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Value of Ocular Endoscopy in Extraction of Intraocular Foreign Bodies of Cilia in Patients with Open Ocular Trauma

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Background: The aim of this study was to analyze the value of ocular endoscopy in detecting and extracting intraocular cilia in patients with ocular trauma.





Material/Methods: We retrospectively analyzed data on identification and extraction of 46 intraocular cilia in 16 eyes with open-globe injury during endoscope-assisted vitrectomy.

Results: A total of the 16 patients with open-globe injury were operated on from September 2002 to June 2019. The cornea in 14 eyes was cloudy. Two eyes had endophthalmitis and 13 eyes had retinal detachment. A total of 46 cilia were extracted through direct observation under the ocular endoscope during vitrectomy 1 to 68 weeks after injury. The number of cilia per eye varied from 1 to 10. Most of the cilia were located in or near the wound. Postoperative IOP was normal in 14 patients. The follow-up after surgery showed hypotony in only 2 eyes (7.2 and 5.8 mmHg, respectively). Compared with preoperative intraocular pressure, there was a statistically significant difference. The postoperative visual acuity improved in 12 eyes and remained unchanged in 3 eyes. The vision after surgery was significantly improved compared with that before surgery ($P=0.006$). The intraocular pressure increased significantly after operation ($P<0.001$). And no glaucoma or retinal detachment or endophthalmitis was found. No eyes needed additional vitreous surgery.

Conclusions: Ocular endoscopy allows surgeons to detect intraocular cilia that were not undetected by CT or B-ultrasound preoperatively in time and to extract them effectively. It improves performance of vitrectomy in the presence of a cloudy cornea and also prevents exogenous endophthalmitis. The vision of patients with ocular trauma was improved.

Keywords: **Cilia • Endophthalmitis • Endoscopes • Vitrectomy**

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Background

Penetrating eye injury is one of the most common diseases that result in serious visual loss and economic burden on the patient and society. An intraocular foreign body is present in 18-41% of open-globe injuries [1] and is the key factor for visual outcome when removing an intraocular foreign body. Cilia is a type of small autogenic biological intraocular foreign body that is difficult to detect by auxiliary equipment prior to surgery, especially when located at the posterior ocular segment [2], and can lead to infective endophthalmitis or uveitis [3]. It was also a key factor leading to intraocular infection after intraocular foreign body removal surgery. Detecting and removing cilia early is very important for patients with ocular trauma. Endoscopy facilitates diagnosis and treatment of anterior segment diseases related to ciliary body, angle of anterior chamber, posterior iris epithelium, intraocular lens (IOL) position, and capsular support, which are difficult to access and visualize with conventional microscopy [4]. However, no studies have reported the value of ocular endoscopy in the detection and removal of cilia in patients with open ocular trauma. Therefore, we present our clinical experience using ocular endoscopy to detect and remove the cilia of patients with open ocular trauma.

Material and Methods

We recruited patients with ocular trauma and corneal opacity or accompanied with endophthalmitis hospitalized in the Beijing Tongren Hospital, Chengdu Aier Eye Hospital and Lixiang Eye Hospital Affiliated to Soochow University from September 2002 to July 2019.

Inclusion criteria were: (1) Patients with a clear history of trauma; (2) Patients with ocular trauma accompanied with corneal opacity, or with endophthalmitis.

Exclusion criteria were: patients with severe systemic disease.

This study was accepted by the Ethics Board of Soochow University, Soochow Jiangsu, China, approval number SLER 2020130.

The Evaluation Prior to Surgery

Patients included were routinely examined using slit-lamp microscopy, ophthalmoscope, B-ultrasound, and orbital computed tomography (CT) or magnetic resonance imaging (MRI) to assess intraocular foreign bodies, retina, and vitreous body. Assessment of visual acuity was performed using a logarithmic visual acuity chart. Thereafter, an appropriate surgical program was selected.

Surgical Procedures

Dr. Y, a licensed physician, performed all surgical procedures.

Three-channel closed vitreoretinal surgery (gauge 20 or 25) was performed under the guidance of ocular endoscopy for all patients.

First, turbid vitreous was removed during surgery. If patients with intraocular foreign bodies were identified before surgery, the blood around the foreign bodies and vitreous or membranes was removed. Then, the foreign bodies found preoperatively were removed using vitreous foreign body forceps. The cilia found preoperatively were taken out with forceps.

Second, an examination was carefully performed using ocular endoscopy. The cilia were carefully taken out with the forceps as soon as they were found.

Finally, the retina was reattached by retinal photocoagulation or cryotherapy, followed by tamponade of silicone oil or gas (SF6 or C2F6). All the intraocular foreign bodies (cilia and other kinds) were removed with endoscopy assistance.

The endoscopes used in this study were: OTI endoscope (Canadian Ophthalmic Technologies, Inc., 10 000 pixels, 3-channel) and a PolyDiagnost endoscope (German PolyDiagnost GmbH, 10 000 pixels, dual-channel) or an EndoOptics endoscope.

Patient Follow-Up

All the patients were followed for 1 year after surgery. Information about visual acuity, intraocular pressure, cornea, and ocular fundus was obtained using a slit lamp, indirect ophthalmoscopy, and B-ultrasound (CT and MRI with special eye coil for review, if necessary).

Statistical Analysis

All data analyses were conducted using SPSS (version 17.0, SPSS, Inc, Chicago, IL, USA). Categorical variables were analyzed using the Mann-Whitney U test. Preoperative and postoperative visual acuity were compared using the paired *t* test. The vision was evaluated using an independent-sample *t* test. Preoperative and postoperative intraocular pressure were compared using the paired *t* test. The values of Snellen or best-corrected visual acuity (BCVA) were converted into the logarithm of the minimum angle of resolution (LogMAR) for statistical analysis. When the vision was <20/800, the LogMAR value was: counting fingers (CF)=2.3, hand motion (HM)=2.6, light perception (LP)=2.9, and no light perception (NLP)=3.2. A *P* value <0.05 was established as the level for statistical significance.

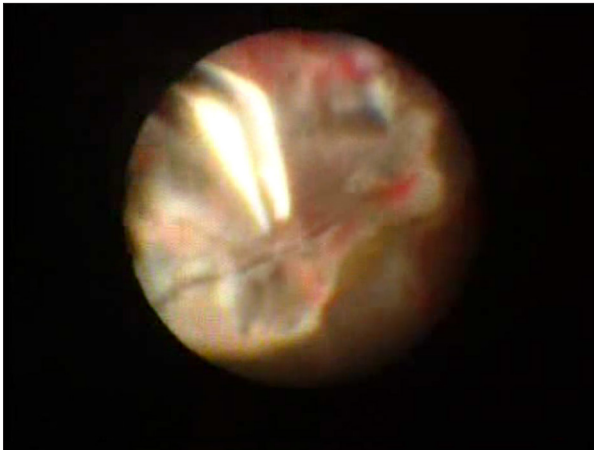


Figure 1. The cilium is located at the temporal scleral wound in patient 8. The patient has explosion injury of both eyes. The visual acuity before and after the operation was light perception.

Results

A total of 16 male patients were included, with an average age of 30.0 ± 16.5 years (range, 5-63 years). Among them, 9 cases were penetrating injury, 5 were explosive injury, and 2 were blunt trauma. One case was associated with endophthalmitis before the operation, and 1 was suspected endophthalmitis during surgery (patients 1 and 13, respectively). The preoperative corneas of the patients were opaque to different degrees with visible corneal laceration suture, except for 2 patients (patients 1 and 9). Thirteen cases were accompanied by retinal detachment, and 8 were combined with other intraocular foreign bodies.

Intraocular pressure of 6 patients were lower than 10 mmHg preoperatively. There were 15 patients with poor vision, manifested as light perception, hand movement, counting figures, or no light perception.

Among these patients, 2 (patients 5 and 7) had already had 1 surgery to remove the intraocular foreign body before the study, and 1 case (patient 13) had 3 vitreoretinal operations before the study. There were only 2 cilia found in 1 case (patient 1) by using a routine examination prior to the operation.

The interval between the injury and operation was from 6 to 479 days.

A total of 46 cilia were found and extracted among these patients using endoscope-assisted vitrectomy. Each patient had 1-10 cilia of foreign bodies, with the length between 1.5 and 8 cm. Most of the cilia were discovered near the wound track, near or at the injured parts of the retina, and at the vicinity of other foreign bodies. Among them, 8 were found around other foreign bodies, 16 at the posterior retinal choroidal laceration, 4 at the anterior chamber angle, and 4 were wrapped in a detached retina next to a traumatic break (Figures 1, 2A, 2B).

Postoperative IOP were normal in 14 patients, and 2 patients had low IOP during the follow-up time (7.2 and 5.8 mmHg, respectively). The intraocular pressure increased significantly after the operation ($P < 0.001$). For postoperative vision, BCVA of many eyes improved significantly after surgery ($Z = -2.763$, $P = 0.006$). Twelve patients showed an improvement of visual acuity, and 3 were the same as before the operation. The visual acuity of 3 eyes without retinal detachment before surgery recovered to 20/400 (Table 1).

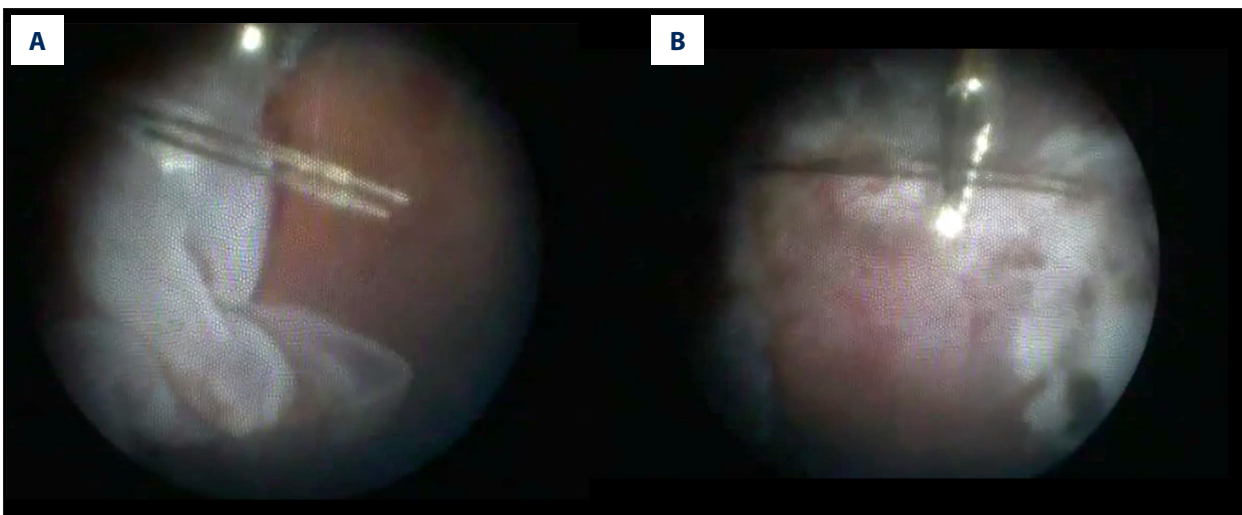


Figure 2. (A, B) The left eye was injured by an iron hook in patient 14, with traumatic retinal choroidal detachment and intraocular foreign body (2 cilia and a glass foreign body were located at the curl of the retinal wound). Preoperative visual acuity was light perception and postoperative visual acuity was hand movement.

One of the 16 cases were filled with water, 5 were filled with gas, and 10 were filled with silicone oil. Four cases received silicone oil removal surgery due to retinal detachment recovery, and there were no obvious postoperative complications such as retinal detachment or endophthalmitis.

Discussion

Ocular trauma is the main reason for monocular vision loss, and an intraocular foreign body often leads to diminution or loss of vision [5]. The incidence of intraocular cilia in blast injuries is about 3%. According to a previous report, 6/11 eyes with intraocular cilia were caused by flips of iron wire [6,7].

Intraocular foreign bodies in the posterior segment present more serious prognoses [8,9]. As a type of autogenic biological foreign body, the eyes' reaction to cilium varies unpredictably. Whether cilia foreign bodies in the posterior segment have to be removed or not through an operation depends on the situation [10]. Intraocular cilium have been reported to be asymptomatic for 50 year in the anterior chamber [11]. However, more reports have shown that cilia left in eyes tend to cause polytype endophthalmitis [1,2]. Therefore, the cilia, especially with follicle found accidentally in the operation, should be taken out at the same time if possible.

CT scanning is useful to detect most IOFB and it is also the criterion standard for diagnosis of intraocular foreign bodies, but

Table 1. Characteristics of intraocular foreign bodies and the prognosis in all patients.

No.	Foreign bodies	Number and length of cilia	Location of the cilia	Corneal condition
1*	Cilia (preoperative found)	2, both 8 mm	Behind the posterior lens capsule	Transparency
2	Cilia	2, both 5 mm	Pole, scar	Corneal suture, edema
3	Magnetic intraocular foreign + cilium	1, 3 mm	Above the temporal	Temporal scar
4	Cilium	1, 3 mm	Anterior chamber angle	Suture
5	Magnetic intraocular foreign body +cilia	3, 3 mm, 3 mm, 5 mm	The temporal side of the optic nerve injuries	Corneal leukoplakia above nasal side
6	Cilium	1, 2 mm	vitreous chamber	Wound, scar, edema
7	Cilia	3, all 3 mm	Temporal ciliar body, under the nasal of the IRIS back	Foreign body, scar
8	Nonmagnetic intraocular foreign body (multi)+cilium	1, 4 mm	Temporalscleral injury	Corneal opacity, foreign body
9	Nonmagnetic intraocular foreignbody+cilium	1, 6.5 mm	Below the nasal	Transparent
10	Cilium	1, 5 mm	Posterior pole	Scar
11	Cilium	1, 3 mm	Wrapped the retina	Scar
12	Nonmagnetic intraocular foreignbody (multi)+cilia	4, 1.5-4 mm	With multipleforeign bodies	Corneal opacity,scar
13	Cilium	1, 3 mm	Near the retina wound	Scar, edema, neovascularization
14	Cilia+nonmagnetic intraocular foreignbody	2, both 4 mm	Wrapped the curly retina	Suture
15	Cilia+magnetic intraocular foreign body	9, 1.5-4 mm	Near the retina wound	Scar, edema
16	Cilia+magnetic intraocular foreign body	10, 1-4.5 mm	Near the retina wound	Scar, edema

Table 1 continued. Characteristics of intraocular foreign bodies and the prognosis in all patients.

No.	RD	Preopera-tivevisual acuity	Last follow-up vision	Preoperative IOP (mmHg)	Final IOP (mmHg)
1*	No	20/20	20/32	14.6	15.2
2	Yes	LP	20/4000	13.2	13.9
3	Yes	HM	CF	6.0	10.5
4	Yes	HM	CF	12.4	11.4
5	Yes	LP	HM	8.6	10.3
6	Yes	LP	20/800	11.5	15.1
7	Yes	LP	HM	12.4	14.3
8	Yes	LP	LP	5.3	5.8
9	No	CF	20/100	13.6	15.5
10	No	LP	20/400	11.5	13.1
11	No	LP	HM	10.4	13.6
12	No	NLP	HM	10.1	14.1
13	No	HM	HM	11.3	13.5
14	Yes	LP	HM	6.9	11.2
15	Yes	NLP	NLP	4.7	7.2
16	Yes	LP	HM	5.2	10.5

The patient lost after postoperative 11 days, he is the only one that the intraocular cilia were found before the operation. RD – retinal detachment; LP – light perception; HM – hand-movement; CF – counting figures; NLP – no-light perception.

detecting lower-density tiny biological foreign bodies is very difficult [12]. Detection of cilia in the posterior segment mainly depends on direct sight during the operation. It is difficult for conventional vitrectomy operation to detect and remove cilia when the cornea is cloudy. In our study, although each of the 2 cases (patients 5 and 7) had 1 conventional vitrectomy under microscopy to remove the intraocular foreign body before the study and 1 case (patient 13) underwent 3 vitreoretinal surgeries under microscopy and non-contact wide-angle funduscopy, 7 cilia that remained in 3 eyes were found by using ocular endoscopy-assisted detection. This also proves that it is very difficult to diagnose intraocular cilia, especially when the corneal transparency is relatively low and the vitreous is cloudy.

Since Thrope published a paper about the application of ocular endoscopy in removal of intravitreal foreign bodies in 1934, endoscopy has developed quickly in recent years, from hard endoscopes to optic endoscopes or electronic ones [13]. Endoscopes have also been widely used for diagnoses and treatment in various clinical subjects. Ocular endoscopes have also continuously improved and become widely used, and gradually been applied in fields of eye surgery. It has a better effect than conventional methods, especially in special cases such

as corneal opacity or surgery for a tiny foreign body which is the blind area [14].

For patients with endophthalmitis, ocular endoscopes can provide a better surgical field of vision to find intraocular foreign bodies, and to conduct complete vitrectomy, which could obviously reduce peripheral vitreous opacity, pathogenic microorganisms, and their metabolites. Thus, the recurrence of infection and complications can be significantly decreased [15]. In this study, patient 1 had been diagnosed with endophthalmitis before the operation, and patient 13 was highly suspected of having chronic endophthalmitis during the operation. In postoperative follow-up, the 2 patients recovered well, and endophthalmitis did not recur.

Even if there is no history of major ocular trauma, patients with unexplained intraocular infection must be examined carefully, and intraocular foreign bodies such as intraocular cilia should also be considered, and detailed examination should be made along the wound tract [16]. In our study, 10 cilia around other foreign body were found and cleared off. The shortest cilia were only 1 mm, which was difficult to detect under the pan-retina funduscope.

Ocular endoscopes can also be used for patients with corneal opacity with disorders in the posterior segment. Operating on these patients with a microscope may miss tiny intraocular foreign bodies, including intraocular cilia. Ocular endoscopes can make up for this deficiency. Furthermore, these patients usually need temporary keratoprosthesis. Ocular endoscopes used can avoid waiting for a donated cornea, and can also avoid corneal transplantation complications such as rejection.

In addition, ocular endoscopes also have a unique advantage during surgery. If a patient has endophthalmitis, the peripheral vitreous needed to be completely removed without touching the clear lens, which was difficult for surgery with a conventional microscope, but ocular endoscopes can easily do this. In our study, in patient 9, accompanied by severe choroid laceration and traumatic aphakia, a corneal approach was relatively safer than a sclerochoroiditis approach. However, a corneal approach under retinoscopy would lead to corneal deformation, which makes the fundus unclear. Therefore, the use of an ophthalmoscope makes the operation safer and more effective to avoid the injury during the operation.

In our study, postoperative intraocular pressure of 14 patients returned to normal after endoscopy-assisted vitrectomy. Compared with preoperative intraocular pressure, there was a statistically significant difference. The visual acuity of 12 patients improved significantly compared with that before the operation. There were 13 patients with retinal detachment, 11 patients were silicone oil tamponade, and the silicone oil in 4 eyes was removed during the follow-up.

The consequence of intraocular cilium was not predictable and can cause inflammation to varying degrees. There were reports of inducing uveitis, iris cyst, cataract, intralenticular abscess, and endophthalmitis [17]. Therefore, if surgery was necessary anyway and once a cilium was found, it should not be left behind because it may cause inflammation. It is difficult to diagnose intraocular cilia foreign bodies before surgery, but the

surgeon should always keep in mind the possibility of finding a cilium during surgery for open-globe injury. Most intraocular cilia foreign bodies are located near the wound track and might not be detected during the operation, even during multiple operations. As a result, the wound track should receive special attention. For patients with serious eye trauma with cloudy cornea or endophthalmitis, endoscope-assisted vitrectomy surgery should be helpful. Endoscopy can carefully observe the base of the vitreous, the ciliary body, and the back of iris. With the help of endoscopy, the intraocular areas beyond the operative field of conventional vitrectomy can be searched by direct sight; the intraocular foreign bodies such as cilia, which are difficult to detect before surgery, can be discovered in a timely manner and removed effectively, without being affected by corneal opacity, and the occurrence of the postoperative endophthalmitis is reduced.

Conclusions

Ocular endoscopy allows the surgeon to detect the intraocular cilia in time and to extract them effectively. It helps to prevent exogenous endophthalmitis, permitting vitrectomy to be performed quickly, even in the presence of a cloudy cornea. Therefore, it is beneficial to use ocular endoscopy for patients with open ocular trauma.

Ethics Statement

All participants provided informed consent and the study protocol was approved by the institute's committee on human research.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors, who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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