• Clinical Research •

Combined anterior corneal elastic sublaminectomy, conjunctival flap, and prosthetic eyepiece for ocular atrophy following foldable capsular vitreous body implantation in severe trauma

Ling-Dan Wu[1], Pei-Jie Huang[1], Zhou Peng[1], Huang Zhang[1], Sheng-Xiang Zhang[2], An-An Wang[1], Meng-Tian Qiu[2], Li-Chang Ma[2], Ye-Feng Zhu[2], Qi-Hua Xu[1]

[1]The Affiliated Eye Hospital, Jiangxi Medical College, Nanchang University, Nanchang 330000, Jiangxi Province, China
[2]Nanchang University, Nanchang 330000, Jiangxi Province, China
Correspondence to: Qi-Hua Xu. The Affiliated Eye Hospital, Jiangxi Medical College, Nanchang University, Nanchang 330006, Jiangxi Province, China. xu7ganggang@163.com
Received: 2024-06-23 Accepted: 2025-05-06

Abstract

● **AIM:** To investigate the outcome of combined anterior corneal elastic sublaminectomy, conjunctival flap, and prosthetic eyepiece for ocular atrophy following foldable capsular vitreous body (FCVB) implantation in severe trauma.

● **METHODS:** This study conducted a retrospective analysis of 38 patients who underwent conjunctival flap coverage followed by prosthetic eyepiece fitting after developing ocular atrophy secondary to FCVB surgery. Anterior corneal elastic sublaminectomy combined with conjunctival coverage was performed on the FCVB-implanted atrophic eyes. Prosthetic lenses were fitted after complete healing of the stroma and conjunctiva and suture removal. Corneal irritation, eyeball protrusion, axial length, lid height, cosmetic satisfaction, and pain numerical rating scale scores were observed before the conjunctival flap covering and after the prosthetic eyepiece surgery.

● **RESULTS:** The ocular protrusion was 11 mm preoperatively and 14 mm postoperatively, with the difference being statistically significant (Z=-5.459, P<0.001). The ocular axis length was 20.82±0.94 mm in the experimental group and 23.57±0.33 mm in the control group, showing a statistically significant difference (t=-20.207, P<0.05). The lid height was 6 mm in the experimental group and 9 mm in the control group, a difference that was statistically significant (Z=-5.326, P<0.001). The appearance satisfaction score was 1 in the experimental group and 4 in the control group, with this difference being statistically significant (Z=-5.447, P=0.001). Regarding the pain numerical rating scale score, the ranges were 0-2 in the experimental group and 0 in the control group. No discomfort was reported after wearing the prosthetic eyepiece, and the difference was not statistically significant (Z=-1.100, P>0.05). There was no statistically significant difference between pre- and post-treatment satisfaction.

● **CONCLUSION:** A conjunctival flap covering and a prosthetic eyepiece after FCVB postoperative atrophy can reduce the number of surgeries, alleviate patients' economic burdens, satisfy patients' psychological eyeball retention requirements, and provide better cosmetic efficacies for patients desiring eyeball retention or silicone-oil dependence.

● **KEYWORDS:** open ocular trauma; conjunctival flap; prosthetic eyepiece; foldable capsular vitreous body

DOI:10.18240/ijo.2025.11.18

Citation: Wu LD, Huang PJ, Peng Z, Zhang H, Zhang SX, Wang AA, Qiu MT, Ma LC, Zhu YF, Xu QH. Combined anterior corneal elastic sublaminectomy, conjunctival flap, and prosthetic eyepiece for ocular atrophy following foldable capsular vitreous body implantation in severe trauma. *Int J Ophthalmol* 2025;18(11):2149-2154

INTRODUCTION

Foldable capsular vitreous body (FCVB) is an emerging vitreous replacement treatment for vitreoretinal pathologies, such as severe ocular trauma, complex retinal detachment, and proliferative vitreoretinopathy (PVR). In patients with severe ocular trauma resulting in loss of and damage to intraocular contents, FCVB can obviate the need for eye removal surgery[1-2]. For diseases, such as retinal detachment and PVR, which require frequent silicone-oil injections to fill the vitreous cavity, FCVB can prevent additional complications and reduce the number of surgeries[3-5]. However, based on long-term observations, some

patients who undergo FCVB surgery may experience corneal decompensation and degeneration, causing corneal leukoplakia or irritation, a complication with rate of 51.8%[6]. Atrophy of the eyeball causes shrinkage and pseudo-ptosis, which further affects a patient's appearance. To address the impact of postoperative complications of FCVB on patients' appearance, this study assessed anterior sub-elastic superficial lamellar keratectomy combined with conjunctival flap masking in 38 patients with corneal leukoplakia, corneal irritation, or pseudo-ptosis due to atrophy of the eyeballs after FCVB. To address appearance issues, patients wore ceramic prosthetic eye piece after the corneal stroma and conjunctiva completely healed. This study aims to examine whether it is safe and effective to treat severe ocular atrophy with FCVB, combined conjunctival flap, and prosthetic eyepiece.

PARTICIPANTS AND METHODS

Ethical Approval This study was reviewed and approved by the Medical Ethics Committee of the Affiliated Nanchang University Eye Hospital (Approval No.2023-XJS-01). The clinical trial adhered strictly to the World Medical Association Declaration of Helsinki. All patients and their families were informed of the purpose, design, and surgical considerations of the study, and they voluntarily signed an informed consent form for surgery.

Participants This is a retrospective cohort study that included patients who underwent FCVB surgery (June 2018-October 2023) leading to ocular atrophy, subsequently underwent conjunctival flap coverage (January 2022-October 2023), and were finally fitted with prosthetic eyepieces (February 2022-November 2023).

The inclusion criteria were as follows: 1) ocular atrophy combined with pseudo-ptosis; 2) corneal degeneration combined with corneal leukomalacia; 3) postoperative visual acuity of only questionable or no light perception after FCVB; 4) no active inflammation in the operated eye and no uveitis in the contralateral eye; 5) wish to improve the appearance or relief of symptoms.

The exclusion criteria were as follows: 1) inability to tolerate surgery, severe cardiac, pulmonary, hepatic, renal insufficiency, or systemic diseases; 2) the presence of other ocular diseases that cannot be controlled.

Ophthalmic Examination All patients were preoperatively examined, including slit-lamp examination, visual acuity, intraocular pressure (IOP), anterior segment of the eye, nine-direction, ocular protrusion, orbital computerized tomography (CT; axial length of the eye), preoperative corneal irritation [pain numeric rating scales (NRS)], and preoperative assessment of satisfaction with appearance.

Surgical Method The patient was placed in a supine position and routinely sterilized and toweled after satisfactory sedation and anesthesia. A 5 mL 1:1 mixture of 2.2% lidocaine+0.75% bupivacaine was used for retrobulbar infiltration anesthesia. The bulbar conjunctiva was cut along the edge of the cornea, and the Tenon's capsule was subconsciously detached until it broke through the intermuscular membrane. The bulbar conjunctiva and fascial tissue were bluntly separated. A circular blade excision of the superficial lamellar tissue was made under the anterior elastic lamina of the cornea and corneal limbal stem cells. Interrupted and para-suturing of the fascia was done using a 7-0 absorbable suture. Continuous contralateral suturing of the bulbar conjunctiva was performed using a 10-0 non-absorbable suture. The operation went smoothly, with little bleeding. A 0.3% tobramycin and 0.1% dexamethasone eye ointment was applied to the conjunctival sac, bandage pressure was applied to the operated eye, and the patient was returned to the ward (Figure 1).

Follow-up Observation All 38 eyes were followed up postoperatively for 6mo-2y, with a median of 9mo. Conjunctival healing checks for conjunctival clefting, flap recession, sac stenosis, and granuloma formation were performed using a postoperative slit-lamp examination. Eyelid height and eye protrusion were measured after wearing the prosthetic eyepiece; eye axis length was measured using CT scanning, and satisfaction scores were used to assess the patients' postoperative satisfaction with their appearance (scale: 5=very satisfied, 4=satisfied, 3=fairly satisfied, 2=unsatisfied, and 1=very dissatisfied), and pain NRS was performed to assess the relief of patients' symptoms of corneal irritation.

Statistical Analysis Statistical analysis was performed using Statistical package for the social sciences SPSS version 25.0. The ocular axis lengths in this study were normally distributed using the Shapiro-Wilk test and expressed as means±standard deviations. The paired *t*-test was used for preoperative and postoperative controls, with $P<0.05$ considered a statistically significant difference. Pain NRS appearance satisfaction rating data and count data, such as ocular prominence and lid height analyzed using the Wilcoxon rank sum test, were non-normally distributed and were expressed as medians, with $P<0.001$ considered statistically significant.

RESULTS

All 38 patients (38 eyes) included in this study were admitted to Nanchang University Eye Hospital, with open ocular trauma and complex retinal detachment. Following FCVB surgery, they developed corneal degeneration leading to leukoplakia, atrophy of the eyeballs, shrinkage, and pseudo-ptosis. Of these, 35 (92.1%) were male, and 3 (7.9%) were female. The mean age of the patients was 45y, with maximum and minimum ages of 60 and 12y, respectively. The time after implantation of the FCVB filler ranged from 4mo to 5y, with a median of 7mo.

During the postoperative follow-up period, slit-lamp

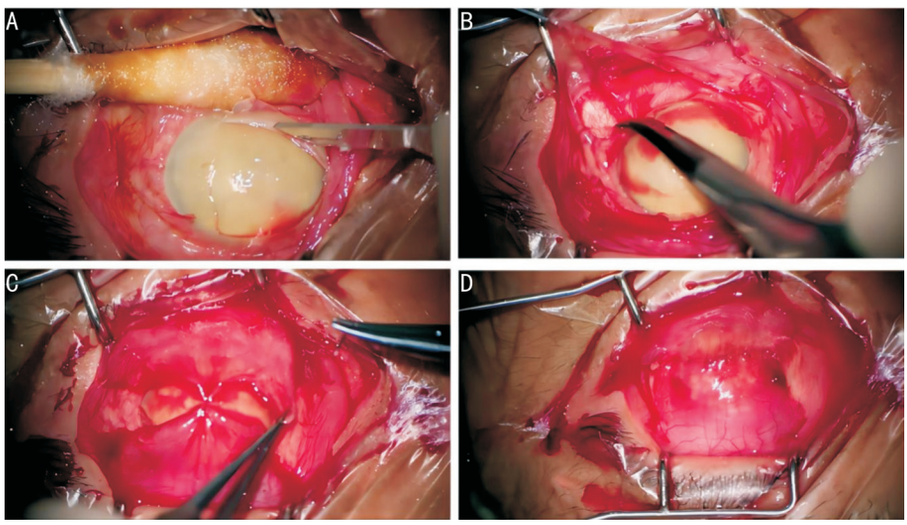

Figure 1 Conjunctival flap surgical procedure A: Cut open the bulbar conjunctiva and separate the Tenon's capsule; B: Circular blade excision of superficial lamellar tissue under the anterior elastic lamina of the cornea and corneal limbal stem cells; C: Contralateral suture of the fascia; D: Suture of conjunctival tissues.

examination results of 37 patients showed that the conjunctiva closely adhered to the corneal stroma and healed well. One case of conjunctival fissure healed well after surgical re-suturing. None of the patients had conjunctival granuloma, sac stenosis, or conjunctival flap posteriorly.

The median ocular protrusion was 11 mm preoperatively and 14 mm postoperatively, which was statistically significantly higher after treatment than before treatment (Z=-5.459, P<0.001).

The mean axial length measured by CT scanning was 20.82±0.94 mm preoperatively and 23.57±0.33 mm postoperatively, which showed a higher value after treatment, with a statistically significant difference (t=-20.207, P<0.05).

The median lid height was 6 mm preoperatively and 9 mm postoperatively. There was a marked improvement during the postoperative period compared to the preoperative period, and the difference was statistically significant (Z=-5.326, P<0.001).

The median appearance satisfaction was 1 preoperatively and 4 postoperatively. There was a marked improvement in appearance after the treatment, and the difference between appearance satisfaction before and after the treatment was statistically significant (Z=-5.447, P<0.001).

Five eyes had pain with an NRS score of 0–2 preoperatively, and all eyes had a score of 0 postoperatively. There was no statistically significant difference in satisfaction before and after treatment (Z=-1.100, P>0.05). Two of the cases had significant corneal irritation signs preoperatively (pain NRS of 2). Postoperatively, the corneal irritation signs disappeared (NRS=0), and the symptoms improved.

Seven patients had obvious corneal leukoplakia preoperatively (Figure 2A, 2B), and their appearance improved significantly postoperatively (Figure 2C). One patient had a severe preoperative eye rupture, and postoperative corneal clouding and atrophy with obvious corneal irritation signs (Figure 3A, 3B, 3C, and 3E), and after conjunctival flap masking surgery (Figure 3D), the appearance improved and irritation was significantly better (Figure 3F-3H). One young male patient with severe compound orbital bone fracture and traumatic ptosis, with marked ocular atrophy and abnormal eye position, showed satisfactory improvement in appearance after multiple surgeries (Figure 4). Preoperatively, the eyeball was atrophied, and a thickened prosthetic lens was worn to improve appearance after conjunctival flap occlusion. Postoperative CT showed that the prosthetic lens properly fitted the eyeball.

DISCUSSION

First, for patients with severe ocular trauma who require vitrectomy surgery for complex retinal detachment, using FCVB as vitreous replacement has been widely practiced in the clinic, and this can be beneficial for preventing and minimizing post-silicone-oil filling complications, such as elevated IOP, silicone-oil emulsification, and secondary glaucoma[7-8]. FCVB combined with silicone-oil filling is effective and safe[9-10]. However, in patients with severe corneal injury, extensive retinal and choroidal detachment, and ciliary body injury, postoperative symptoms, such as corneal leukoplakia, hypotony, or ptosis, may occur. Li *et al*[1] suggested the following possible reasons for this observation. The majority of patients with ocular trauma suffer severe damage to the eyeball and undergo multiple surgeries, which eventually disrupt the eye's normal structure and function. Implantation of an FCVB alters the microenvironment of the aqueous humor, impairing the corneal blood and nutrient supplies and leading to corneal endothelial failure and eventual corneal decompensation[11].

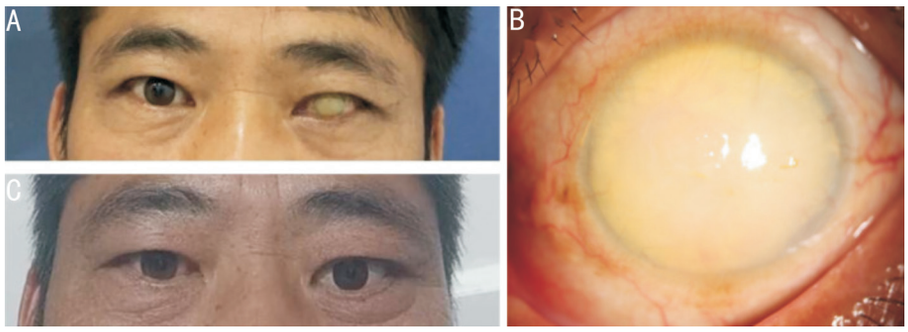

Figure 2 FCVB was implanted in the vitreous cavity after trauma to the left eye in March 2023 A, B: Corneal degeneration leading to corneal leukoplakia was seen on review in September 2023, with lid fissure height of 6 mm, ocular protrusion of 12 mm, and an axial length of 21.58 mm; C: Postoperative appearance after conjunctival flap masking surgery with prosthetic eye piece. Blepharospasm height 9 mm, eyeball prominence 15 mm, eye axis length 23.78 mm, appearance improved significantly. FCVB: Foldable capsular vitreous body.

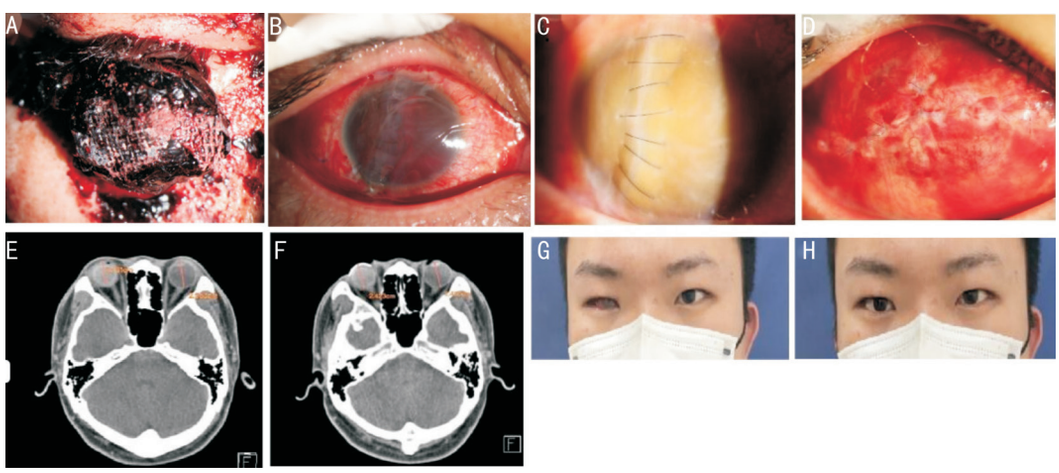

Figure 3 Vitreous cavity implanted into FCVB after severe ocular trauma in the right eye in December 2022 A, B: Anterior segment of the eye at the time of injury and after one-stage debridement suture in December 2022; C, E: Corneal clouding and atrophy with obvious corneal irritation at the time of the patient's re-examination in March 2023, with an axial length of the eye of 21.61 mm, a height of the lids of 6 mm; D, F, G, H: Anterior segment of the eye after conjunctival flap masking surgery and appearance after wearing the prosthetic eye piece, with the length of the eye axis 24.23 mm, the height of the lid fissure 8 mm, and the protruding degree of the eyeball 11 mm, and the orbital CT showed that the prosthetic eye piece fit tightly with the eyeball. FCVB: Foldable capsular vitreous body; CT: Computerized tomography.

Second, in some patients, the toxic effects of multiple silicone-oil injections lead to corneal pathologies. Chen *et al*[12] reported cases of corneal perforation, corneal dystrophy, and a series of other complications in the affected eyes after silicone-oil injection, which show that the duration of silicone-oil filling, aphakia, and the entry of silicone oil into the anterior chamber are all relevant and important risk factors. Again, the function of the ciliary body can be impaired due to trauma, inflammation, shock, *etc*[13-15], resulting in low IOP and shallow anterior chamber in the affected eye, causing ocular atrophy with pseudo-ptosis, and insufficient power to regulate the pupillary muscle groups leading to difficulty in anterior chamber formation, which in turn causes further damage to the cornea[16-17]. Finally, some scholars have found that the position of the surgical incision for FCVB implantation can affect the postoperative position of the iris, further affecting the depth of the anterior chamber and ciliary body function, causing corresponding complications.

In this study, most of the patients underwent multiple restorative surgeries and developed severe corneal damage. For patients with complications, asymmetry in both eyes can greatly affect the patient's appearance. This leads to low self-esteem and other adverse psychological emotions that affect the quality of life. Currently, corneal lamellar transplantation combined with conjunctival flap masking or conjunctival flap masking combined with amniotic membrane transplantation for the treatment of keratoconus due to various diseases has proven to be safe and effective[6,18-19]. For patients with symptoms, such as corneal leukoplakia, corneal irritation, and ptosis due to ocular atrophy after FCVB, and patients with the need to improve their appearance, we used corneal anterior elastic sublaminectomy of the superficial lamina cribrosa combined with conjunctival flap masking, and waited for conjunctival inflammation to subside and proper healing to occur after the surgery. In this study, five of the 38 patients developed symptoms of corneal irritation; however,

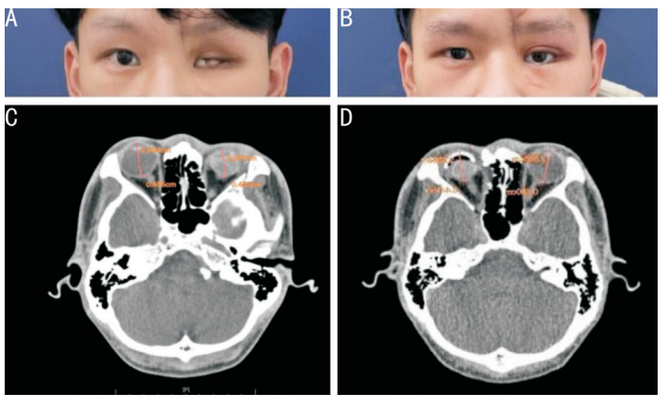

Figure 4 Vitreous cavity implanted into FCVB after severe ocular trauma in the left eye in October 2022 A, C: In January 2023, during the follow-up examination, there was eyeball atrophy accompanied by upper eyelid ptosis and significant eye misalignment. The axial length of the eye was 20.07 mm, which was significantly atrophied compared to the opposite eye. The height of the eyelid fissure was 5 mm, and the degree of eyeball protrusion was 5 mm; B, D: After wearing the artificial eye patch in March 2023, the appearance was significant improved with axial length of 23.06 mm, eyelid crack height of 9 mm, eyeball protrusion of 9 mm, and orbital CT showing partial gap between the prosthetic eye film and the eyeball. FCVB: Foldable capsular vitreous body; CT: Computerized tomography.

the preoperative and postoperative comparisons were not statistically significant.

Regarding pain, the mean value of the preoperative pain score was 2 in the five patients, and the postoperative pain scores were 0. The patients all complained of a decrease in pain. Therefore, it is reasonable to hypothesize that for corneal irritation caused by corneal dystrophy and other reasons, conjunctival flap masking surgery together with postoperative prosthetic eyewear can effectively alleviate corneal irritation. Postoperatively, wearing ceramic prosthetic eyepieces supports the upper lid while increasing the patient's ocular prominence and lengthening the ocular axis. In this study, the eyeball prominence, eye axis length, and lid height increased significantly when the post-prosthetic eye patch-wearing period was compared with the preoperative period. Better symmetry of both eyes and restoration of the patient's original appearance directly met the patient's psychological need for improved appearance. This procedure not only relieved the patient's ocular surface discomfort but also met the patient's psychological requirement of preserving the eyeball while providing the patient with a better cosmetic outcome and improving patient satisfaction.

For patients with severe ocular trauma, the traditional surgical approach of eyeball removal and intraocular content enucleation combined with hydroxyapatite prosthetic table implantation is associated with more postoperative complications, such as prosthetic table exposure or displacement, shallow vault, eyelid recession, conjunctival cysts, inflammation, and edema[20]. With the later development of vitrectomy technology, vitrectomy combined with silicone-oil injection surgery has provided a better solution to this problem. However, silicone-oil dependence also occurred from time to time, and patients not only needed multiple surgeries but also suffered silicone-oil retention complications, such as elevated IOP, silicone-oil emulsification, and secondary glaucoma, resulting in ocular discomfort. We chose to perform FCVB+silicone-oil filling followed by conjunctival flap masking for wearing the prosthetic eye piece at a later stage, which had the following advantages: 1) There was no need to remove the eyeball, therefore avoiding serious psychological problems. 2) The extraocular muscles and maintenance of part of the eye movement were better preserved. 3) Eyeball protrusion, axial length of the eye, and height of the eyelid fissure improved, together with an increase in eyeball realism. 4) The occurrence of surgical injuries and complications reduced, and the safety of surgery improved. 5) The cost of surgery was low, reducing the economic burden on patients. The patients' postoperative satisfaction significantly improved.

In conclusion, conjunctival flap covering and prosthetic eyepiece for postoperative ocular atrophy following FCVB can remarkably improve a patient's appearance while preserving the eyeball.

ACKNOWLEDGEMENTS

Special thanks go to the staff and faculty at the Affiliated Eye Hospital, Jiangxi Medical College, Nanchang University, who have provided us with a conducive environment and resources necessary for the completion of this thesis.

Authors' Contributions: Conceptualization (Xu QH and Wu LD); Methodology (Wu LD, Huang PJ and Peng Z; Validation (Wu LD and Xu QH); Investigation (Zhang H, Zhang SX and Wang AA); Formal analysis (Zhu YF); Writing—original draft preparation (Wu LD and Qiu MT); Writing—review and editing (Xu QH and Wu LD); Resources (Xu QH and Wu LD); Data curation (Zhang SX and Wang AA); Visualization (Peng Z, Ma LC and Qiu MT); Supervision (Xu QH); Project administration (Xu QH); Funding acquisition (Xu QH and Wu LD). All authors have read and agreed to the published version of the manuscript.

Foundations: Supported by National Natural Science Foundation of China (No.82260210); General Project of Jiangxi Provincial Traditional Chinese Medicine Science and Technology Plan (No.2023B1368).

Conflicts of Interest: Wu LD, None; **Huang PJ,** None; **Peng Z,** None; **Zhang H,** None; **Zhang SX,** None; **Wang AA,** None; **Qiu MT,** None; **Ma LC,** None; **Zhu YF,** None; **Xu QH,** None.

REFERENCES

1 Li SY, Wang XX, Dou ZX, *et al*. Study on maintenance of eyeball morphology by foldable capsular vitreous body in severe ocular trauma. *BMC Ophthalmol* 2023;23(1):463.

2 Zhang XY, Tian XM, Zhang BK, *et al*. Study on the effectiveness and safety of foldable capsular vitreous body implantation. *BMC Ophthalmol* 2019;19(1):260.

3 Li ML, Tang Y, Li SY, *et al*. Foldable capsular vitreous body implantation for complicated retinal detachment caused by severe ocular trauma. *Retina* 2022;42(8):1512-1519.

4 Zhang C, Xiao RH, Wang AN, *et al*. Silicone oil-filled foldable capsular vitreous body versus silicone oil endotamponade for treatment of no light perception after severe ocular trauma. *Retina* 2022;42(3):553-560.

5 Ma SN, Zhao SZ, Zhang CX, *et al*. Study on the efficacy and safety of foldable capsular vitreous body in the severe retinal detachment eyes. *BMC Ophthalmol* 2022;22(1):491.

6 Chen S, Tian MW, Zhang L, *et al*. Reattachment after foldable capsular vitreous body implantation in severe retinal detachment eyes. *Transl Vis Sci Technol* 2021;10(11):8.

7 Chen H, Feng SF, Liu YQ, *et al*. Functional evaluation of a novel vitreous substitute using polyethylene glycol sols injected into a foldable capsular vitreous body. *J Biomed Mater Res A* 2013;101(9):2538-2547.

8 Morescalchi F, Costagliola C, Duse S, *et al*. Heavy silicone oil and intraocular inflammation. *Biomed Res Int* 2014;2014:574825.

9 Lin XF, Ge J, Gao QY, *et al*. Evaluation of the flexibility, efficacy, and safety of a foldable capsular vitreous body in the treatment of severe retinal detachment. *Invest Ophthalmol Vis Sci* 2011;52(1):374-381.

10 Lin XF, Wang ZF, Jiang ZX, *et al*. Preliminary efficacy and safety of a silicone oil-filled foldable capsular vitreous body in the treatment of severe retinal detachment. *Retina* 2012;32(4):729-741.

11 Kuhn F. Ocular traumatology: prevention, prevention, prevention. *Graefes Arch Clin Exp Ophthalmol* 2010;248(3):299-300.

12 Chen Y, Kearns VR, Zhou LY, *et al*. Silicone oil in vitreoretinal surgery: indications, complications, new developments and alternative long-term tamponade agents. *Acta Ophthalmol* 2021;99(3):240-250.

13 Cinar E, Zengin MO, Kucukerdonmez C. Evaluation of corneal endothelial cell damage after vitreoretinal surgery: comparison of different endotamponades. *Eye* (*Lond*) 2015;29(5):670-674.

14 Venkatesh P, Chawla R, Tewari HK. Spontaneous perforation of the cornea following silicone oil keratopathy. *Cornea* 2005;24(3):347-348.

15 Yeung AM, Pherwani A, Tint NL, *et al*. Silicone oil-induced corneal perforation following complex retinal detachment. *Retin Cases Brief Rep* 2009;3(4):367-368.

16 Jiang H, Xue C, Gao YL, *et al*. Clinical application of foldable capsular vitreous bodies in the treatment of severe ocular trauma and silicone oil dependent eyes. *J Ophthalmol* 2022;2022:3608162.

17 Shekhawat NS, Kaur B, Edalati A, *et al*. Tenon patch graft with vascularized conjunctival flap for management of corneal perforation. *Cornea* 2022;41(11):1465-1470.

18 Du YL, Wang JS, Geng W, *et al*. Amniotic membrane transplantation combined with conjunctival flap covering surgery for the treatment of corneal perforations in fungal keratitis. *Heliyon* 2023;9(12):e22693.

19 Wang YC, Wang JS, Wang B, *et al*. Two-step strategy-conjunctival flap covering surgery combined with secondary deep anterior lamellar keratoplasty for the treatment of high-risk fungal keratitis. *Int J Ophthalmol* 2023;16(7):1065-1070.

20 Lin CW, Liao SL. Long-term complications of different porous orbital implants: a 21-year review. *Br J Ophthalmol* 2017;101(5):681-685.