Posterior Polar Ocular Perforating Injury

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Abstract

Posterior pole perforating ocular injury (PPPOI) is a special type of POI in which the exit wound is located at the posterior pole, and the suturing of the small exit wound is virtually impossible due to its location and associated bad outcomes. The most severe complications caused by PPPOI are the direct damages to the macular and optic nerve, or the sequelae of the intraorbital foreign body, that may result in the ultimate irreversible visual impairment or blindness. The important issues in regard to PPPOI management include timing of vitrectomy and the disposal of exit wound and intraorbital foreign body. These issues are discussed in more detail based on our experience in this case-series report. The main controversies of PPPOI treatment appeared to be focused on whether to suture posterior pole exit wounds and the removal of retained intraorbital foreign body. In this chapter, we report a case-series study in order to better illustrate the clinical features, surgical techniques as well as the relative prognostic factors of PPPOI.

Keywords

Posterior pole perforating ocular injury Emergency · Vitrectomy · Foreign body Suturing

11.1 Introduction

Perforating ocular injury (POI) refers to the presence of an entrance and an exit wound, and both wounds were caused by the same object. Although the incidence of POI has been shown to be 0.2–2.9% in open globe injuries, the injury typically resulted in severe ocular complications and poor prognosis [1–3]. One option for the treatment of PPPOI was to place an autologous tenon capsule patch in the posterior exit wound. One common postoperative complication of that treatment was subretinal membrane proliferations which then result in traction with fixed retinal folds around the patch [4]. In an attempt to achieve better treatment outcomes of PPPOI, we explored new ways and surgical techniques to deal with problems associated with the posterior pole exit wound, timing of vitrectomy, and management of the intraorbital foreign body. Most of the previ-

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ous POI studies were case reports with no in-depth analysis of the clinical characteristics, treatment approaches, prognosis, and relative risk factors in PPPOI [5–9]. The main controversies of PPPOI treatment appeared to be focused on whether to suture posterior pole exit wounds and the removal of retained intraorbital foreign body. In this chapter, we report a case-series study in order to better illustrate the clinical features, surgical techniques as well as the relative prognostic factors of PPPOI.

11.2 Definition

Posterior pole perforating ocular injury (PPPOI) is a special type of POI in which the exit wound is located at the posterior pole, and the suturing of the small exit wound is virtually impossible due to its location and associated bad outcomes.

11.3 Case (Brief Case Report Based on Figs. 11.1, 11.2, 11.3, and 11.4)

In this retrospective, noncomparative, and consecutive case series study, 22 patients with PPPOI who underwent combined vitrectomies in Tianjin Medical University General Hospital and Xiamen Eye Center from November 2010 to December 2019 were enrolled. In all 22 patients, 20 (90.9%) were male and 2 (9.1%) were female. The age ranged from 15 to 63 years old with an average of 41.5 ± 12.1 years. Twenty-one patients presented in the emergency within 24 h, and only one patient delayed 5 days after injury due to misdiagnosis in the local hospital. All patients had different levels of proliferative vitreoretinopathy (PVR) after PPPOI which included grade B in 8 eyes and grade C in 14 eyes. The follow-up period ranged from 1 month to 30 months with a mean of 6.7 ± 6.6 months.

The diagnosis and classification were performed according to Birmingham Eye Trauma Terminology System and Ocular Trauma Classification Group [10, 11]. Informed consent forms were obtained from all patients, and the approval of the Ethics Committee of Tianjin Medical University General Hospital and Xiamen Eye Center was carried out.

Clinical data including reasons of PPPOI, visual acuity, intraocular pressure (IOP), location and size of the entrance and exit wounds, concomitant damages of intraocular tissues, treatment, outcomes, and postoperative complications were collected from the Eye Injury Register of Tianjin Medical University General Hospital and Xiamen Eye Center in patients with PPPOI.

11.3.1 Case 1

Patient 1 with long iron nail penetrating the eye after posterior pole perforating ocular injury. (A, B) A 44-year-old man was injured by an iron nail on the right eye with the vision of hand movement, and the long iron nail penetrated the eye from the cornea to orbit confirmed by CT. (C) The slight exudates in the anterior chamber was observed 2 days after emergency surgery for suturing corneal wound. (D) A large amount of vitreous hemorrhage was observed by ocular B-scan ultrasonography. (E) The delayed vitrectomy was performed 10 days after primary surgery, and an exit wound was found proximity to fovea with hemorrhage overlying and sclera exposure during vitrectomy. (F, G) The injured cornea healed well, the scleral scar exposed at the posterior wound, and the optic nerve was atrophy 5 months after vitrectomy (white arrow). The final vision was finger counting at the last follow-up.

11.3.2 Case 2

Patient 2 with final retained intraorbital foreign body after posterior pole perforating ocular injury. (A) A 43-year-old man was injured by an iron dust on left eye during mechanical work with the vision of light perception. Slit-lamp examination revealed a 3 mm full-thickness irregular corneal laceration inferotemporal with iris incarcerated in the corneal wound. (B) The emergency orbital CT demonstrated a metallic foreign body in the orbit of the left eye. (C) The corneal wound healed well with posterior synechia of the iris 10 days after the emergency sur-

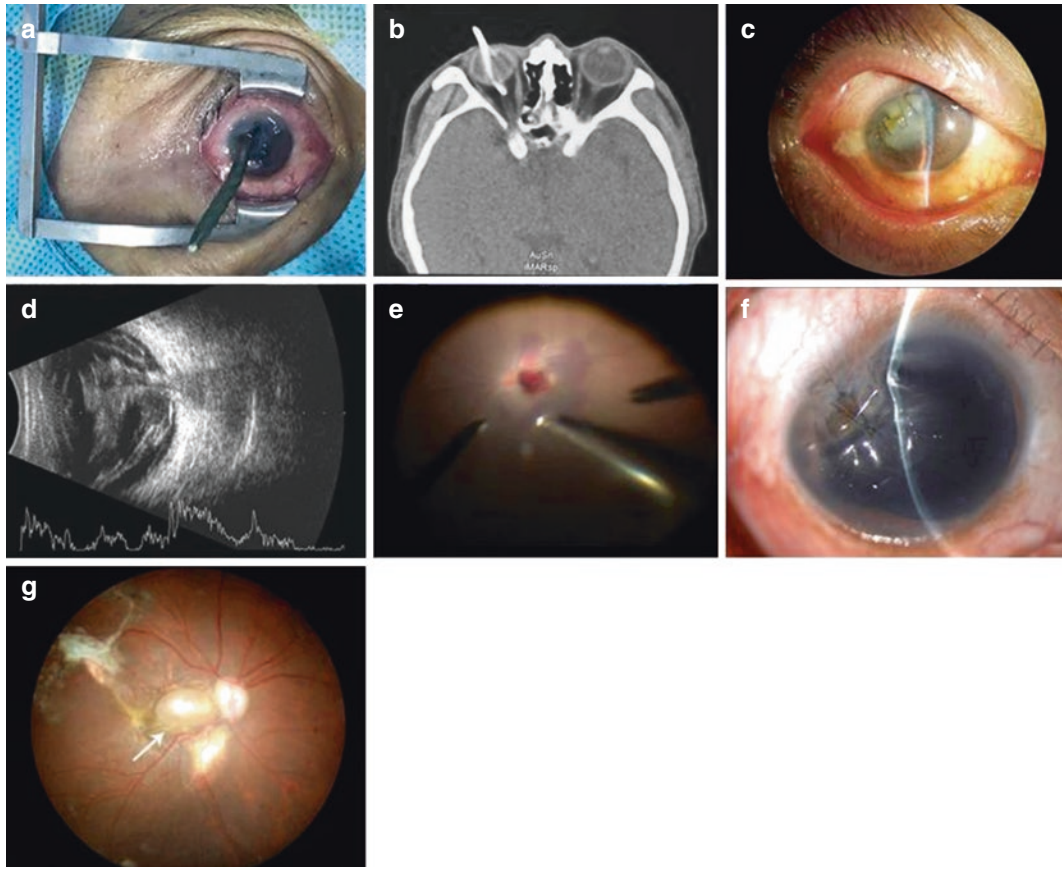

Fig. 11.1 (**a**, **b**) A 44-year-old man was injured by an iron nail on the right eye with the vision of hand movement, and the long iron nail penetrated the eye from cornea to orbit confirmed by CT. (**c**) The slight exudates in the anterior chamber was observed 2 days after emergency surgery for suturing corneal wound. (**d**) A large amount of vitreous hemorrhage was observed by ocular B-scan ultrasonography. (**e**) The delayed vitrectomy was performed 10 days after primary surgery, and an exit wound was found proximity to fovea with hemorrhage overlying and sclera exposure during vitrectomy. (**f**, **g**) The injured cornea healed well, the scleral scar exposed at the posterior wound, and the optic nerve was atrophy 5 months after vitrectomy (white arrow)

gery. (D) The dense vitreous hemorrhage was shown by an ocular B-scan examination. (E) Delayed vitrectomy was performed 11 days after primary surgery, and a self-sealed exit wound was observed inferotemporal to the fovea with hemorrhage overlying and partial sclera exposure during vitrectomy. (F, G, H, I) The injured cornea healed smoothly, the retina attached and the posterior wound healed with the scleral scar exposed (white arrow), the vitreous cavity was clear, and the foreign body lodged in the orbit without infection confirmed by orbital CT 5 months after vitrectomy. The final best-corrected visual acuity (BCVA) was 0.4.

11.3.3 Case 3

Patient 3 with final retained intraorbital foreign body after posterior pole perforating ocular injury. (A) A 23-year-old man was injured by an iron dust on right eye with the vision of no light perception. Slit-lamp examination revealed an 8 mm full-thickness irregular corneal laceration from 3:00 directly extending to 7:00, and was sutured closely in emergency surgery. (B) The emergency orbital CT demonstrated a metallic foreign body in the orbit of the right eye. (C) The dense vitreous hemorrhage was seen by ocular B-scan examination 12 days after repair-

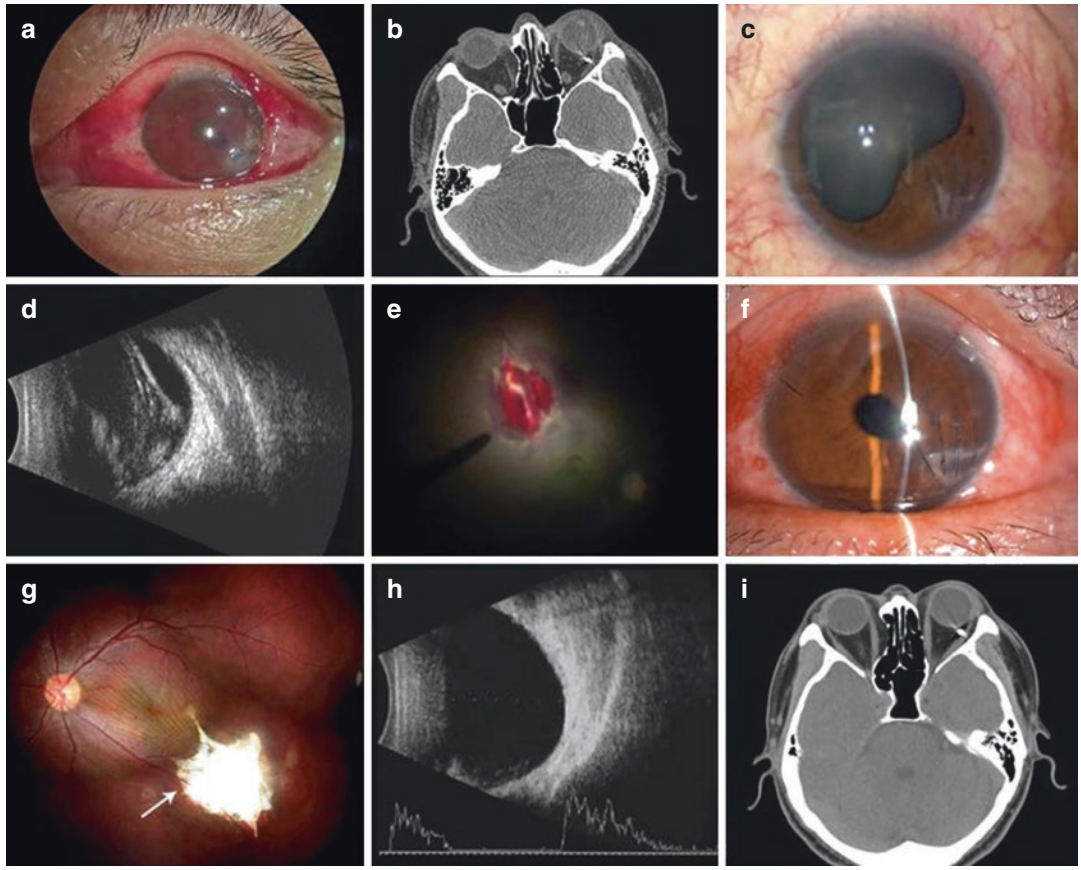

Fig. 11.2 (**a**) A 43-year-old man injured by an iron dust on left eye during mechanical work with the vision of light perception. Slit-lamp examination revealed a 3 mm full-thickness irregular corneal laceration inferotemporal with iris incarcerated in the corneal wound. (**b**) The emergency orbital CT demonstrated a metallic foreign body in the orbit of the left eye. (**c**) The corneal wound healed well with posterior synechia of iris 10 days after the emergency surgery. (**d**) The dense vitreous hemorrhage was shown by ocular B-scan examination. (**e**) Delayed vitrectomy was performed 11 days after primary surgery, and a self-sealed exit wound was observed inferotemporal to the fovea with hemorrhage overlying and partial sclera exposure during vitrectomy. (**f–i**) The injured cornea healed smoothly, the retina attached and the posterior wound healed with the scleral scar exposed (white arrow), the vitreous cavity was clear, and the foreign body lodged in the orbit without infection confirmed by orbital CT 5 months after vitrectomy

ing surgery. (D) Delayed vitrectomy was performed 13 days after primary surgery, and a self-sealed exit wound was observed proximity to fovea with hemorrhage covering and partial sclera exposure during vitrectomy. (E, F, G) The cornea was clear with neovascularization growing into the scar, the retina attached and the scleral scar exposed with the posterior wound healed (white arrow), and the retained orbital foreign body was stable without infection 30 months after vitrectomy. The final BCVA improved to 0.1.

11.3.4 Case 4

Patient 4 with an iron foreign body penetrating the eye after posterior pole perforating ocular injury. (A) A 26-year-old woman was injured by an iron foreign body in her right eye for 8 h on the right eye with the vision of no light perception. And the iron foreign body penetrated the eye from cornea to orbit confirmed by CT. (B) Slit-lamp examination revealed a 6 mm full-thickness irregular corneal laceration from 4:00 directly extending to 6:00, and was

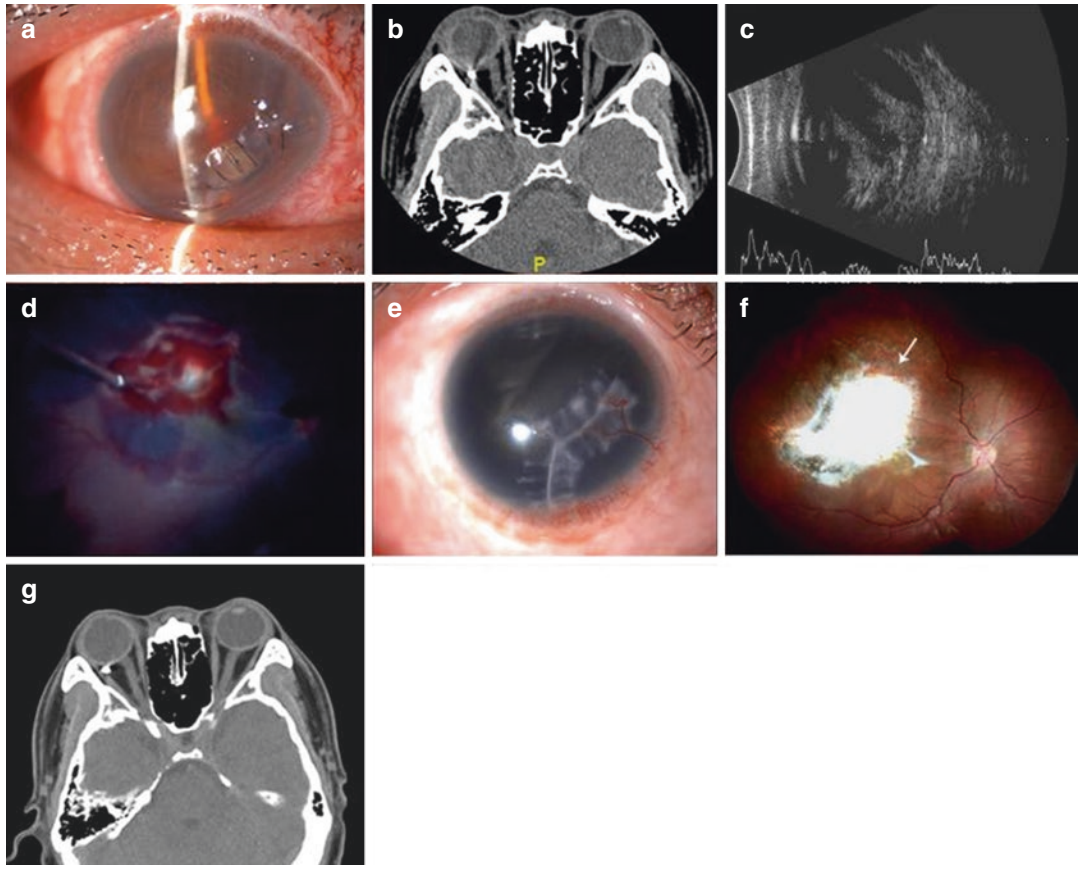

Fig. 11.3 (**a**) A 23-year-old man was injured by an iron dust on right eye with the vision of no light perception. Slit-lamp examination revealed an 8 mm full-thickness irregular corneal laceration from 3:00 directly extending to 7:00, and was sutured closely in emergency surgery. (**b**) The emergency orbital CT demonstrated a metallic foreign body in the orbit of the right eye. (**c**) The dense vitreous hemorrhage was seen by ocular B-scan examination 12 days after repairing surgery. (**d**) Delayed vitrectomy was performed 13 days after primary surgery, and a self-sealed exit wound was observed proximity to fovea with hemorrhage covering and partial sclera exposure during vitrectomy. (**e**–**g**) The cornea was clear with neovascularization growing into the scar, the retina attached and the scleral scar exposed with the posterior wound healed (white arrow), and the retained orbital foreign body was stable without infection 30 months after vitrectomy

sutured closely after emergency surgery. (C) The dense vitreous hemorrhage was shown by ocular fundus examination. (D) The vitreous hemorrhage was cleared 2 weeks after a delayed vitrectomy was observed by ocular B-scan ultrasonography. (E) The foreign body was removal confirmed by CT. The final BCVA improved to 0.4. (F) The fundus image obtained 2 months after removement of the FB. The retina was attached and fibrous membrane tied to the injured retina.

11.4 Important Signs, Examinations, Diagnosis, Surgical Procedures, or Postoperative Treatment for Complications

11.4.1 Pre- and Post-operative Examinations and Diagnosis

The diagnosis and classification were performed according to Birmingham Eye Trauma

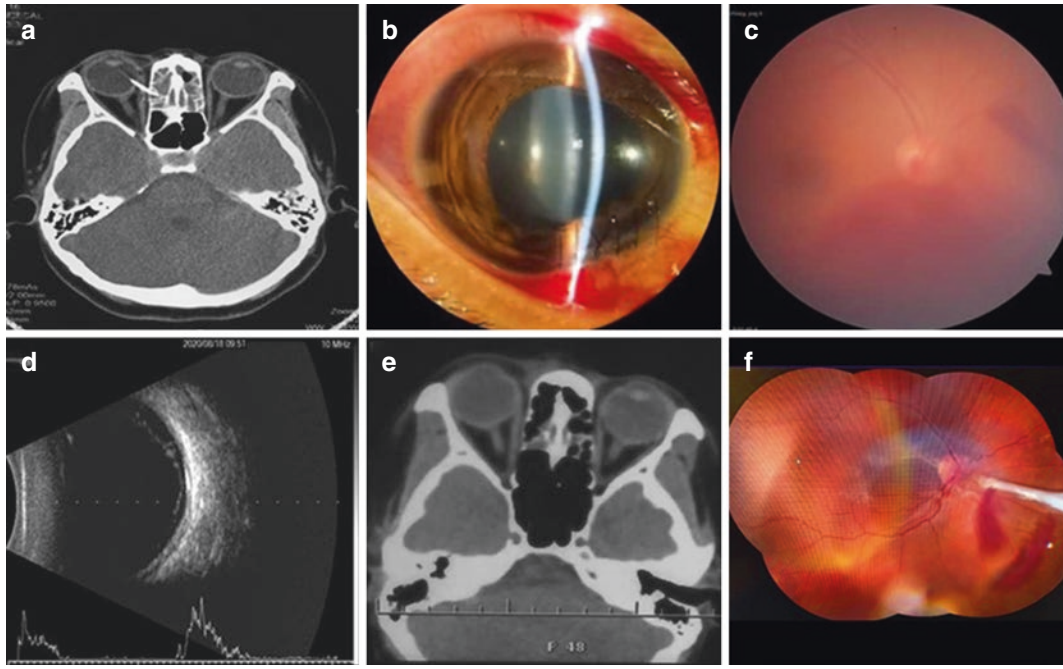

Fig. 11.4 (**a**) A 26-year-old woman was injured by an iron foreign body in her right eye for 8 hours on right eye with the vision of no light perception. And the iron foreign body penetrated the eye from cornea to orbit confirmed by CT. (**b**) Slitlamp examination revealed an 6 mm full-thickness irregular corneal laceration from 4:00 directly extending to 6:00, and was sutured closely after emergency surgery. (**c**) The dense vitreous hemorrhage was shown by ocular fundus examination. (**d**) The vitreous hemorrhage was cleared two weeks after a delayed vitrectomy observed by ocular B-scan ultrasonography. (**e**) The foreign body was removal confirmed by CT

Terminology System and Ocular Trauma Classification Group [10, 11]. The pre- and postoperative examinations mainly included visual acuity, slit-lamp examination, ocular fundus, and IOP. Ocular computerized tomography (CT) scanning was performed in all eyes for determining the foreign body before repairing surgeries in an emergency. Ocular B-scan ultrasonography was carried out to identify the changes of the posterior segment after the entrance wound sutured.

11.4.2 Surgical Procedures

11.4.2.1 Emergency Repairing Surgery

The emergency repairing surgery was performed under local anesthesia by retrobulbar and peribulbar injections of 2% lidocaine (Tianjin Jinyao Pharmaceutical Company, Tianjin, China) in all PPPOI patients. In cases of uveal prolapse, an attempt was made to reposit the uveal tissue after irrigation with balanced salt solution. The globe was then closed and secured with nylon suture. The orbital foreign bodies were removed by an electromagnet in three eyes just after the wound closure, and the foreign bodies across the eyewall were directly removed by forceps in two eyes (Fig. 11.1). Prophylactic intravitreal injection of vancomycin (Eli Lilly Italia S.P.A, Italy) 1 mg/0.1 ml was administered at the end of the repairing surgery to prevent the occurrence of endophthalmitis. Systemic antibiotics was given for 3 days postoperatively, and antibiotic combined with corticosteroid eye drops were used three times a day for 1 week postoperatively. The postoperative ocular examinations were performed routinely every day for 1 week.

11.4.2.2 Timing of Vitrectomy

The average interval time from primary repairing surgery to delayed vitrectomy was 9.8 ± 5.3

days with a range from 1 to 21 days. Only one patient received early vitreoretinal surgery 1 day after repairing surgery for traumatic endophthalmitis, and two eyes for suspicious intraocular foreign bodies.

11.4.2.3 Vitrectomy

All 23-gauge vitrectomies were performed under local anesthesia. Anterior segment reconstruction was performed by removal of papillary membranes, lenticular remnants and condensed anterior vitreous. After the vitreous hemorrhage had been excised, the retinal tissue and posterior wound were exposed, and 0.1 ml triamcinolone acetonide (TA) (40 mg/ml, Kungming Jida pharmaceutical company, Kung Ming, China) was injected into eyes to clearly visualizing the tiny residual vitreous gel and proliferative membranes [12, 13]. The hemorrhage and proliferation on the surface of the posterior wound were dissected carefully and completely by a vitrectomy cutter. In eyes with the retina incarceration or retinal rugosity at the exit wound, prophylactic retinectomy was performed to avoid the postoperative PVR and tractional retinal detachment [14, 15]. Laser photocoagulation was not applied routinely if the retina around the posterior wound self-sealed and attached well; otherwise, it was conducted after air-fluid exchange. In patients with concomitant retinal tears besides the posterior wound, laser was performed simultaneously. Intravitreal reinjection of 0.1 ml TA (40 mg/ml) was performed to prophylactic inhibition of proliferation at the end of the surgery. Silicone oil was instilled in eyes with retinal detachment. The orbital foreign bodies were taken out by electromagnet in four eyes intraoperatively. Patients with silicone oil filling were instructed to keep face-down position for 2 weeks. In all patients, 18 eyes (81.8%) filled with silicone oil, 2 (9.1%) filled with C3F8, 2 (9.1%) with the balanced salt solution according to the retinal status. The antibiotic and corticosteroid eye drops were used three times a day for 1 week postoperatively. Follow-up was performed daily during the first postoperative week, then every week for 1 month, and every 3 months up to 1 year after surgery. Follow-up visits then were performed every 6–12 months. Silicone oil removal was usually performed around 3 months postoperatively, and the intraocular lens (IOL) implantation was considered simultaneously if best-corrected visual acuity (BCVA) was better than 0.1 [16].

For the 19 patients complicated with traumatic cataract, 15 eyes underwent lensectomy, 4 eyes underwent phacoemulsification simultaneously during vitrectomy, and 2 eyes performed secondary IOL implantation after 5–6 months. Laser photocoagulation was applied in 11 eyes around the posterior wound due to the local retinal detachment among which 2 eyes had prophylactic retinectomy.

11.4.3 Characteristics of Wounds in Posterior Pole Perforating Ocular Injury

The entrance wounds were located on the cornea in 10 eyes (45.5%), on the sclera in 5 eyes (22.7%), on the limbus in 2 eyes (9.1%), and across the cornea and sclera in 5 eyes (22.7%). The average length of the entrance wound was 4.7 ± 1.3 mm with a range from 3 to 8 mm. Iris laceration was observed in four eyes (18.2%).

The detailed information of the exit wounds was documented during the vitrectomy. After removing the posterior vitreous cortex, the posterior wounds appeared covered with a large amount of blood and little fibrous membranes. When the hemorrhage and proliferative membrane around the irregular retinal wound were carefully cleared away, the irregular exit wound presented with a scleral scar covered. The unsutured posterior wound sealed very well without any leakages except in two eyes with early vitrectomies (Figs. 11.1, 11.2, and 11.3). The average length of the posterior wound was 2.5 ± 0.7 papilla diameter (PD) with a range of 1–4 PD. The posterior wounds located at the fovea in 4 eyes (18.2%), proximity to the fovea in 8 eyes (36.4%), and others in 10 eyes (45.5%).

The posterior wound leakage was only found in two eyes who underwent early vitrectomy 1 day after primary surgeries for removing the sus-

picious intraocular foreign bodies, and the immediate air-fluid exchange was conducted to prevent further leakage and waited for the delayed vitrectomy.

11.4.4 Visual Acuity

The BCVA ranged from no light perception (NLP) to 0.12 in all eyes after PPPOI. It was 0.12 in one eye, 0.06 in one eye, finger counting (FC) in two eyes, hand movement (HM) in six eyes, light perception (LP) in eight eyes, and NLP in four eyes. Postoperatively, the final BCVA ranged from NLP to 0.6. The vision improved in 14 of 22 eyes (63.6%), remained stable in 5 eyes (22.7%), and decreased in 3 eyes (13.6%). In 19 eyes with traumatic cataracts, only 2 eyes received secondary IOL implantation 5–6 months after vitrectomy, and the BCVA improved from 0.06 to 0.6 and from HM to 0.4 respectively with IOLs well-centered at the last visit.

11.4.5 Management of Intraorbital Foreign Bodies

Of the 18 eyes with intraorbital foreign bodies, the foreign bodies were extracted by an electromagnet in 3 eyes (16.7%) during primary surgery, and in 4 eyes (22.2%) during delayed vitrectomy, and retained in 11 eyes (61.1%) for hard to be removed.

11.4.6 Anatomic Outcomes

The irregular corneal and scleral wounds healed well. All eyes (100%) had a final retinal attachment. Four eyes (18.2%) had recurrent retinal detachments which underwent successful repeat vitrectomies. Scar tissue with the flat edge of the attached retina exhibited around the posterior wound in all eyes (100%) (Figs. 11.1, 11.2, and 11.3). The posterior wounds healed in all cases.

11.4.7 Intraocular Pressure

The mean postoperative IOP was 12.0 ± 3.7 mmHg with a range from 7.1 to 20 mmHg at the final follow-up. There was no hypotony or elevated IOP.

11.4.8 Comparisons of Factors Related to the Final Vision

Fisher's exact test was used to analyze the factors related to a postoperative vision which included age, presenting vision, iris laceration, hyphema, the anterior wound site and size, the posterior wound site, traumatic cataract, PVR, timing of vitrectomy, and situation of foreign bodies. The result illustrated that the posterior wound located in the fovea ($P = 0.0000$) and PVR at Grade C ($P = 0.0001$) were the related factors to final poor vision.

11.4.9 Postoperative Complications

The postoperative complications mainly included secondary glaucoma and optic nerve atrophy in one eye (4.5%), and recurrent retinal detachment in four eyes (18.2%) which were required repeat vitrectomies. There was no incidence of infection in retained intraorbital foreign body cases. No cases of endophthalmitis and sympathetic ophthalmia were noted.

11.5 Personal Experience or Matters Need Attention

The most severe complications caused by PPPOI are the direct damages to the macular and optic nerve, or the sequelae of the intraorbital foreign body, that may result in the ultimate irreversible visual impairment or blindness. The important issues in regard to PPPOI management include timing of vitrectomy and the disposal of exit wound and intraorbital foreign body. These issues are discussed in more detail based on our experience in this case-series report.

11.5.1 Timing of Vitrectomy

The purpose of primary surgery is to restore the structural integrity of the globe as early as possible and to prevent endophthalmitis and further prolapse of intraocular contents in treating POI. We had performed all emergency surgeries within 24 h except one delayed surgery for 5 days due to the misdiagnosis of outside referring hospital. Vitrectomy plays a crucial role in treating POI. Although the optimal timing of vitrectomy remained controversial for the treatment of ocular trauma, most of the surgeons advocated an interval time of 7–14 days to prevent severe intraocular hemorrhage, inflammatory reaction, and overwhelmed PVR formation [17, 18]. Therefore, the factors such as exit wound healing and avoiding PVR formation should be considered when PPPOI was treated with vitrectomy. In our study, the mean interval time between primary surgery and delayed vitrectomy was 9.8 ± 5.3 days. All 23-gauge vitrectomies were performed under local anesthesia, due to the posterior wound healed around 1 week after primary surgery. The prompt vitrectomy has resulted in better clinical outcomes of exit wound healing and less severe PVR formation.

11.5.2 Dealing with the Scleral Wound

Is the suturing of a small exit wound necessary in PPPOI? Usually, the wound of the eyewall should be sutured in time to prevent endophthalmitis or sympathetic ophthalmia in open globe injures [19, 20]. However, suturing the exit wound is a technical challenge in PPPOI due to the unique location at the posterior pole of the eye. The improper management of the exit wound may result in secondary devastating sequels such as traction damage of the optic nerve, more prolapse of intraocular contents, or even rapid collapse of the globe. It is often necessary to temporarily dissect rectus muscles and overstretch the globe to suture the exit wound which will then cause possible intraocular hemorrhage and prolapse of intraocular contents. Since most of the posterior wound is small, it is possible to heal without suturing by pinning of the orbital tissue. Therefore, we recommend that suturing of the small exit wound is not necessary during emergency surgery and vitrectomy. In our study, the average size of the exit wound was 2.5 ± 0.7 PD and was not sutured in all eyes without any evidence of postoperative hypotony.

The posterior wound healed very well without any leakages in non-sutured eyes around 1 week after primary surgery. We observed the exit retinal wound sealed spontaneously with the sclera exposed and retina attached during vitrectomy. The possible mechanism of exit wound healing was the effect of pinning from intraorbital tissue on the sclera side. The blood clot and inflammatory reaction at the posterior wound easily allow for the tissue adhesion of retina, RPE, and sclera by associated factors of platelet-derived growth factor (PDGF), transforming growth factor (TGF), insulin-like growth factor (IGF), vascular endothelial growth factor (VEGF) released by the activated platelet [21].

11.5.3 A Special Paragraph to Discuss the Specific Challenges

Vitrectomy for PPPOI is a great challenge in consideration of the potential leakage from the exit wound, disposal of exit retinal wound and possible intraoperative bleeding, and use of tamponade and laser photocoagulation.

The intraoperative IOP should be controlled normally during and at the end of vitrectomy so as to avoid the wound dehiscence and leakages of intraocular fluid or tamponades from the posterior wound. Yonekawa [22] suggested to keep IOP < 30 mmHg during POI vitrectomy. Kuhn [23] considered only about a half or two-thirds silicone oil tamponade that the eye would usually require is sufficient in order to manage the dehiscence of exit wound temporarily and timely suspending surgery is always needed at this time.

The complete posterior vitreous detachment (PVD) during vitrectomy is indispensable for the cause of the vitreous remnants could potentially

provide a scaffold for fibroblastic proliferation in open globe injuries [24]. However, the vacuum of vitrectomy should be controlled very well to avoid the excessive traction at the retinal wound that makes the healed retina reopened during PVD. Sufficient shaving of the hemorrhage and epiretinal proliferation should be conducted from the peripheral to the center around the exit retinal wound area until the sclera and the edge of retina tear are exposed.

The laser photocoagulation was unnecessary in PPPOI patients with already attached retina around the exit wound during vitrectomy; otherwise, it should be applied. The reason is that the superfluous laser exacerbates intraocular cellular proliferation around the exit retinal wound that could induce possible traction or damage to the retina. In the present study, 11 eyes (50%) appeared local retinal detachment or elevated retinal margins around the exit retinal wounds, and endolaser were applied. However, the posterior wounds showed scar tissue with flat retina edge and without leakage and hypotony in eyes without laser photocoagulation at the final visit. As we know from previous studies, laser photocoagulations at the attached exit retina site are controversial [25–27].

TA was used in all eyes in our study for preventing post-traumatic PVR. Usually, intravitreal TA injection during vitrectomy can assist the completed PVD, hemostasis, and staining the tiny remaining vitreous and proliferative membrane on the retina, which is helpful to facilitate the vitrectomy procedure [13]. With the use of TA during vitrectomy, the successful rate of retina attachment was 81.8% after one vitrectomy procedure in this study.

Traumatic PVR is a crucial cause for visual loss of the severely injured eye and also leads to the anatomical loss of the eyeball. In PPPOI patients with retina incarceration or retinal rugosity at the exit wound, prophylactic chorioretinectomy was performed to prevent the development of PVR that could result in tractional retinal detachment [14, 15]. There were two eyes that received retinectomy at the exit retinal wound in our study, and the outcomes were favorable with the retina attached.

The intraorbital foreign body is not always removed due to its special position in some of the POI patients. Fulcher [28] established a simplified but comprehensive protocol, when complications of strabismus, infection, or fistula formation arise, the surgery should be performed. The severity of intraorbital foreign body complications is highly depending on the location, material, and size. Therefore, long-term follow-up of the complications relative to intraorbital foreign body retaining is needed. Foreign bodies like metal or glass are well tolerated, and it may be left in situ if not causing any abnormal symptoms or signs [29]. However, organic matters like wood and vegetable are poorly tolerated and liable to elicit fungal infection which should be removed as soon as possible [28, 30–34]. In this series of cases, 11 eyes without removal of the intraorbital iron foreign body received close follow-up, and there was no endophthalmitis, orbital abscess, or orbital cellulitis finally.

Investigations on the risk factors associated with poor visual outcomes in PPPOI is of great importance which can predict the prognosis and provide some suggestion on the management of PPPOI. Our results indicated that the risk factor of poor postoperative vision is the site of exit retinal wound and PVR though this is not a study on a large sample. That means the closer the posterior wound is located to the fovea, the worse vision will be. In our study, four eyes (18.2%) had a retinal wound at fovea with the final vision of NLP. So far, few studies focus on the prognosis of PPPOI. Marcus's study concluded that both sites of entrance and exit wounds were the best predictors of functional and anatomic success in their patients [35].

PPPOI usually resulted in the worst prognosis due to damage of the macular and optic nerve [36]. By using our innovative surgical technique such as non-suturing of a small posterior scleral wound and without laser photocoagulation at the attached retinal wound, we achieved an encouraging outcome of 63.6% eyes with improved vision and 36.4% eyes with BCVA 0.1 or better. There was no endophthalmitis, sympathetic ophthalmia, hypotony or phthisis eventually. These outcomes compare favorably to the previous

reports [6, 7, 35]. In this present study, we also performed the treatment of four eyes with NLP, and final vision was 0.1 in one eye, and hand movement in one eye.

To our knowledge, there are few previous studies on detailed analysis of the clinical features, surgical interventions and prognosis of PPPOI in the Chinese population. Although our study is a small sample size case-series report and limited because of the heterogeneity of surgical management options, we draw a limited conclusion that combined vitrectomy is a safe and effective method in PPPOI without suturing the small exit wound. Further studies on a larger scale with longer follow-ups are warranted in order to confirm our findings.

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