7 Choroidal and Retinal Detachment Combined with Cyclodialysis in Open Globe Injury

Su Jin Park and Dong Ho Park

Abstract

Open globe injury (OGI) is defined as a full-thickness defect of the cornea or sclera. Depending on the severity of the trauma, the involvement of vitreoretinal lesion varies, and examination may be difficult. Therefore, to better understand the patient's severity before surgery, various examination methods such as computed tomography, B-scan ultrasonography, gonioscopy, and anterior segment optical coherence tomography should be appropriately used. In most cases of OGI, the primary suture is performed immediately after the trauma, and the secondary surgery is planned. In this chapter, we reviewed the retinal detachment, choroidal detachment, and cyclodialysis that could accompany open globe injury and summarized the diagnosis, treatment and post-operative complications.

Keywords

Open globe injury · Choroidal detachment
Cyclodialysis · Retinal detachment

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7.1 Introduction

Ocular trauma causing open globe injury (OGI) is an important cause of vision loss, and more than 200,000 OGI occur worldwide every year [1]. In OGI, vitreoretinal involvement causes significant vision loss or blindness. However, depending on the severity of the trauma, the examination may be difficult, especially predicting hidden wounds. Therefore, in this chapter, among the various event that may accompany OGI, we will discuss particularly retinal detachment (RD), choroidal detachment, and cyclodialysis.

7.2 Definition

According to the Birmingham Eye Trauma Terminology (BETT) criteria [2], an OGI is defined as a full-thickness defect of the cornea or sclera. According to the injury mechanism, the OGI is divided into ruptures or lacerations: ruptures are caused by blunt objects and lacerations are caused by sharp ones. Lacerations are further subdivided into *penetrating* injury, *intraocular foreign body* (IOFB) injury, and *perforating* injury. A penetrating injury has only an entrance wound, an IOFB injury has an entrance wound and a retained IOFB, and a perforating injury has an entrance and an exit wound. According to the location relative to the limbus, injuries are

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divided into three zones: a zone I injury is isolated to the cornea (including the limbus), a zone II injury involves the sclera no more than 5 mm posterior to the limbus, and a zone III injury involves the sclera more than 5 mm posterior to the limbus [3].

Severe globe rupture caused incarcerated retina to the lesion site. The residual retina was detached and funnel-like detachment will result in poor visual acuity and severe proliferative vitreoretinopathy (PVR). Retinal dialysis is the most common cause of traumatic RD. Retinal tears are the second-most common predisposing lesion, responsible for about 20% of the traumatic RD [4].

A cyclodialysis cleft is the most common complication in closed globe injuries, with an incidence of 1–11% [5]; it occasionally occurs in open globe injuries and iatrogenic injuries. A cyclodialysis is the disinsertion of the longitudinal ciliary muscle fibers from the scleral spur resulting in a cleft [6]. One of the consequences of cyclodialysis is the opening of communication between the anterior chamber and the suprachoroidal space. Then, ocular hypotony occurs, which is accompanied by choroidal detachment and chorioretinal folds, which affect the macula and cause visual loss [7].

A choroidal detachments are rare conditions that occur when there is an accumulation of fluid or blood in the suprachoroidal layer, located between the choroid and sclera [8]. The pathogenesis of traumatic ciliochoroidal detachment is an increase in the permeability of the ciliary vessels after blunt injury, leading to extravascular leakage of the plasma components [9].

7.3 Case

A 43-year-old male visited the emergency room because of a traumatic right eye injury by a metal hook. The initial best-corrected visual acuity (BCVA) was hand motion (HM) in the right eye and 20/50 in the left eye. Slit-lamp examination showed that scleral laceration of about 1 cm or more in length and uveal and vitreous tissues prolapsed from the lesion site. The anterior chamber was collapsed, and iris defect was accompanied from 12 to 3 o'clock (Fig. 7.1). Since fundus was not visible, B-scan ultrasonography and computed tomography (CT) were additionally performed (Figs. 7.2 and 7.3). B-scan and CT showed hemorrhagic choroidal detachment and no IOFB.

Under the diagnosis of scleral laceration with iridodialysis and suprachoroidal hemorrhage, the patient had an emergency operation. After uveal reposition, the scleral wound was sutured with 8-0 ethilon, and the anterior chamber was irri-

Fig. 7.1 Slit-lamp photograph of the right eye. Scleral laceration with prolapse of vitreous and uveal tissue on the nasal side of the eye

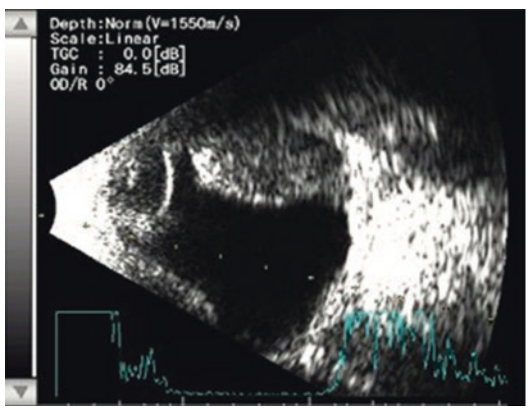

Fig. 7.2 B-scan ultrasonography showed hyperechogenic lesions in the suprachoroidal space, indicating hemorrhagic choroidal detachment

gated with antibiotics, including vancomycin and ceftazidime.

At 1 month after the surgery, though suprachoroidal hemorrhage disappeared on the B-scan, the fundus was not observed due to traumatic cataract, and visual acuity was HM (Fig. 7.4). The second operation of cataract surgery was completed by putting the intraocular lens in the bag with normal fundus findings. One month after the second surgery, BCVA was 20/100 in the right eye.

Fig. 7.3 Axial computed tomography of paranasal sinuses. Hyperdense lesions involving the periphery of the right orbit, but with sparing the posterior third on the axial image

7.4 Important Signs, Examinations, Diagnosis, Surgical Procedures, and Postoperative Treatment for Complications

Due to the severe pain, clinical examination of traumatic injuries is more difficult than other diseases. The factors that make the posterior segment examination difficult are as follows: anterior segment injury, including hyphema, corneal edema, or opacification, and posterior segment pathology, including vitreous hemorrhage.

7.4.1 Important signs

The OGI is accompanied by many signs, including hyphema, which is the most common sign on admission (76.7%), iris prolapse (57.9%), vitreous hemorrhage (52.2%), laceration on the eyelid and/or eyebrow (34%), and retinal detachment (29.6%) [10]. Hongsheng et al. reported that among the patients with rupture injuries, 17.3% had a ciliary injury, 62.7% had choroidal injuries, and ciliary and choroidal injuries were both detected in 20% of patients[11].

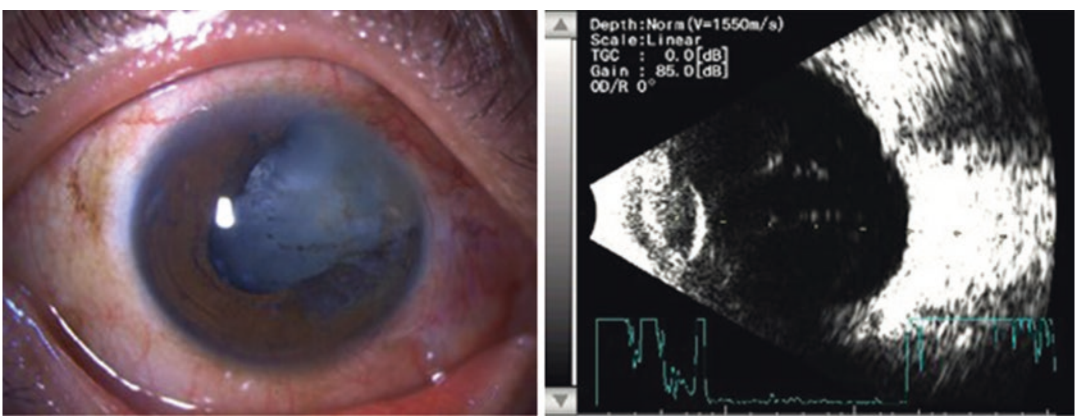

Fig. 7.4 Slit-lamp photograph and B-scan ultrasonography image 1 month after surgery. Traumatic cataract and iris defects are seen on a slit-lamp examination, and posterior vitreous detachment is confirmed by B-scan

7.4.2 Examination and Diagnosis

7.4.2.1 Slit-Lamp Examination

When patients with trauma visit, the slit-lamp examination is performed first. At this time, damage to the vitreoretinal area should be suspected if there are signs such as severe hemorrhagic chemosis, shallow anterior chamber, prolapsed uvea and vitreous, and eccentric pupil.

7.4.2.2 Computed Tomography

The CT scan should be performed to determine the IOFB and occult OGI. In case of traumatic ocular injury, the findings that can be observed on CT are as follows: change in globe contour, volume loss, intraocular air, change in anterior chamber depth, dislocated or absent lens, vitreous hemorrhage, and retinal or choroidal detachment [12].

Ora serrata is an inferred reference point in distinguishing between RD and choroidal detachment on imaging. On the axial plane, ora serrata is located at the 2 and 10 o'clock position of the globe immediately posterior to the ciliary bodies [13].

RD with bilateral V-shaped leaflets converging towards the optic disc. Importantly the anterior margin of the leaflets does not extend beyond the ora serrata reference point at the 2 and 10 o'clock position. However, choroidal detachment with convex lens shape leaflets anteriorly extending beyond the ora serrata reference point and posteriorly limited by insertions of the vortex veins [14].

7.4.2.3 B-Scan Ultrasonography

B-scan ultrasonography is an important diagnostic tool for providing information on diagnosis and prognosis in OGI. In particular, RD and choroidal detachment are mainly diagnosed by B-scan ultrasonography when the funduscopic examination is not possible due to hemorrhage. In OGI, the first b-scan is performed the day after primary closure of the globe due to ocular instability. However, most retinal detachments (53%) were not diagnosed until a week after the trauma. Considering the delayed occurrence of RD, careful follow-up is necessary after the primary closure of the OGI [15].

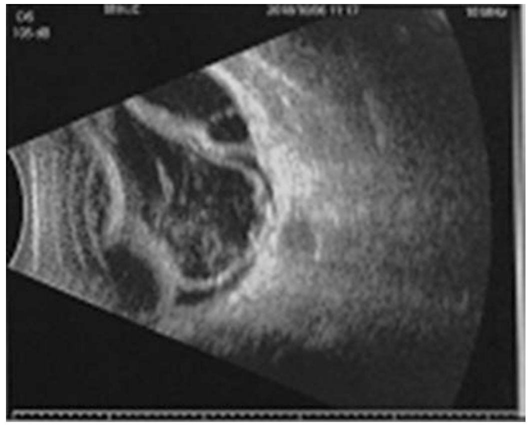

Fig. 7.5 Choroidal detachment with retinal detachment in B-scan ultrasonography. By courtesy of professor Hua Yan from Tianjin Medical University, China

In partial detachment, thin and mobile linear echogenic membrane is observed and usually extends to the optic nerve head, but not across it. In the case of total RD, it is observed in the vitreous cavity in a "V" shape because the retina is attached to the ora serrata anteriorly and the optic nerve head posteriorly. On the other hand, thick and rigid echogenic bands are observed in the choroidal detachment and protrude convexly into the vitreous. These end at the level of the exit foramina of the vortex veins and do not extend to the optic disc [16] (Fig. 7.5).

7.4.2.4 Gonioscopy, Ultrasound Biomicroscopy and Anterior Segment Optical Coherence Tomography

A slit lamp gonioscopy is useful in cases with clear media. However, cyclodialysis clefts are often missed gonioscopically for various reasons such as hyphema, iris bowing, extreme hypotony, distorted anatomy or Descemet's folds [17, 18]. Ultrasound biomicroscopy (UBM) has been described in these situations as supplementing gonioscopic findings. UBM is a noninvasive method that uses high-frequency (50–60 MHz) transducers to image anterior segment structures [19] (Fig. 7.6).

However, since UBM also requires an anesthetic gel and needs to be in contact with the patient's eyes, it is difficult to use immediately

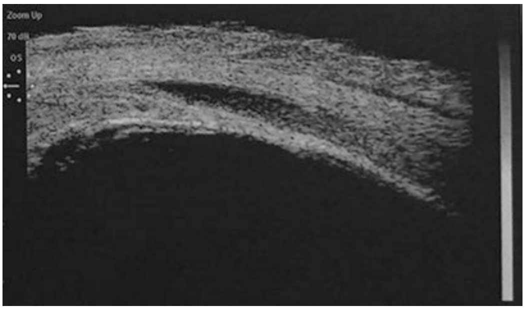

Fig. 7.6 A cyclodialysis cleft confirmed by ultrasound biomicroscopy. Expansion of suprachoroidal space due to detachment of the ciliary body. By courtesy of professor Hua Yan from Tianjin Medical University, China

after OGI. Therefore, in open injuries, anterior segment optical coherence tomography (AS-OCT) can be usefully used in that contact is not required. AS-OCT provided high-resolution images of iridocorneal angle abnormalities in the presence of abnormal anterior segment anatomy [20].

7.4.3 Treatment

Multiple operations are required for patients with OGI. In the open-wound state, the eye is soft, and the intraocular tissues are mostly prolapsed. Therefore, first, primary suture and intraocular tissue reposition are required. The prolapsed iris and choroid should be repositioned after complete irrigation, and the prolapsed vitreous body can be removed.

The second surgery is usually planned according to the condition of the eye after the first emergency surgery. Because the OGI is characterized as a multiple damaged state, meticulous and thorough examinations at each step are required to plan the most effective and the least invasive surgery.

7.4.3.1 Treatment for Retinal Detachment and Choroidal Detachment

In most cases, patients with OGI underwent primary closure immediately. However, the timing of vitreoretinal intervention is varied. In addition, the type of vitreoretinal intervention varies depending on the condition of the eye. Several authors report early vitreoretinal intervention to be performed between 3 and 14 days after OGI [21–26]. In animal study, posterior vitreous detachment occurred at 1–2 weeks after injury, and retinal detachment occurred between 7 and 11 weeks [27]. In a histological study, PVR formation was found between 1 and 2 weeks after severe penetrating trauma in eyes with an RD [28]. Therefore early vitreoretinal intervention reduces the risk of the formation of extensive PVR

7.4.3.2 Cyclodialysis Treatment

Cyclodialysis in small sizes can be treated with medical management such as 1% atropine or laser photocoagulation. If medical or laser treatment does not respond, several surgical treatments can be considered: transscleral diathermy, cryotherapy, and direct cyclopexy [17]. The principle of surgical repair includes the obliteration of the cyclodialysis space and apposition between the sclera and the wall of the ciliary body [29].

Recently, several reports have proposed alternative novel techniques. Portney and Purcell proposed the idea of anterior buckling using a silicone rod under a partial thickness scleral flap [30]. Meanwhile, methods of using a capsular tension ring (CTR) or haptics of large IOLs for internal apposition (internal cerclage) of the ciliary body to sclera have been reported [31–33].

7.4.4 Postoperative Treatment for Complication

There are several postoperative complications of OGI repair. The delayed presentation was an important risk factor for endophthalmitis, microbial keratitis and postoperative wound leak [34]. Possible complications can be divided according to the anatomical wound position. Traumatic cataracts and corneal scarring were the most prevalent vision-limiting complications in patients with zone I (cornea-only) lacerations. The most common vision-limiting factors in eyes with zones II and III lacerations (involving sclera) were cataracts and RD detachments [35].

Several studies reported complications following vitreoretinal surgery for traumatic RD. Surgery mostly accompanies cataracts in the phakic eyes [36–38]. Secondary glaucoma was also a significant complication and, in some cases, required surgical intervention [39, 40]. Patients developed phthisis bulbi, with up to 30% of patients experiencing this complication in certain studies [36, 39, 41–43]. PVR was a significant finding postoperatively, as it was found in up to 56% of patients [40–43].

Very high IOP may follow after successful cyclodialysis cleft surgery. In most cases, the IOP can be controlled through medical treatment, and long-term treatment is not usually required if glaucoma has not been present [29].

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References

1. Négrel AD, Thylefors B. The global impact of eye injuries. Ophthalmic Epidemiol. 1998;5(3):143–69. https://doi.org/10.1076/opep.5.3.143.8364.
2. Kuhn F, Morris R, Witherspoon CD. Birmingham Eye Trauma Terminology (BETT): terminology and classification of mechanical eye injuries. Ophthalmol Clin N Am. 2002;15(2):139–43, v. https://doi.org/10.1016/s0896-1549(02)00004-4.
3. Pieramici DJ, Sternberg P Jr, Aaberg TM Sr, Bridges WZ Jr, Capone A Jr, Cardillo JA, et al. A system for classifying mechanical injuries of the eye (globe). The Ocular Trauma Classification Group. Am J Ophthalmol. 1997;123(6):820–31. https://doi.org/10.1016/s0002-9394(14)71132-8.
4. Sheard RM, Mireskandari K, Ezra E, Sullivan PM. Vitreoretinal surgery after childhood ocular trauma. Eye (London, England). 2007;21(6):793–8. https://doi.org/10.1038/sj.eye.6702332.
5. Grosskreutz C, Aquino N, Dreyer EB. Cyclodialysis. 1995;35(1):105–9.
6. Ormerod LD, Baerveldt G, Sunalp MA, Riekhof FT. Management of the hypotonous cyclodialysis cleft. Ophthalmology. 1991;98(9):1384–93. https://doi.org/10.1016/S0161-6420(91)32121-3.
7. Cerio-Ramsden CD, Muñoz-Negrete FJ, Rebolleda G. Post-traumatic cyclodialysis cleft treated with transscleral diode laser. Archivos de la Sociedad Espanola de Oftalmologia. 2009;84(1):47–50. https://doi.org/10.4321/s0365-66912009000100008.
8. Diep MQ, Madigan MC. Choroidal detachments: what do optometrists need to know? Clin Exp Optom. 2019;102(2):116–25. https://doi.org/10.1111/cxo.12807.
9. Yang J, Liu Q, Li X, Zhou L, Sun P, Wang X. Clinical evaluation of traumatic ciliochoroidal detachment with surgical treatment. Eye Sci. 2013;28(3):124–8. 39
10. Sahin Atik S, Ugurlu S, Egrilmez ED. Open globe injury: demographic and clinical features. 2018;29(3):628–31. https://doi.org/10.1097/scs.0000000000004156.
11. Bi H, Cui Y, Li Y, Wang X, Zhang J. Clinical characteristics and surgical problems of ruptured globe injury. Curr Therap Res. 2013;74:16–21. https://doi.org/10.1016/j.curtheres.2012.10.002.
12. Arey ML, Mootha VV, Whittemore AR, Chason DP, Blomquist PH. Computed tomography in the diagnosis of occult open-globe injuries. Ophthalmology. 2007;114(8):1448–52. https://doi.org/10.1016/j.ophtha.2006.10.051.
13. Kubal WS. Imaging of orbital trauma. Radiographics: a review publication of the Radiological Society of North America, Inc. 2008;28(6):1729–39. https://doi.org/10.1148/rg.286085523.
14. Roy AA, Davagnanam I, Evanson J. Abnormalities of the globe. Clin Radiol. 2012;67(10):1011–22. https://doi.org/10.1016/j.crad.2012.03.006.
15. Stryjewski TP, Andreoli CM, Eliott D. Retinal detachment after open globe injury. Ophthalmology. 2014;121(1):327–33. https://doi.org/10.1016/j.ophtha.2013.06.045.
16. De La Hoz PM, Torramilans Lluís A, Pozuelo Segura O, Anguera Bosque A, Esmerado Appiani C, Caminal Mitjana JM. Ocular ultrasonography focused on the posterior eye segment: what radiologists should know. Insights Imaging. 2016;7(3):351–64. https://doi.org/10.1007/s13244-016-0471-z.
17. Küchle M, Naumann GO. Direct cyclopexy for traumatic cyclodialysis with persisting hypotony. Report in 29 consecutive patients. Ophthalmology. 1995;102(2):322–33. https://doi.org/10.1016/s0161-6420(95)31021-4.
18. Bhende M, Lekha T, Vijaya L, Gopal L, Sharma T, Parikh S. Ultrasound biomiscroscopy in the diagnosis and management of cyclodialysis clefts. Indian J Ophthalmol. 1999;47(1):19–23.
19. Pavlin CJ, Harasiewicz K, Sherar MD, Foster FS. Clinical use of ultrasound biomicroscopy.

Ophthalmology. 1991;98(3):287–95. https://doi.org/10.1016/s0161-6420(91)32298-x.
20. Mateo-Montoya A, Dreifuss S. Anterior segment optical coherence tomography as a diagnostic tool for cyclodialysis clefts. Archiv Ophthalmol (Chicago, IL: 1960). 2009;127(1):109–10. https://doi.org/10.1001/archophthalmol.2008.561.
21. Sobaci G, Mutlu FM, Bayer A, Karagül S, Yildirim E. Deadly weapon-related open-globe injuries: outcome assessment by the ocular trauma classification system. Am J Ophthalmol. 2000;129(1):47–53. https://doi.org/10.1016/s0002-9394(99)00254-8.
22. Hui Y, Wang L, Shan W. Exploratory vitrectomy for traumatized eyes with no light perception and dense vitreous hemorrhage. [Zhonghua yan ke za zhi] Chin J Ophthalmol. 1996;32(6):450–2.
23. Brinton GS, Aaberg TM, Reeser FH, Topping TM, Abrams GW. Surgical results in ocular trauma involving the posterior segment. Am J Ophthalmol. 1982;93(3):271–8. https://doi.org/10.1016/0002-9394(82)90524-4.
24. Coleman DJ. Early vitrectomy in the management of the severely traumatized eye. Am J Ophthalmol. 1982;93(5):543–51. https://doi.org/10.1016/s0002-9394(14)77367-2.
25. Mieler WF, Mittra RA. The role and timing of pars plana vitrectomy in penetrating ocular trauma. Archiv Ophthalmol (Chicago, IL: 1960). 1997;115(9):1191–2. https://doi.org/10.1001/archopht.1997.01100160361017.
26. de Bustros S, Michels RG, Glaser BM. Evolving concepts in the management of posterior segment penetrating ocular injuries. Retina (Philadelphia, PA). 1990;10(Suppl 1):S72–5. https://doi.org/10.1097/00006982-199010001-00012.
27. Cleary PE, Ryan SJ. Method of production and natural history of experimental posterior penetrating eye injury in the rhesus monkey. Am J Ophthalmol. 1979;88(2):212–20. https://doi.org/10.1016/0002-9394(79)90468-9.
28. Winthrop SR, Cleary PE, Minckler DS, Ryan SJ. Penetrating eye injuries: a histopathological review. Br J Ophthalmol. 1980;64(11):809–17. https://doi.org/10.1136/bjo.64.11.809.
29. Ioannidis AS, Barton K. Cyclodialysis cleft: causes and repair. Curr Opin Ophthalmol. 2010;21(2):150–4. https://doi.org/10.1097/ICU.0b013e3283366a4d.
30. Portney GL, Purcell TW. Surgical repair of cyclodialysis induced hypotony. Ophthalmic Surg. 1974;5(1):30–2.
31. Yuen NS, Hui SP, Woo DC. New method of surgical repair for 360-degree cyclodialysis. J Cataract Refract Surg. 2006;32(1):13–7. https://doi.org/10.1016/j.jcrs.2005.05.035.
32. Mardelli PG. Closure of persistent cyclodialysis cleft using the haptics of the intraocular lens. Am J Ophthalmol. 2006;142(4):676–8. https://doi.org/10.1016/j.ajo.2006.05.027.
33. Hoerauf H, Roider J, Laqua H. Treatment of traumatic cyclodialysis with vitrectomy, cryotherapy, and gas endotamponade. J Cataract Refract Surg. 1999;25(9):1299–301. https://doi.org/10.1016/s0886-3350(99)00160-1.
34. Kong GY, Henderson RH, Sandhu SS, Essex RW, Allen PJ, Campbell WG. Wound-related complications and clinical outcomes following open globe injury repair. Clin Exp Ophthalmol. 2015;43(6):508–13. https://doi.org/10.1111/ceo.12511.
35. Thakker MM, Ray S. Vision-limiting complications in open-globe injuries. Can J Ophthalmol. 2006;41(1):86–92. https://doi.org/10.1016/s0008-4182(06)80074-8.
36. Rouberol F, Denis P, Romanet JP, Chiquet C. Comparative study of 50 early- or late-onset retinal detachments after open or closed globe injury. Retina (Philadelphia, PA). 2011;31(6):1143–9. https://doi.org/10.1097/IAE.0b013e3181f9c22e.
37. Sisk RA, Motley WW III, Yang MB, West CE. Surgical outcomes following repair of traumatic retinal detachments in cognitively impaired adolescents with self-injurious behavior. J Pediatr Ophthalmol Strabismus. 2013;50(1):20–6. https://doi.org/10.3928/01913913-20121002-01.
38. Kolomeyer AM, Grigorian RA, Mostafavi D, Bhagat N, Zarbin MA. 360° retinectomy for the treatment of complex retinal detachment. Retina (Philadelphia, PA). 2011;31(2):266–74. https://doi.org/10.1097/IAE.0b013e3181eef2c7.
39. Wang NK, Chen YP, Yeung L, Chen KJ, Chao AN, Kuo YH, et al. Traumatic pediatric retinal detachment following open globe injury. Ophthalmologica Journal international d'ophtalmologie International journal of ophthalmology Zeitschrift fur Augenheilkunde. 2007;221(4):255–63. https://doi.org/10.1159/000101928.
40. Lesniak SP, Bauza A, Son JH, Zarbin MA, Langer P, Guo S, et al. Twelve-year review of pediatric traumatic open globe injuries in an urban U.S. population. J Pediatr Ophthalmol Strabismus. 2012;49(2):73–9. https://doi.org/10.3928/01913913-20110712-02.
41. Nashed A, Saikia P, Herrmann WA, Gabel VP, Helbig H, Hillenkamp J. The outcome of early surgical repair with vitrectomy and silicone oil in open-globe injuries with retinal detachment. Am J Ophthalmol. 2011;151(3):522–8. https://doi.org/10.1016/j.ajo.2010.08.041.
42. Ehrlich R, Polkinghorne P. Small-gauge vitrectomy in traumatic retinal detachment. Clin Exp Ophthalmol. 2011;39(5):429–33. https://doi.org/10.1111/j.1442-9071.2011.02485.x.
43. Eliott D, Hauch A, Kim RW, Fawzi A. Retinal dialysis and detachment in a child after airbag deployment. J AAPOS. 2011;15(2):203–4. https://doi.org/10.1016/j.jaapos.2010.11.021.