

# Efficacy of Combined Vitreous Surgery and Choroidal Suture Fixation on Choroidal Avulsion

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## Abstract

**Purpose:** To evaluate the feasibility and efficacy of combined vitreous surgery and choroidal suture fixation on choroidal avulsion.

**Methods:** A total of 21 patients (21 eyes) with choroidal avulsion, secondary to open eye trauma and a history of one-stage eyeball wall closure were retrospectively evaluated in the present study. Preoperative findings included 3 to 7.5 mmHg (averagely  $5.1 \pm 1.1$  mmHg) of intraocular pressure and presence/suspicion of visual light perception. Vitreo-retinal surgery in combination with choroidal suture fixation was conducted for these patients at 4 to 21 days (averagely  $9.41 \pm 2.7$  days) after the trauma. The postoperative follow-up lasted for 3 to 9 months (averagely  $5.5 \pm 1.5$  months).

**Results:** The intraoperative findings indicated several choroid residuals with different densities attached on the sclera at the choroidal detachment area. Retinal proliferation/detachment, incarceration and/or partial retinal loss were also observed. Intraoperatively, the retina was separated and released, and the suture fixation outside the sclera in combination with intraocular photocoagulation and silicone oil filling were performed at the avulsed choroidal area. The suture fixation on the ciliary body was also introduced in some of the patients. At one month postoperatively, a complete choroidal reattachment was achieved in 16 eyes (16/21, 76.19%) and partial reattachment in the remaining 5 eyes. At the end of follow-up, partial choroidal redetachment was observed in 4 of 16 eyes (25%), resulting in complete reattachment in 12 eyes (12/21, 57.1%) and partial reattachment in 9 eyes (9/21, 33.34%). The complete choroidal reattachment rate at the end of follow-up was not significantly different from that observed at one month after the surgery (Chi-square test,  $P < 0.05$ ), while the complete retinal reattachment rate at this time point was significantly lower than that at one month postoperatively (Chi-square test,  $P > 0.05$ ).

**Conclusion:** Transscleral suture fixation serves as a reliable technique, particularly improving the choroidal reattachment

rate in the choroidal avulsion. (*Eye Science* 2011;26:143–147)

**Keywords:** Choroidal avulsion; ocular trauma; vitreous surgery

Choroidal avulsion is a serious subtype of ocular trauma, defined as a severe separation of choroid membrane from the sclera and irregular choroidal residuals on the scleral wall, usually accompanied by the detachment or avulsion of ciliary body at the corresponding quadrant, caused by a sudden external force burst<sup>1</sup>. After avulsion or detachment, the local choroid loses the blood supply and will develop fibrosis and contraction over time, leading to the impaired compliance of the avulsed tissue, affecting the choroidal reattachment and retinal oxygen supply and reattachment. The intraocular low pressure and atrophy of eyeball are also present due to the choroidal avulsion/detachment and cyclodialysis. In 1984, Bordeianu used a term “choriodialysis” to describe this condition<sup>1</sup>. In China, Jiang et al employed the term “choroidal separation” to define the condition and introduced an intraocular biogel into the treatment. In addition, another author also named the condition as the “ruptured choroidal detachment” in order to distinguish this condition from the simple choroidal detachment and to imply the difficulties of surgical reduction and the dismal outcome<sup>3</sup>. Because the choroidal avulsion is usually secondary to a severe ocular trauma, particularly an open one, it is frequently complicated with intraocular massive hemorrhage, retinal detachment/incarceration, PVR, iridal and ciliary body contusion, resulting in a poor outcome such as atrophy of eyeball. In the past therapeutic opinion, the importance of vitreous and retinal surgery was excessively focused on, ignoring the necessity of the immediate choroidal reduction instead, impairing the prognosis of this condition.

Since 2009, besides the primary vitreous and retinal surgery, we have introduced a choroidal suture fixation into 21 patients with choroidal avulsion as well as severe ocular trauma and reported the evaluation results as follows.

## Patients and methods

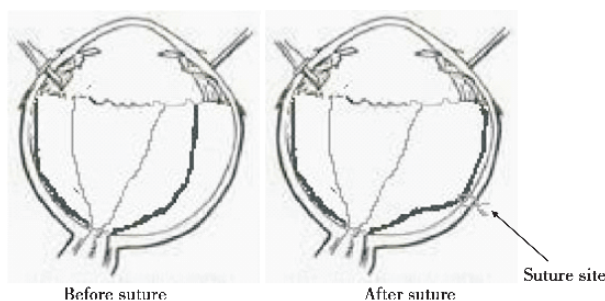
### Patients' information

A total of 21 patients (21 eyes; 19 men and 2 women) with choroidal avulsion and severe ocular trauma, aged 15 to 56 years, having a one-stage surgical eyeball wall closure history for an open eye injury were retrospectively analyzed. Four of the 21 cases were secondary to explosive injury, 4 to blunt object injury, 6 to sharp object injury (including 2 cases of penetrating injury) and 7 to road traffic accident. The ophthalmological ultrasonography showed an intraocular structure disarrangement and hemorrhage, demonstrating the presence of the detachment/separation of retina, choroid membrane and/or ciliary body. The intraocular pressure preoperatively examined was ranged 3~7.5 mmHg ( $5.1 \pm 1.1$  mmHg). The presence of visual light perception was observed in 14 eyes (66.7%) and suspicion of visual light perception in 7 eyes (33.3%). The follow-up duration ranged from 3~9 months ( $5.5 \pm 1.5$  months).

### Surgical procedure

The time interval between the occurrence of trauma and surgical intervention was 4 to 21 days ( $9.41 \pm 2.7$  days). A closed pars plana vitrectomy was conducted for all the patients under a topical anesthesia. The intraoperative findings included loss or breakage of lens, retinal proliferation, detachment and incarceration at the original perforated site as well as the subchoroidal blood accumulation/organization. The choroidal rupture at the detachment site was also observed in 6 of the eyes (6/21, 28.6%). Considering the detachment site of the ciliary body or the choroidal rupturing site as the approach to access, the subchoroidally accumulated blood and organized bodies were removed, exposing several choroidal residuals with different densities attached to the scleral surface. The partial retinal loss was also concurrent in 8 of the eyes (8/21, 38.1%). The incarcerated retina was released, the proliferated membrane on and below the retina was removed and

a partial or complete retinal incision was performed. After the fold was released and fixed, 1 to 42 cm scleral incision(s) involving the whole scleral layer were performed according to the scope of the avulsion at the site of the sclera corresponding to the avulsed choroid membrane adjacent to the scleral equator to reduce the detached choroid, which was then fixed on the scleral wall using 10-0 nylon suture before the scleral incision(s) were closed. The heavy water was filled to facilitate a further attachment of retina and choroid to the sclera. The intraocular photocoagulation and silicone oil injection was performed to seal the retinal holes and incisions. A suture fixation to the ciliary body was also introduced for 16 of the eyes (16/21, 76.2%). The patients were advised to maintain a prone or lateral position after the surgery (Figures 1 and 2).

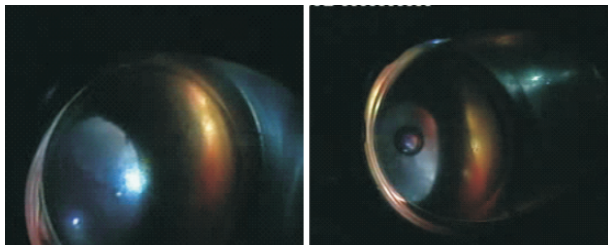


**Figure 1** Operation diagram: choroidal avulsion was sutured via sclera, and choroidal reattachment was achieved.

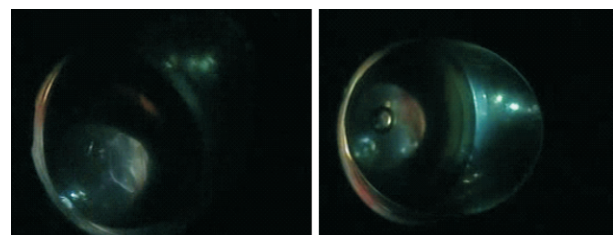
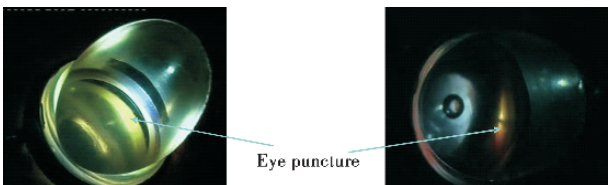
## Results

### Postoperative retinal and choroidal reduction status

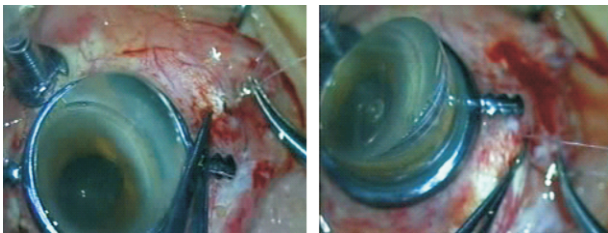
Immediately after surgery, a reattachment of the detached choroid was achieved to diverse extents in all the patients, in absence of severe complications such as intraocular hemorrhage, and the full appearance of the ocular fundus and retina was visible. The anatomical reattachment status of the choroid and retina after the surgery was described as follows: At one month posterior to the surgery, a complete choroidal reattachment was achieved in 16 eyes (16/21, 76.19%) and partial reattachment in the remaining 5 eyes; at the end of follow-up, a partial choroidal redetachment was observed in 4 of 16 eyes



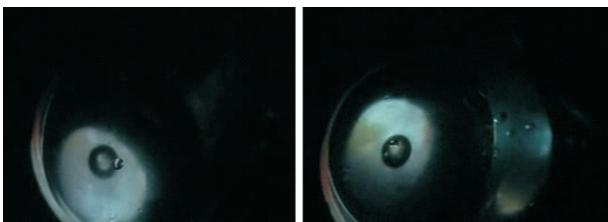
Before suture: after heavy water was injected, nasal choroidal reattachment was achieved, but ciliary body, choroidal avulsion in two quadrants were still rigid, and no reattachment was noted.



Choroidal reattachment was performed by eye forceps traction



Choroid was sutured and fixed onto sclera

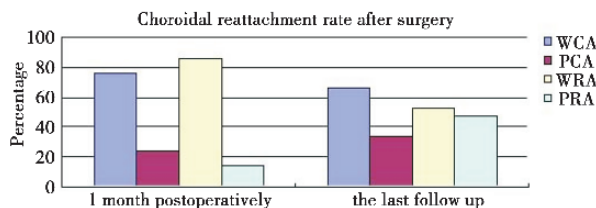


The choroidal reattachment in inferior and superior temporal quadrants after suture and fixation

**Figure 2** Surgery procedure: choroidal avulsion suture fixation in temporal quadrant; choroidal avulsion suture fixation in superior temporal quadrant

(25%), resulting in 12 eyes of complete reattachment (12/21, 57.1%) and 9 eyes of partial reattachment (9/21, 33.34%); the complete retinal re-

duction was observed in 11 eyes (11/21; 52.38%) and partial retinal reduction in 10 eyes (10/21; 42.9%). These indicated that the complete reduction rate of the choroid and retina would decrease over time and a part of reattached structure even showed an aggravated detachment tendency. The complete choroidal reattachment rate at the end of follow-up was not significantly different from that observed at one month after the surgery (Chi-square test,  $P > 0.05$ ), while the complete retinal reattachment rate at this time point was significantly lower than that at one month after the surgery (Chi-square test,  $P < 0.05$ ) (Figure 3).



**Figure 3** Comparison on retinal and choroidal reattachment 1-month postoperatively and during the final follow up. The complete reattachment rate of retina and choroid declined as time proceeded, and partially presented a trend of aggravated detachment. No significant difference was noted regarding the complete reattachment rate of choroid between 1-month postoperatively and the final follow up (Fourfold table chi-square test,  $P > 0.05$ ). The complete retinal reattachment rate during final follow up was significantly lower compared with that 1-month postoperatively, with statistical significance (Fourfold table chi-square test,  $P < 0.05$ ) (Abbr.WCA-complete choroidal reattachment; PCA-partial choroidal reattachment; WRA-complete retinal reattachment; PRA-partial retinal reattachment).

During the follow-up period, the injected silicone oil could be stabilized in the vitreous cavity or the anterior chamber, without subchoroidal leakage. At the end of the follow-up, a massive periretinal proliferation, contractive retinal detachment and/or retinal contraction was observed in the 10 patients with partial retinal reattachment (10/21, 47.62%), but without postoperative eyeball atrophy and exacerbation of the choroidal and retinal detachment. The silicone oil was not removed during the follow-up period.

**Postoperative intraocular pressure distribution**

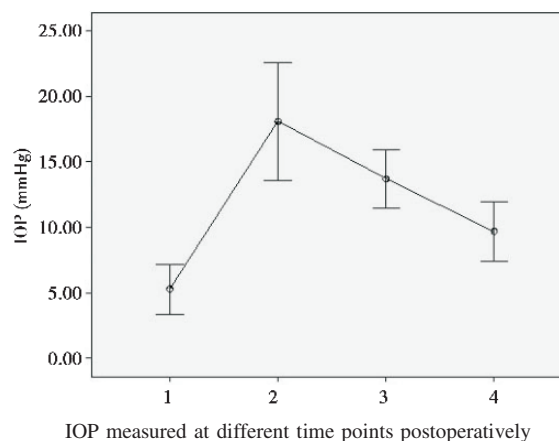
At day 1 after the surgery, the intraocular pres-

sure in all of the patients significantly increased from the baseline value ( $5.3 \pm 1.6$  mmHg), even equal to or greater than 21mmHg in 4 of the eyes (4/21, 19%). The mean values at 1 day and 1 month after the surgery and at the end of the follow-up were  $24.1 \pm 7.5$  mmHg,  $18.7 \pm 4.6$  mmHg and  $10.3 \pm 2.8$ mmHg, respectively. The multiple comparisons for the intraocular pressure before and after the surgery showed significant difference ( $P < 0.05$ , S-N-K test, ANOVA), indicating that the markedly increased postoperative intraocular pressure would significantly fluctuate to decrease over time (Figure 4).

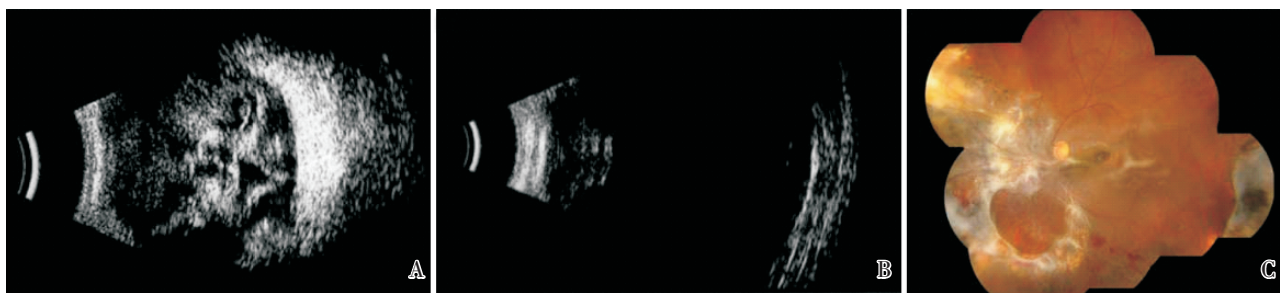
#### Visual acuity evaluation at 1 week postoperatively

After the surgery, all the patients reported an active improvement of visual acuity or eye symptom. At the end of the first month of the postoperative follow-up, the visual acuity findings were: suspected light perception in 2 eyes (10%), light perception in 2 eyes (9.5%), hand movement in 8 eyes (28.6%), counting fingers in 6 eyes (38.1%) and the visual acuity at 0.02 in 2 eyes (9.5%) and at 0.05 in 1 eye

(4.7%).



**Figure 4** Changes in IOP before and after operation. Significant differences were noted before and after surgery regarding IOP level using multiple comparison ( $P < 0.05$ ). LSD test and ANOVA showed that IOP increased postoperatively. Evident IOP variations were observed as time proceeded. Note: 1 represents prior to operation, 2 represents 1 day after operation, 3 represents 1-month postoperatively, 4 represents the late stage of follow up.



**Figure 5** A supplementary case report. A. B-mode ultrasound examination preoperatively. The patient had steel penetrating injury, causing eye rupture in more than two quadrants, had a suture history 5 days prior to surgery. Before surgery: 5.6 mmHg IOP; B-mode ultrasound showed full choroidal avulsion, and straight and stretched band echo was observed toward anterior segment. B. The surgery was performed 4 days after injury. B-mode ultrasound revealed normal eye wall and full choroidal reattachment. C. Fundus image 3-month after operation.

## Discussion

During the severe ocular trauma, based on the principle of the external force delivery along the eyeball wall, when an external force leads to a drastic deformation of the eyeball, the maximal tension will focus on the peripheral part of the visual disc and vitreous base, resulting in an avulsion or even a retro-equatorial detachment of the choroid from the sclera. This detachment will lead to an immediate

damage of the choroidal blood supply. Depending on a vast number of capillaries and the abundant interstitial substance it has, as well as the participation of outer choroidal brown lamina and the inner choroidal pigment epithelia into the tissue repair, a good many fibrous connective tissues were produced during the repair, leading to a choroidal atrophy or sclerosis, which hinders the choroidal reattachment (Even heavy water and scleral buckling can not fulfill the attachment of choroid to the sclera). Therefore, the

outcome of the choroidal avulsion will be determined by the treatment timing, method and technique. Some authors introduced the choroidotomy into the treatment against choroidal avulsion and reported a higher retinal and choroidal reattachment rate, optimal corrected visual acuity and eyeball survival rate in the choroidotomy group than that in the non-choroidotomy group<sup>4</sup>. However, this procedure can affect the retinal blood supply and heavy water and silicone oil may leak into the suprachoroidal cavity via the open choroidal rupture as reported previously<sup>5</sup>. Moreover, choroidal resection may increase the incidence of the intraocular low pressure and have influence on the outcome. Other methods reported including the application of intraocular titanium nail and tissue adhesives also showed an equivocal efficacy. In the present study, a combined vitrectomy and choroidal suture fixation was performed against choroidal avulsion, resulting in a mechanical fixation of choroid on the sclera. The silicone oil filling was also combined, contributing to a further reattachment of the choroid to the sclera, improving the choroidal and retinal reattachment rate markedly.

In this series, the marked increase of postoperative intraocular pressure indicated the successful control of eyeball atrophy by the surgery and the holding of the normal eyeball appearance and effective intraocular pressure, providing a basis for the improvement of visual function. The multiple comparisons for the intraocular pressure before and after the surgery showed significant differences ( $P < 0.05$ , LSD test, ANOVA). After the surgery, the intraocular pressure in some of the patients still showed a tendency to decrease because the choroidal and retinal detachment in these patients will exacerbate over time due to the organization and contraction of the tissues, which were the pathological outcomes of the advancement of postoperative proliferative traumatic retinopathy (PTR). Therefore, the anatomical choroidal and retinal reattachment is only a short-term surgical achievement and how to control the occurrence of PTR should be further studied. Although the mean

central vision in this series was not improved markedly after surgery, the patients still reported an improvement of visual sensitivity, indicating the surgery remedied a part of important light sensation function. For the surgical timing, an early stage surgery is recommended. In this series, the surgery was performed at a mean period of 9.41 days after the trauma because the choroid was not atrophic and stiff at this time, making the suturing-resulted reattachment become possible. The injured choroid will contract, be stiffened and lose compliance after a long period, and can not be reduced even by proper suturing under this circumstance.

Avulsed choroid reattachment by suturing may facilitate the reattachment and functional improvement of the detached retina under the background of intraocular filling. For those combined with an avulsion of ciliary body, a suture fixation for the ciliary body should also be conducted, which could help controlling postoperative intraocular low pressure. The best efficacy of this combined surgery is to maintain the appearance of the eyeball, partially restore the intraocular pressure and improve the visual function to exceed the light perception, showing a favorable clinical value.

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