· Brief Report ·

Scleral buckling combined with internal cyclopexy for severe traumatic cyclodialysis cleft in open globe injuries

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Abstract
● **This study aimed to evaluate the effect of scleral buckling combined with internal cyclopexy on the treatment of severe traumatic cyclodialysis cleft in open globe injuries (OGIS). This retrospective study recruited 10 patients of 10 eyes. With our surgical intervention, all the 10 eyes achieved retinal and ciliary body anatomic re-attachment. The choroidal ruptures in nine eyes were closed with complete choroidal reattachment. Postoperative best-corrected visual acuity of nine eyes had various improvements. The mean intraocular pressure was increased from 8.9±2.6 mm Hg to 13.4±4.4 mm Hg. Eventually, six eyes underwent silicone oil (SO) removal without complications, two eyes still had SO tamponade and two eyes became SO-dependent eyes. The result shows that internal direct cyclopexy combined with scleral buckling is an effective treatment for severe traumatic cyclodialysis cleft in OGIS.**
● **KEYWORDS:** cyclodialysis; ocular trauma; cyclopexy; scleral buckling; pars plana vitrectomy
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INTRODUCTION

Open globe injuries (OGIS) are a major cause of blindness, causing approximately 203 000 such cases per year worldwide[1]. According to the different location of injuries, OGIS can be divided into three zones by Ocular Trauma Classification Group (OTCG)[2]. Briefly, zones are defined as the cornea and limbus (I); the anterior 5 mm of the sclera (II) and posterior to zone II (III). Severe OGIS, especially the zone II and/or zone III injuries which included cyclodialysis, vitreous hemorrhage, choroidal detachment, retinal detachment and so on, may lead to worse outcomes[3-4]. With the development of microsurgical techniques, pars plana vitrectomy (PPV), has dramatically improved the outcome of OGIS involving the posterior segment[5-6]. However, some problems of OGIS with severe intraocular damage still deserve attention. After received primary emergency ocular injury debridement suture, in these patients, cyclodialysis, choroidal detachment and unclosed choroidal rupture, which were usually accompanied by severe intraocular structure abnormality (lens extrusion, iris defect and so on), could be defined as "severe traumatic cyclodialysis cleft". This kind of traumatic cyclodialysis cleft is much more serious than the common traumatic cyclodiaysis cleft, which occurs almost exclusively as a result of blunt ocular trauma[7-8]. In these patients, the unclosed choroidal rupture will lead to the suprachoroidal space collection of tamponading agents, such as silicone oil (SO). SO may migrate through the choroidal rupture into the suprachoroidal space, which can possibly lead to persisent hypotony after surgery[9-10]. When cyclodialysis and choroidal detachment combined with choroidal rupture, the hypotony will be more serious and impact patients' visual function and appearance. Our search of Medline database failed to reveal a similar report on managing this kind of traumatic cyclodialysis cleft during the primary PPV. In this study, we introduced an effective technique using the scleral buckling combined with internal cyclopexy to treat the severe traumatic cyclodialysis cleft in OGIS.

SUBJECTS AND METHODS

Ethical Approval This retrospective study included patients who consecutively attended the Tongji Hospital diagnosed with severe OGIS from November 2016 to June 2017. The review board of the Tongji Hospital approved our study, and the study followed the tenets of the Declaration of Helsinki. As it was a retrospective assessment and all the data were obtained during routinely taking care of patients, the necessity of an informed consent by the participants was waived by the ethics committee.

The OGIS patients who had been diagnosed with severe traumatic cyclodialysis cleft were included in our study. All these patients had received an emergency ocular injury debridement suture in the Tongji Hospital. Before the PPV, the preoperative examinations included best-corrected visual acuity (BCVA), intraocular pressure (IOP) and slit lamp of the anterior segment. Because of the corneal edema, cataract or severe vitreous hemorrhage, ultrasound B scans were taken to confirm detachment of choroid. Cyclodialysis was diagnosed during PPV process.

All the surgeries were carried out by the same vitreoretinal ophthalmologist (Yang H) with 23G standard three-port PPV. Two transparent corneal incisions were made for temporary infusion cannula and vitrector. After lensectomy and anterior vitrectomy, the conventional three-port (infusion cannula, light cannula and vitrector cannula) could be made and the cyclodialysis could be located by the scleral depression. The infusion pressure was maintained at 25 mm Hg. The major internal cyclopexy procedures were as follow: a double-armed straight needle was inserted through the patient's opposite limbus incision towards the location of the cyclodialysis. Meanwhile, two 30G needles at the proposed anatomical site, which were located at the cyclodialysis area and 2 mm posterior to the limbus, were used to guide the straight needles through the detached ciliary body and sclera to the outside of the eyeball (Figure 1A-1C, Figure 2A). The free ends of the polypropylene thread were then tied to re-attach the ciliary body (Figure 1D). The knot of the suture was placed on the surface of the sclera and was covered by conjunctiva. The extent of each paired suture was around 20°. In most of the severe OGIS, the extent of cyclodialysis usually exceeded 20°, and some of them were even close to 360°. So, several pairs of paired sutures were used according to the extent of the cyclodialysis. After re-fixation of the ciliary body, PPV was continued to remove the posterior vitreous body. Then, the unclosed choroidal rupture and choroidal detachment could be marked by scleral depression. The scleral buckling procedures were as follows: a 4.5-7 mm silicone sponge was sewn to the marked scleral area overlying the choroidal rupture (Figure 2B, 2C). To complete the routine PPV, the suture was adjusted to ensure a high enough buckle to close the choroidal rupture. After that, the SO tamponade was performed in all the cases.

Follow-up examinations including BCVA, IOP, slit lamp and ultrasound biomicroscopy (UBM) of the anterior segment and fundus examination were performed 1 and 2wk, 1, 3, 6 and 12mo after surgery. SO was removed 6-12mo after surgery for patients with retinal attachment and stable normal IOP.

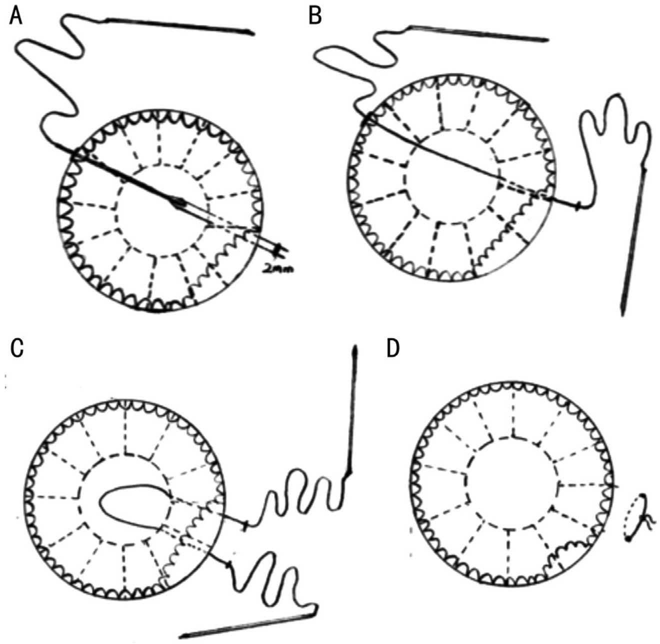

Figure 1 Diagrammatic drawing of internal cyclopexy using double-armed straight needle A: A 30G syringe needle from ~2 mm posterior to the limbus at the cyclodialysis area was used to guide the straight needle; B: One of the straight needles was passed through the detached ciliary body and sclera to the outside of the eyeball; C: The second straight needle was introduced to the detached area with the same method as in Figure 1B, 2 mm away from the first thread; D: The free ends of the polypropylene thread are then tied and part of the ciliary body was re-attached.

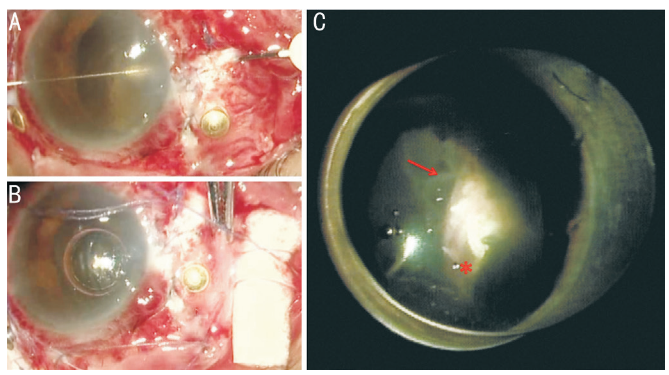

Figure 2 The surgical color photographs of patient two A: The straight needle guided by 30G guide needle as same as that in Figure 1A; B: The outer view of scleral buckling towards the choroidal rupture; C: The inner view of the choroidal rupture (red asterisk) and detached retina (red arrowhead) on the ridge of scleral buckling.

RESULTS

Our study included 10 eyes of 10 patients (8 men) with a mean age of 41.6±16.7y (range from 3 to 66y). The causes of OGIS included being hit by metallic stick, fish, wood bar, the explosion of firecrackers, car accidents, cutting injury, and so on. Before the surgery, the BCVA of four eyes were no light perception (NLP), four eyes were light perception (LP) and two eyes were hand motion (HM). The location of the wound was zone II in three eyes and zone III in seven eyes. The length

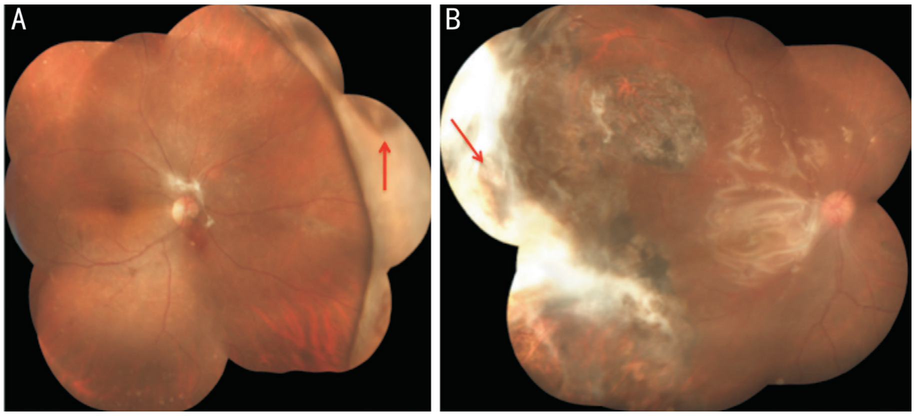

Figure 3 The fundus photographs of representative patients at the last follow up visit A: The fundus photograph of patient five. Red arrow shows the choroidal rupture was tightly closed. SO had already been removed. B: The fundus photograph of patient three. The choroidal rupture (red arrow) was surrounded by white scars and was also closed. SO was still in the vitreous cavity.

of the wound was 12.9±2.8 mm (range from 9 to 17 mm). The unclosed choroidal ruptures of eight eyes were located in front of the equator while the other two were exceeded across the equator to the posterior choroid.

The clinic data of 10 cases are presented in Table 1. Four eyes received retinotomy, three eyes received choroidotomy and all the eyes received SO tamponade because of the complicated and severe retinal detachment. Four eyes have partial iris defect. Six eyes have lens extrusion during the injury; the other four eyes have lensectomy because of the severe cataract or dislocation of the lens. The extent of the cyclodialysis was 170.5°±74.9° (range from 80° to 360°). The postoperative follow-up was longitudinally performed up to 12mo. The average follow-up time was 8.9±1.79mo (range from 7 to 12mo).

Postoperatively, the ciliary body was re-attached in all the eyes, as confirmed by UBM at the end of follow-up. The choroidal ruptures in nine eyes were closed with complete choroidal reattachment (Figure 3, Table 1). In the other one eye, although the choroidal rupture was not fully closed, the choroidal detachment was less extensive than pre-operation. After the SO tamponade for 6 to 12mo, all the eyes achieved retinal anatomic re-attachment, which included one eye undergoing re-operation due to the recurrence of retinal detachment in SO. Six eyes received SO removal without complications, two eyes still had SO tamponade (Figure 3B, Table 1) and two eyes became SO-dependent eyes due to the IOP<8 mm Hg with SO tamponade. The postoperative BCVA of nine eyes was various improvements from HM to 20/80 except for one eye still NLP (Table 1). Two eyes were performed temporary elevation of IOP after surgery and were controlled with the topical anti-glaucoma applications. Finally, the mean IOP was increased from 8.9±2.6 mm Hg (preoperative IOP, range from 5 to 12 mm Hg) to 13.4±4.4 mm Hg (postoperative IOP, range from 7 to 21 mm Hg).

DISCUSSION

Severe OGIS, especially combined with severe traumatic cyclodialysis cleft, is still a complicated challenge even for current PPV. In our retrospective study, although the OGIS were complex and serious, the BCVA was improved in most eyes. All the 10 patients who received internal cyclopexy combined with scleral buckling successfully achieved ciliary body reattachment and most of the choroidal ruptures were closed. Only two eyes became SO-dependent eyes with hypotony. We speculate that there are some reasons causing SO-dependence: 1) the extensive retinal defect caused by primary severe and complicated injury may increase the exposure of the choroid which can lead to hypotony; 2) the extensive detachment of ciliary body in these two cases may reflect more severe ciliary damage causing irreversible reduction of aqueous humor; 3) traumatic cyclitic membranes in child also may permanently inhibit the formation of aqueous humor.

There are some differences between traditional techniques in repairing the ciliary body detachment, most of which use scleral flap for external direct cyclopexy to reattach ciliary body[7-8,11-12]. Briefly, a scleral flap is made at the region of the cyclodialysis and the detached ciliary body can be directly visualized. The ciliary body is sutured under direct vision to the sclera, followed by suturing the scleral flap both using 10/0 nylon sutures. Compared to conventional external direct cyclopexy, our techniques have some advantages: 1) There is no need to prepare scleral flap which may interfere the three-port of scleral incision for vitrectomy. 2) Our technique is suitable for patients with extensive cyclodialysis, which will lead to instability or/and ischemia of the eyeball due to large extent of scleral flap if treated by the traditional external cyclopexy. 3) This method is especially suitable for aphakia, which allows us to directly observe and suture the cyclodialysis without densely or inadequately suturing. Our

Table 1 Clinical data of 10 patients with OGIS, functional and anatomical status after surgical procedures

Case No.	Age/ sex/ eye	Trauma location (cause)	Length of wound	Length of follow up (mo)	Unclosed choroidal rupture's location	Extent of the cyclodialysis	Retinotomy/ choroidotomy	Vision (BCVA) (preop./final)	Ocular endotamponade	IOP (preop./ postop., mm Hg)	Anatomical outcome
1	41/F/R	Zone III (metallic stick)	15 mm	8	Before the equator	130°	No/no	NLP/20/400	SO	8/15	Ciliary body re-attached, retina flat, chroidal rupture close, chroidal flat (SO still in vitreous cavity)
2	22/M/R	Zone III (knife cut)	9 mm	7	Before the equator	110°	Yes/no	LP/20/80	SO	6/11	Ciliary body re-attached, retina flat, chroidal rupture close, chroidal flat (SO has been removed)
3	43/M/R	Zone II (wood bar)	11 mm	10	Across the equator to the posterior choroid	80°	Yes/yes	LP/HM	SO	11/14	Ciliary body re-attached, retina flat, chroidal rupture close, chroidal flat (SO still in vitreous cavity)
4	50/M/L	Zone III (explosion of firecrackers)	17 mm	8	Before the equator	230°	Yes/no	NLP/HM	SO	5/7	Ciliary body re-attached, retina flat, chroidal rupture close, chroidal flat (SO still in vitreous cavity)
5	39/M/R	Zone II (metallic stick)	13 mm	12	Before the equator	135°	No/no	LP/20/100	SO	12/18	Ciliary body re-attached, retina flat, chroidal rupture close, chroidal flat (SO has been removed)
6	3/M/L	Zone III (wood bar)	14 mm	7	Across the equator to the posterior choroid	360°	Yes/yes	NLP/NLP	SO	6/7	Ciliary body re-attached, retina flat, chroidal rupture not fully closed, chroidal detachment not fully flat (SO still in vitreous cavity)
7	51/M/R	Zone III (fish hit)	15 mm	11	Before the equator	155°	No/no	LP/CF	SO	10/13	Ciliary body re-attached, retina flat, chroidal rupture close, chroidal flat (SO has been removed)
8	50/M/R	Zone III (car accident)	16 mm	9	Before the equator	145°	No/yes	HM/20/200	SO	11/15	Ciliary body re-attached, retina flat, chroidal rupture close, chroidal flat (SO has been removed)
9	51/M/L	Zone II (car accident)	9 mm	7	Before the equator	160°	No/no	NLP/CF	SO	12/21	Ciliary body re-attached, retina flat, chroidal rupture close, chroidal flat (SO has been removed)
10	66/F/R	Zone III (metallic stick)	10 mm	10	Before the equator	200°	No/no	HM/20/400	SO	8/13	Ciliary body re-attached, retina flat, chroidal rupture close, chroidal flat (SO has been removed)

BCVA: Best-corrected visual acuity; IOP: Intraocular pressure; NLP: No light perception; HM: Hand motion; SO: Silicone oil; LP: Light perception; CF: Counting fingers.

method of internal cyclopexy is similar with that Wang *et al*[13] reported. However, we made some modifications due to the aphakia in most of the patients. First, we used scleral depression to precisely locate the region of the cyclodialysis. Meanwhile, the pars plana sclerotomy was replaced by limbus as the location of piercing into the eye which did not cause iatrogenic cyclodialysis and did not need suturing. Thus, with these modifications, our method is more convenient and safe for the severe cyclodialysis.

There are some favorable surgical techniques to repair traumatic cyclodialysis cleft that included capsular tension ring, intraocular lens, cryotherapy or endolasercoagulation combined with cyclopexy and PPV combined with vitreous cavity endotamponade[8,12,14-16]. However, all of these techniques are not suitable for these OGIS patients who have cyclodialysis, choroidal detachment and unclosed choroidal rupture. The choroidal rupture may become rigid, and lead to SO migration into suprachoroidal spaces which may cause long-term hypotony[10]. Thus, choroidal detachment will not recover unless we fix both choroidal rupture and cyclodialysis in severe OGIS. In our technique, firstly we use internal cyclopexy to reattach the ciliary body, which can block the communication from the anterior chamber to suprachoroidal space and stabilize the detached choroid. Secondly, the scleral buckling was followed with the internal cyclopexy to close the choroidal rupture and enhance choroidal reattachment. As we expected, our study data demonstrated that scleral buckling combined with internal cyclopexy could effectively reattached ciliary body, close the choroidal rupture, minimize choroidal detachment, and eventually prevent hypotony. Our study also has some limitations. First, our study is retrospective and the number of patients is relatively less, which may lead to selection bias. Second, our investigation did not include a control group that did not allow the comparison among different surgical techniques. Third, the limited cases also restricted the statistical analysis, such as for investigating the success rate of surgery and risk factors of SO-dependent. However, the preliminary results of our study are encouraging.

In conclusion, our study shows the internal direct cyclopexy combined with scleral buckling is an effective way for repairing the severe traumatic cyclodialysis cleft in OGIS.

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Conflicts of Interest: Chen B, None; **Wang GX,** None; **Zhang X,** None; **Yang H,** None.

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