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Original Article

Management and clinical outcomes of intraocular foreign bodies with the aid of orbital computed tomography

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Abstract

Background: Computed tomography (CT) is known to be the first-line imaging method for patients with or suspect to have intraocular foreign bodies (IOFBs). The purpose of this study is to evaluate clinical outcomes in the management of IOFBs with the aid of CT.

Methods: Retrospective chart review of patients who received orbital CT prior to the removal of an IOFB between January 2000 and December 2010 was carried out. Patients with an IOFB who did not receive an operation or those without a preoperation CT examination were excluded. Twenty patients with a mean age of 37 years were selected. The duration between injury and surgery ranged from hours to 4 months. Detailed information and ophthalmologic examination results including patient history, visual acuity (VA), slit-lamp examination, fundoscopic examination, operation notes and bacterial culture results were recorded for all patients. The orbital CT images were performed with multidetector CT scanners with a 2–3.75 mm slice thickness.

Results: This study found 18 patients (90%) with only one IOFB on CT image, in which only nine IOFBs were discovered on clinical assessment. The CT image failed to discover the IOFB in two patients who had tiny iron dust fragments located in the cornea stroma or embedded in the lens. Preoperative determination of the IOFB size and location was helpful in the decision-making of the route of extraction.

Further, there was a correlation between clinical presentation about vitreous hemorrhage and the development of postoperative retinal detachment (Fisher's exact test, $p = 0.029$). The presence of positive bacterial cultures was also found to be associated with decreased VA (Fisher's exact test, $p = 0.047$). The injured eyes were anatomically preserved in all patients. However, two patients had loss of light perception. Eleven patients (55%) had improved VA of more than two lines on Snellen's chart, seven patients worsened, and two patients retained the same initial VA.

Conclusion: Multidetector CT plays an important role in the detection, localization, size measurement, and surgical approach towards the extraction of the IOFB. The presence of vitreous hemorrhage is a predictive factor for postoperative retinal detachment, and positive bacterial cultures result in poorer visual outcomes.

Keywords: intraocular foreign body; orbital computerized tomography; postoperative retinal detachment; vitreous hemorrhage

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1. Introduction

Sustained intraocular foreign bodies (IOFBs) following penetrating eyeball injury may cause severe visual loss with serious complications such as endophthalmitis and retinal detachment (RD).[1] However, the emphasis on occupational health and safety in the past 50 years has reduced the number

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of IOFBs seen in manual laborers by two thirds.[2] It is also thought the decreased prevalence of IOFBs is likely to be a result of decreased amounts of heavy industry. Further, modern vitrectomy techniques and the use of broad-spectrum antibiotics have improved visual outcomes, even when the removal of the IOFB is delayed after 24 hours.[1,2]

Computed tomography (CT) has played a role as the first-line imaging method for exploring ocular trauma in patients with a suspected IOFB.[3–6] In this study, we reviewed the cases of IOFB in Taipei Veterans General Hospital during a 10-year period, evaluated the surgical outcomes, and determined the accuracy and role of CT in the planning and management of patients with an IOFB.

2. Methods

A total of 41 medical records for patients with the diagnosis of IOFB who were admitted to our hospital between January 2000 and December 2010 were reviewed retrospectively. All records were reviewed after de-identification and consent by all patients. Detailed information and ophthalmologic examination results included patient history, VA, slit-lamp examination, fundoscopic examination, operation notes, and bacterial culture results. The orbital CT images were performed with multidetector CT scanners with a 2–3.75-mm slice thickness along the transaxial direction with the sections parallel to the optic nerve along a line from the inferior orbital rim to the upper pinna. The coronal sections were performed with a 3-mm slice thickness from the globes to the *dorsum sella*. All CT images in both the bone and soft tissue windows were reviewed by the same radiologist without knowledge of the patient's information. Subsequent management decisions and operations were based on the CT imaging and ophthalmologic examination. Swabs from the wounds were collected and sent for culture in the operation room prior to the surgery.

Excluded from this study were patients with an IOFB who did not receive operations due to an unstable medical condition or severe injury to the brain (2 patients). Twelve patients who had clinically identifiable IOFB and thus no preoperative CT examination were also excluded. Six patients who lacked a complete medical record, including the type of injury, complete ophthalmic examination, swab culture during the operation, and types of IOFB, were also excluded. Finally, one patient who did not have a follow-up for at least 1 month was not enrolled.

Statistical analysis was performed using SPSS software version 18.0 (SPSS Inc., Chicago, IL, USA). Categorical variables were analyzed using Fisher's exact test. A p value of <0.05 was considered statistically significant.

3. Results

A total of 20 eyes with an IOFB, preoperative CT images, and complete ophthalmic data from January 2000 to December 2010 were enrolled in the study. The demographic data and characteristics of all patients are listed in Table 1. All 20 patients were male, and their ages ranged from 5 years to 56 years (mean, 37 ± 12.33 years). The mean follow-up time ranged from 1 month to over 10 years (mean, 26.6 months).

Eighty-five percent (17 of 20) of the patients were labor workers (including 2 farmers and 2 blacksmiths) and were injured while working. The common causes of the IOFB were hammering (50%), weeding (15%), and grinding (10%). The nature of the IOFB was metal (17 cases), stone (2 cases), and wood (1 case). The preoperative VA ranged from 0.9 to light perception: worse than hand motion (2 cases), between hand

Table 1
Demographic data and outcome of all patients.

No.	Sex/Age	Material of IOFB	Clinical detection of IOFB	IOFB entry route	Culture	Other clinical findings	Postop RD	Initial VA	Final VA
1	M/36	Iron dust	Slit lamp	Cornea	—	Nil	–	0.9	0.9
2	M/32	Nail	Slit lamp	Cornea	—	VH	+	CF	0.4
3	M/44	Copper	Fundoscopy	Cornea	—	IOFB, VH	–	0.6	0.8
4	M/40	Iron dust	Fundoscopy	Cornea	—	IOFB	–	0.2	0.5
5	M/23	Iron dust	Fundoscopy	Cornea	+	VH	–	0.7	0.2
6	M/44	Metal	Fundoscopy	Cornea	—	IOFB	+	0.5	0.7
7	M/56	Iron chip	Fundoscopy	Cornea	—	IOFB, VO	–	0.2	0.1
8	M/38	Metal	No	Cornea	+	AC reaction, cataract	–	HM	NLP
9	M/47	Iron	No	Cornea	—	Cataract	–	CF	0.7
10	M/44	Metal	No	Cornea	—	Cataract	–	HM	0.1
11	M/30	Stone	No	Cornea	—	Endophthalmitis	+	LP	NLP
12	M/10	Stone	N0	Cornea	+	AC reaction, cataract	+	HM	LP
13	M/38	Metal	No	Cornea	—	Cataract with subluxation	–	LP	CF
14	M/49	Nail	No	Cornea	—	Cataract	+	HM	CF
15	M/50	Wood	Fundoscopy	Sclera	—	IOFB, retinal hemorrhage	–	0.7	1.0
16	M/42	Nail	Fundoscopy	Sclera	+	IOFB, shallow RD, VO	–	0.9	0.7
17	M/34	Iron dust	Fundoscopy	Sclera	+	IOFB, VH	–	0.06	0.9
18	M/35	Iron dust	No	Sclera	—	VO, no IOFB	–	0.3	0.5
19	M/44	Iron dust	No	Sclera	—	VH, no IOFB	–	CF	CF
20	M/5	Fishhook	Slit lamp	Sclera	—	IOFB in AC	–	0.8	0.7

AC = anterior chamber; CF = counting finger; HM = hand motion; IOFB = intraocular foreign body; LP = light perception; M = male; NLP = no light perception; RD = retinal detachment; VA = visual acuity; VH = vitreous hemorrhage; VO = vitreous opacity.

motion to 0.1 (8 cases); between 0.1 and 0.5 (3 cases); and better than 0.5 (7 cases). The mean duration between injury to removal of the IOFB ranged from hours to 4 months. Among them, 55% (11 of 20) of the cases were able to receive operations within 24 hours.

CT failed to reveal an IOFB in two patients who had tiny iron dust fragments located in the cornea stroma or embedded in the lens. Among the other 18 patients who had positive CT of the IOFB, the IOFB could not be found clinically in nine patients (50%), either by slit lamp biomicroscopy or fundus examination. This was because of traumatic cataract in four eyes, direct entry through the sclera wall in two eyes, severe anterior chamber reaction in two eyes, and endophthalmitis in one eye. Endophthalmitis was noted in one patient injured by a stone with a final outcome of bulbar atrophy. However, no endophthalmitis development was noted in the other 19 cases.

The size of the IOFB in each eye on CT image was measured using digital calipers on the CT scan and later compared with the size of the removed IOFB. The ratio of sizes on the CT scan to actual IOFB sizes varied from 0.75 to 2.7 (mean, 1.48).

Vitrectomy was done in 18 cases, and lens removal was performed at the same time in 10 of those cases. In 15 of those 18 cases, the IOFB was removed with either a magnet or intraocular forceps through the sclerotomy or another limbus incision wound. Two IOFBs were removed with a magnet externally from the posterior sclera-penetrating wound, and the IOFB in Patient 8 was removed with an open sky vitrectomy due to its large size of 11 mm × 1 mm. The other two cases of IOFB were removed with forceps from the anterior chamber without performing vitrectomy.

Clinical presentation of VH was statistically correlated with the development of postoperative RD (Fisher's exact test, $p = 0.029$). The mean final VA ranged from no light perception to 1.0. Two patients had a result of no light perception after removal of the IOFB. Improved VA was defined as an increase of two lines on Snellen's E chart when compared with the initial VA. Eleven patients had improved final VA, seven patients had worse, and two patients remained the same after removal of the IOFB. Absence of culture growth from wound swabs was associated with improved VA outcomes (Fisher's exact test, $p = 0.047$).

4. Discussion

In accordance with previous reports, our study showed all patients with IOFB were males with a mean age of 37 years. Further, as in other reports, hammering, chiseling, and grass trimmers were the most common causes of IOFB in our series.[2,7–9]

Multidetector CT scans can provide high-resolution images within a short time with excellent distinction between normal and abnormal bony and soft tissue structures.[4] With a thin section of 3 mm collimation to further reduce scanning time and radiation dose, the spatial resolution, and quality of the reconstruction images remained at an acceptable and diagnostically reliable level.[10] Radiologic imaging, even when an IOFB is clearly seen on clinical examination, is still recommended for a possible second hidden IOFB.[2] The slice thickness was 2–3 mm in all our cases, except one which used 3.75 mm collimation. The sensitivity of the CT image in our study to detect IOFB was 90% and only failed to discover IOFB in two patients. One of these patients had a tiny speck of iron dust located in the cornea stroma, and the other had an IOFB embedded in the lens. In both patients, the sizes of the IOFB were smaller than 1 mm × 1 mm, and they were both detected by slit-lamp examination.

CT imaging also plays an important role in correlation with clinical presentation. Both slit-lamp and fundoscopy examination failed to visualize the IOFB in nine patients with positive clinical history and signs. Most of these patients had a corneal entry wound associated with severe AC reaction or traumatic cataract that precluded the detection of the IOFB. By contrast, in the subgroup of patients with a sclera entry route, fundoscopic examination failed to detect an IOFB that was very close to the sclera wall. Thus, the CT image was important in this subgroup as well.

Preoperative estimation of the IOFB size and location by CT scan was helpful in the decision-making regarding the route of extraction.

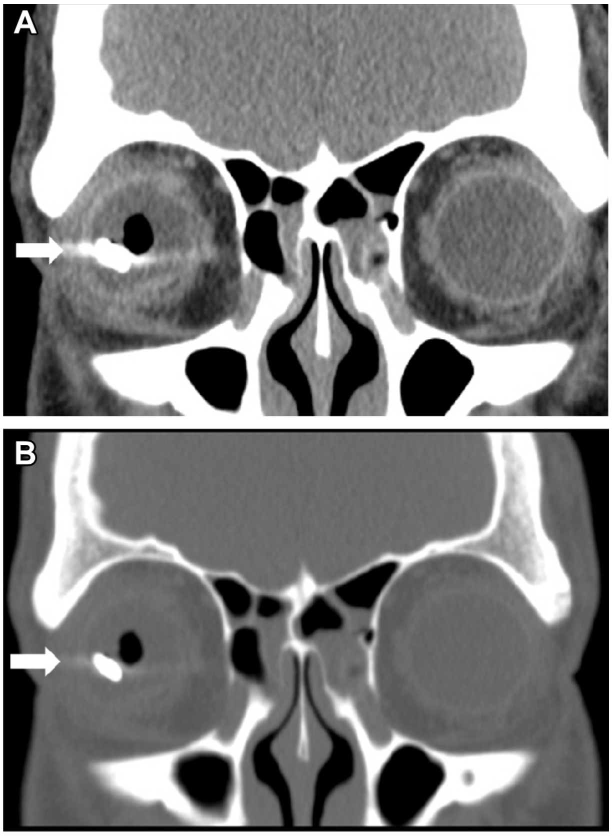

Fig. 1. Computed tomography (CT) of Case 13. (A) Original coronal CT shows that a metal foreign body in the right eyeball (arrow) is contributing to blooming artifacts, which is hampering the visualization of the intact sclera wall. It is easy to overestimate that the intraocular foreign body is through the scleral wall. (B) After adjustment of the window level of the CT images with fewer blooming artifacts, coronal view shows that the intraocular foreign body is in the posterior segment of the right eyeball with an intact scleral wall.

Fig. 2. Computed tomography of Case 5, who had an intraocular foreign body embedded within the scleral wall with part of it protruding into the extraocular space. The intraocular foreign body was removed by magnet externally from the posterior sclera wound via a periorbital approach.

Fifteen patients with IOFB identified in the posterior segment or embedded on the scleral wall had their IOFB removed by either a magnet or intraocular forceps through the sclerotomy vitrectomy (Fig. 1). When the size of the IOFB shown on CT was estimated to be much larger than the sclerotomy (1.0 mm), even after enlargement, it was then decided to remove the IOFB via another limbus incision wound or open-sky. By contrast, IOFBs penetrating through the scleral wall with part of it protruding into the extraocular space were removed by a magnet externally from the posterior sclera wound with a periorbital approach (Fig. 2).

Estimation of the size of the IOFB by preoperative CT scan is important in planning the surgical procedures. Overestimation of size of metallic IOFBs by a factor of 1.26–2.29 on the soft tissue window setting is a well known phenomenon in CT scans.[10,11] By contrast, the bone window setting measurement, which is closer to the actual size, has a difference ranging from 28% to 86% compared to those using the soft tissue window setting.[10] This study measured the size of the IOFBs on the CT scan after viewing both the soft tissue and bone windows. The larger one was then compared with the actual IOFB size removed during operation. The ratio varied from 0.75 to 2.7 (mean, 1.48). The cause of overestimation of the size is due to blooming artifacts caused by a metal IOFB. Adjustment of the window width and center values of the CT scans to reduce blooming artifacts is helpful to evaluate the size more precisely.

Five patients who developed postoperative RD were noted to have VH either under fundoscopic examination or during the operation. Vitrectomy is essential in these cases, for clearance of the hemorrhage, but it cannot prevent postoperative RD. Postoperative RD rates were 6.3–36.8%,[1] which may have been caused by possible subsequent inflammation and proliferative vitreoretinopathy.

In our study, all patients preserved the injured eye. Univariate analysis showed only positive bacterial culture growths from the wound swab were statistically correlated with poor visual outcomes in our study. This may be due to our relatively small sample size and the bias of defining improved VA as an increase in two lines of Snellen's E chart compared with the initial VA.

Penetrating wounds with an IOFB is still a common and serious form of eye trauma in the labor population. In our study, CT was essential in patients who lacked significant evidence of IOFB on their ophthalmic examination but with an exposure history.

In conclusion, with the aid of multidetector CT and reconstruction techniques, the detection, localization, size measurement, and surgical approach towards extraction of IOFB has become efficient and reliable. We also found that VH was a strong indicator of postoperative RD and negative bacterial culture results in better visual outcomes. Finally, we successfully preserved all injured eyes, and most of our patients showed improved or preserved VA after the removal of the IOFB.

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