), was unchanged in 4 eyes (15.38%), and worsened in 4 eyes (15.38%). The 18 eyes (69.23%) with visual acuity better than CF had an attached retina with no signs of active proliferation after successful removal of silicone oil. Poor visual acuity (CF or less) was observed in 8 eyes (30.77%) because of proliferative tissue of different degrees, of which 4 eyes (15.38%) failed to gain useful vision (HM, LP and NLP).

Martin *et al*¹¹ reported functional success of 62.5% (10 of 16 double-penetrating injuries), anatomical success but functional failure of 6.25% (one eye), and ultimate failure of 31.25% (five eyes). Ramsay *et al*⁹ reported that anatomical success was achieved in 57.9% (11 of 19 eyes) after vitrectomy for perforating injuries and functional success was achieved in 52.63% (10 of 19 eyes).

Macular involvement either early by the foreign body or late by proliferation was the main cause of low visual outcome. In the study by Ramsay *et al*,⁹ several prognostic risk factors were determined, including initial visual acuity, extent of vitreous haemorrhage, and the ability to excise the vitreous completely.

In this study, vitrectomy was performed at the second week after primary repair, as we thought that time allows better coaptation of the entry wound and development of spontaneous PVD, which makes vitrectomy safer and more likely to be completed. Vatne and Syrdalen¹⁰ could not identify a beneficial effect of early vitrectomy performed within 14 days of injury, and Ramsay *et al*⁹ recommend delaying a variable length of time before vitrectomy to allow separation of the posterior hyaloid.

In our study, the final visual acuity depends on anatomical success, macular involvement, and development of vision-threatening complications. Poor visual acuity developed in eyes with extensive proliferation, optic atrophy, macular scar, or detachment. Fourteen of 16 eyes with dense vitreous haemorrhage had improvement in VA (10 of them gained 20/100 or better). Ramsay *et al*⁹ considered that the initial extent of vitreous haemorrhage had an important prognostic factor, where only 5 of 13 eyes with dense vitreous haemorrhage were successfully repaired. Some authors estimated 25% PVR after vitrectomy for penetrating eye injury with posterior segment IOFB.¹² In our study, extensive proliferative tissue response developed in eight eyes (30.77%), which was the main reason for re-detachment or poor visual acuity especially with macular involvement.

The severity of the primary injury was identified as the best prognostic indicator for final visual results as reported by Vatne and Syrdalen¹⁰ who reviewed the results of 41 consecutive cases of perforating injuries who underwent vitrectomy, with a functional success of 56% (visual acuity of 0.025 or better).¹³ In our study, macular or optic nerve involvement was the main cause of low visual outcome.

A prophylactic scleral encircling band was used to support the vitreous base as it was placed at the posterior border of the vitreous base; in addition, we positioned the encirclement at the posterior border of the site of the scleral entry in all cases to support the vitreous base. Some authors used scleral buckling only in preexisting or iatrogenic retinal breaks.⁴

We recommend using this as a routine step in all cases with perforating eye injuries, as it supports the vitreous base and in most of these cases total PPV is difficult because of bad visualization caused by haemorrhage.

No eye from the operated cases ended in phthisis bulbi. On the other hand, during the follow-up period, all the eyes that were not operated ended in phthisis bulbi. This could be due to severity of the injury or proliferation extending from entry to exit site (fibrous ingrowths^{5,6}). In our opinion, PPV with thorough excision of the vitreous at the exit site would stop this process.

Better visualization using the wide-field system, brighter light sources, and improvement in machine technology may be the causes of better results as compared with previous results.

Conclusion

We conclude that some eyes sustaining gunshot injury with POI retain some vision with this surgical sequence and others may be saved from phthisis. Many of these eyes attain useful vision.

Summary

What was known before

- POI is an end-stage condition for the eye under perforation that ends with atrophía bulbi.

What this study adds

- POI can be managed, and in some cases may preserve some vision or at least avoid atrophía bulbi if we cannot save some vision in the perforated eye.

Conflict of interest

The authors declare no conflict of interest.

References

- 1 Aylward GW. Vitreous management in penetrating trauma: primary repair and secondary intervention. *Eye* 2008; **22**: 1366–1369.
- 2 Machemer R, Buettner H, Norton EW, Parel JM. Vitrectomy: a pars plana approach. *Trans Am Acad Ophthalmol Otolaryngol* 1971; **75**: 813–820.
- 3 Benson WE, Machemer R. Severe perforating injuries treated with pars plana vitrectomy. *Am J Ophthalmol* 1976; **81**: 728–732.
- 4 Conway BP, Michels RG. Vitrectomy techniques in the management of selected penetrating ocular injuries. *Ophthalmology* 1978; **85**: 560–583.
- 5 Topping TM, Abrams GW, Machemer R. Experimental double perforating injury of the posterior segment in rabbit eyes. *Arch Ophthalmol* 1979; **97**: 735–742.
- 6 Winthrop SR, Cleary PE, Minckler DS, Ryan SJ. Penetrating eye injuries: a histopathological review. *Br J Ophthalmol* 1980; **64**: 809–817.
- 7 Brinton GS, Aaberg TM, Reeser FH, Topping TM, Abrams GW. Surgical results in ocular trauma involving the posterior segment. *Am J Ophthalmol* 1982; **93**: 271–278.
- 8 De Juan E Jr, Sternberg P Jr, Michels RG. Penetrating ocular injuries: types of injuries and visual results. *Ophthalmology* 1983; **90**: 1318–1322.
- 9 Ramsay RC, Cantrill HL, Knobloch WH. Vitrectomy for double penetrating ocular injuries. *Am J Ophthalmol* 1985; **100**: 586–589.
- 10 Vatne HO, Syrdalen P. Vitrectomy for double perforating eye injuries. *Acta Ophthalmol* 1985; **63**: 552–556.
- 11 Martin DF, Meredith TA, Topping TM, Sternberg P Jr, Kaplan HJ. Perforating (through-and-through) injuries of the globe: surgical results with vitrectomy. *Arch Ophthalmol* 1991; **109**: 951–956.
- 12 Szijártó Z, Gaál V, Kovács B, Kuhn F. Prognosis of penetrating eye injuries with posterior segment intraocular foreign body. *Graefes Arch Clin Exp Ophthalmol* 2008; **264**: 161–165.
- 13 Kuhn F, Morris R, Mester V, Witherspoon CD, Mann L, Maisiak R. Epidemiology and socioeconomics. *Ophthalmol Clin North Am* 2002; **15**: 145–151.