FORTY-SEVEN CONSECUTIVE CASES OF INTRA-OCULAR FOREIGN BODY

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A CONSIDERABLE literature has accumulated upon the subject of retained intra-ocular foreign body, with arguments extolling the virtues of the anterior route method of extraction over the posterior route and *vice versa*. Various authors have attempted to formulate precise indications for one or other method which in principle have amounted to anterior removal of the smaller foreign bodies and posterior removal of the larger. It is not the purpose of this paper to add to the argument, but to review a series of cases which have been dealt with almost exclusively by the anterior route method using an immobile giant magnet, and to discuss the prognosis in the light of the experience gained, taking into account such variable factors as size of foreign body and depth of penetration.*

MATERIAL

The series comprises 47 consecutive cases of retained metallic intra-ocular foreign body occurring over a period of 20 months, representing 0.104 per cent. of all new out-patients and 0.24 per cent. of all new accident cases. The average age of the patient injured was 34 years. Clegg (1916), reporting a series of 130 cases of retained intra-ocular and intra-orbital foreign body occurring over a period of 15 years at the same Hospital, found the proportions to be 0.125 per cent. of all out-patients and 0.51 per cent. of all accident cases.

Causes of Injury.—It is significant that so many of the injuries (24 cases, 51 per cent.) were caused by one particular type of manoeuvre, that of striking the head of a chisel or some other metal tool with a hand hammer, and that a further six injuries (12.8 per cent.) were caused by metal chippings flying from a neighbouring workman's hammering (Table I, opposite). Inquiries revealed that in some instances the patient had been taking a short cut in an engineering job, by hammering or chipping off metal parts instead of using a more appropriate and time-consuming, although apparently safer, procedure. However, this seemed to be accepted as normal practice by all concerned and the dangers not appreciated until too late. Twenty men were injured whilst using the hammer in the right hand, and fifteen of these suffered injury to the left eye. This preponderance of left eye injuries in this type of work supports the observations of Goulden (1908) and Parsons (1916) that the posture of the worker striking with the right hand places the left eye forwards towards the work, thus rendering it more exposed to injury, while the 'parapet' of the nasal bridge protects the right eye. However,

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TABLE I
CAUSES OF INJURY

Causes of Injury	Cases		Eye	
	No.	Per cent.	Right	Left
Hand hammer	24	51.0	6	18
Neighbour's hand hammer ..	6	12.8	2	4
Total Hammer	30	63.8	8	22
Metal from working machinery ..	7		5	2
Sledge hammer	1		—	1
Wire from air-brush	1		1	—
Wire cutting	2		1	1
Airgun pellet	1		—	1
Petrol tank explosion	1		—	1
Unclassified	4		2	2
Grand Total	47		17 (36.2 per cent.)	30 (63.8 per cent.)

three of the four left-handed men working with a hand hammer also suffered injury to the left eye, which according to the foregoing observations should be less exposed to injury. There seems to be no logical explanation for this apparent contradiction.

As may be expected, accidents occurring when less specific tasks were undertaken did not result in one eye being more commonly damaged than the other; eleven right eyes and twelve left eyes were injured in these miscellaneous operations. With the exception of certain of the hammer and chisel accidents the industrial injuries in this series occurred in spite of normal personal protective measures and in circumstances which for the most part could not be foreseen.

Roper-Hall (1954) noted a swing from right to left preponderance of injuries as the foreign body increased in size. In this series the foreign bodies under 2 c.mm. show a preponderance of 2:1 left-eye injuries, and for larger foreign bodies the preponderance is reduced to 3:2, a trend in the opposite direction. These figures exclude the three injuries caused by wire fragments.

Time of Attendance.—Thirty-one cases (68 per cent.) attended within 5 hours of injury, four (8.5 per cent.) during the day following the injury, and five (10.6 per cent.) within 8 days. The remainder attended after considerably longer intervals. Most of the sixteen patients who had delayed had been aware of an eye injury but had ignored it as trivial until the onset of symptoms. None of the late-comers complained of pain, only that the eye was 'red' or 'sore' or that vision was deteriorating. One man was found to have a hitherto unsuspected retained intra-ocular foreign body at his attendance for an unrelated eye condition. Contrast with these the distress caused by a superficial corneal or sub-tarsal foreign body which sends the patient hurrying to the casualty department.

Irritation of the tissues by the foreign body was infrequently seen as the majority of patients attended within 5 hours of injury and had the foreign body extracted within 24 hours.

Of six patients who attended within 8 days complaining of a 'sore' or 'red' eye,

five had a metallic foreign body embedded in the iris surrounded by exudate with a mild localized iritis, and one had a small scleral entry wound with the foreign substance retained in the ciliary body.

Five patients complained of deteriorating vision and were found to have cataracts in various stages of development; the delay in these cases averaged 10 days.

Four other patients attended with deterioration of vision as the main complaint, two of whom had an established endophthalmitis.

Siderosis was seen only once, having occurred after a foreign body had been retained for 2 months; it was found to be resting in the middle of a chorio-retinal scar and the iris surface was stippled with pigment as well as the retina surrounding the metal, which was subsequently removed through a posterior scleral incision. The patient made an uneventful recovery and achieved 6/9 vision.

The last patient in this group of late-attenders had a chronic uveitis without evidence of siderosis. From the history the foreign body had probably been present in the globe for $6\frac{1}{2}$ years after a petrol tank explosion, and had only been giving rise to symptoms for 3 months before his first attendance. The foreign body was found adjacent to the ora serrata with a surrounding area of chorio-retinal scarring. The cyclitis resolved within 14 days of the removal of the foreign body. The explanation of this late onset of symptoms may be that the foreign body had migrated from the site at which it originally came to rest, and that a destructive irritation commenced when its capsule of fibrous tissue broke down.

What were the effects of delay in attendance upon the ultimate prognosis? Obviously the siderosis would not have developed had the patient attended sooner. The foreign bodies embedded in the iris and which had been present for up to 8 days, although surrounded by exudate were not firmly fixed and gave no difficulty at operation; they were easily dislodged by the hand magnet and there was no need to perform an iridectomy. The question of infection is important when considering the effects of delay in removing the foreign body. Before the days of antibiotics speed of extraction was essential as I believe it still is. Admittedly antibiotics can be used as a prophylaxis against infection, but as will be seen later this is not always successful and intra-ocular infection, once established, is hard to control and retain useful vision in the eye.

TREATMENT

Magnetic Response.—All but seven of the retained intra-ocular foreign bodies (14.9 per cent.) were able to be magnetized. The non-magnetic foreign bodies are described in Table II (opposite).

The copper wire foreign bodies (Cases 18 and 26) were both small lengths which struck the patient as he was trimming off larger coils. Neither penetrated further than the cornea, but they came to rest in the anterior chamber from which they were removed with difficulty. The first was grasped by non-toothed forceps and withdrawn from the globe through a keratome section. The second was similarly withdrawn through the enlarged entry wound.

The minute foreign body (Case 24) had prolapsed into the anterior

TABLE II
NON-MAGNETIC FOREIGN BODIES

Case No.	Type of Foreign Body	Size (c.mm.)	Visual Acuity after 3 Months
18	Copper wire	2½ mm. long	6/6
24	Small metal particle	0.25	6/9
26	Copper wire	5 mm. long	6/6
31	Brass chipping	21	Enucleation
37	Unrecovered	1	6/5
40	Unrecovered	1	6/6
47	Airgun pellet	250	Enucleation

chamber and came to lie on the surface of the iris near the pupil when attempts were made to remove it from the deeper layers of the cornea. It showed no magnetic response. The patient was not disturbed from the operating table lest the foreign body be dislodged and fall into the angle of the anterior chamber. A small keratome incision was made at the limbus, care being taken not to lose any aqueous, and the tip of an evacuation curette was gently inserted towards the foreign body which was washed out of the anterior chamber with the rush of aqueous and into the groove of the instrument.

The two foreign bodies which showed no magnetic response after three magnet trials of 10–15 minutes each and which were not removed from the eye (Cases 37 and 40), had both been *in situ* for some time before the patient attended. The first was the result of an injury 2½ years previously, the patient had 6/5 vision and there was no evidence of siderosis or other degenerative change. The eye showed a small atrophic iris scar with an underlying localized stationary lens opacity which were discovered at routine examination. X-ray examination confirmed the presence of an unsuspected intra-ocular foreign body. The other patient had had the foreign body in the eye for 78 days, and again the eye had good vision and showed no signs of degenerative change. Both particles measured less than 1 c.mm. radiologically and it was decided to leave them undisturbed. So far, after a follow-up of 4 months, each eye has remained quiet and without change.

Enucleation.—The excision rate for this series is 12.8 per cent. (six cases: 4 magnetic and 2 non-magnetic). The size of the foreign body concerned averaged 90 c.mm. Three of these eyes were lost because of infection; one because of an intractable cyclitis; and two because of irreparable damage to the eye by foreign bodies of approximately 250 c.mm. each.

Intra-Ocular Infection.—Four cases (8.5 per cent.) suffered intra-ocular infection, two pre-operatively and two post-operatively, and all but one lost the eye. This patient (Case 22) attended with an endophthalmitis 5 days after injury, having been struck in the left eye whilst cleaning the inside of a boiler with an air-brush. A black spot was noted flush with the sclera

12 mm. from the limbus in the 10 o'clock meridian, and to this the pole piece of the magnet was applied. A piece of wire 20 mm. long was withdrawn through the sclera from the vitreous. Intensive chemotherapy was instituted and the infection cleared, but this was the only patient in the series in whom intra-ocular infection once established could be controlled and the eye retained. Vision 6 months after the injury was 6/24; at that time some vitreous opacities were present, but the patient has not attended for further follow-up examination and it is not known whether there is any further improvement. As a routine all cases were treated with a course of sulphamezathine and intramuscular penicillin for 5 days post-operatively, and anti-tetanus toxin was given. Both the cases of post-operative infection occurred after the routine antibiotics had been discontinued, and once established the infection proved to be uncontrollable.

Operation.—In accord with other surgeons at this hospital (Clegg, 1916; Duthie, 1941), the anterior route is preferred to the posterior route in extracting retained intra-ocular foreign bodies; it was used in all but three cases. It has been argued that the anterior route method of extraction is suitable only for small foreign bodies, Stallard (1950) suggesting 3 mm. as the critical dimension. However, experience in this series has shown that the larger foreign bodies are also readily accessible by the anterior route. Those larger particles that are rectangular in shape present end-on to the magnet (Duke Elder, 1954) and slide easily forwards without increase in damage to the intra-ocular tissues. The irregularly-shaped foreign bodies cause large entry wounds and extensive damage to the unresisting intra-ocular tissues. These wounds require surgical repair and it is felt to be better surgical practice to withdraw the foreign body along its track of entry and out through the entry wound rather than create a second track towards a second incisional wound in the globe, thus adding to the trauma and increasing the risk of complications. When the foreign body is embedded in the retina at an accessible site it is then proper to make a scleral incision through an area of diathermy directly over the metal and to withdraw it posteriorly. This was done in two cases, in which foreign bodies were, so to speak, sitting targets situated in an area of retinal disturbance.

Complications.—These are listed in Table III (opposite). Patients who were found to have gaping entry wounds with prolapsed uveal tissue were treated as acute emergencies and were operated upon immediately, pausing only for x-ray examination. It has been suggested that prolapse of uveal tissue through a penetrating wound can be taken to exclude the presence of a retained foreign body. Four patients with large iris prolapse had retained metallic foreign bodies, this was 5.5 per cent. of all patients with penetrating wounds and uveal prolapse treated during the period covered by this series. Removal of the foreign body anteriorly through the entry wound was followed by surgical repair of the wound.

TABLE III
COMPLICATIONS

Complication	Pre-operative	Post-operative
Infection	2	2
Hyphaema	10	2
Vitreous haemorrhage	4	2 (organized)
Lens damage	17	—
Iris damage	8	—
Siderosis	1	—
Retinal detachment	0	2
Chorio-retinal scarring	—	8
Cyclitis	—	2

Patients with small entry wounds were carefully examined under full mydriasis, and unless the foreign body could be seen within the globe they were x-rayed and the foreign body accurately localized by Sweet's improved method as described by Reid (1951) in order to plan the direction of magnetic pull required to draw the foreign body through the circumlental space (Fig. 1).

FIG. 1.—Sweet's improved method of x-ray localization of intra-ocular foreign body.

Care was taken to dilate the pupil fully in order to facilitate the passage of the foreign body forwards into the anterior chamber and to avoid its becoming entangled in the iris. By this method it was unnecessary to perform an iridectomy. The keratome section was always made at the temporal side in order to take advantage of the wide approach to the globe in which to manoeuvre the hand magnet.

POSITION, SIZE, AND DEPTH OF PENETRATION OF FOREIGN BODIES, AND EFFECTS ON PROGNOSIS

Position.—The distribution of the foreign bodies was anterior segment 21.3 per cent., lens 14.9 per cent., and posterior segment 63.8 per cent. The site at which the foreign body comes to rest depends upon size, velocity, and point of entry. Those penetrating no further than the iris or lens were all small, averaging no more than 2 c.mm. in size, whereas the larger foreign bodies penetrated more deeply.

FIG. 2.—Relation of size of the foreign body to prognosis.

IV, opposite). Nineteen cases in which the foreign body was less than 1 c.mm. in size achieved 6/9 vision or better, and a further three foreign bodies under 1 c.mm. were responsible for injury to the lens (13.6 per cent.). The incidence of lens damage for foreign bodies over 1 c.mm. in size was 37.5 per cent.

TABLE IV
FOLLOW-UP AND RESULT ACCORDING TO SIZE*

Size of Foreign Body (c.mm.)	No. of Cases	Length of Follow-up (mths)	Visual Result
1 or less	5	3	6/9 and better
	9	3-6	6/9 and better
	5	6-18	6/9 and better
	3	5-18	Cataract
1 to 2½ mm. long	3	5-14	6/9 and better
	1	9	Cataract
4	2	2	6/9 each
4½	1	6	Cataract
6½	1	15	6/12
6	1	12	Cataract
8	1	5	Detachment
9	1	16	6/60
10 and larger	2	6-9	6/18, 6/24
	3	6-9	Cataract

* Not included in this Table are the 3 wire foreign bodies or six cases in which the eye was enucleated

Depth of Penetration

(1) *Corneal penetration only.*—Three foreign bodies penetrated the cornea only and came to rest in the anterior chamber without penetrating further. They were each non-magnetizable and consisted of two small lengths of copper wire measuring 2½ mm. and 5 mm. in length and approximately 0.5 mm. in diameter, and one very small non-magnetic particle of less than 0.25 c.mm. The methods of extraction have already been described. None of the patients attended for longer than 3 months for follow-up, but their vision at the end of that period was good, two achieving 6/6 and one 6/9. In view of the simple nature of the injuries it is improbable that vision would deteriorate as a result of the original injury.

(2) *Corneal penetration with retention of the foreign body in the substance of the iris.*—Seven foreign bodies penetrated the cornea and became embedded in the iris. Six were less than 1 c.mm. in size and were extracted anteriorly through limbal sections by means of the hand magnet. The larger foreign body was 2.5 c.mm. in size, and it was found to be more convenient to remove it through the corneal entry wound. As might be expected the visual results were universally good: four were followed-up for over a year and maintained 6/6 vision; one patient failed to attend again after 3 months but had a visual result of 6/5; and two patients watched for less than 3 months

to date had a visual result of 6/9 and 6/5. There seems no reason to suppose that, a good post-operative result having been attained, there should be any deterioration of vision in any of the three patients followed-up for the shorter periods.

(3) *Injury to the lens.*—Seventeen patients suffered damage to the lens as a result of the injury and for the purposes of description have been divided into two groups, those with intra-lental foreign bodies, and those in whom the foreign body passed through the lens. The foreign body had entered the lens through the pupil in five cases and through the iris in twelve cases.

(a) *Seven patients had intra-lental foreign bodies* (Table V).—Only one of these achieved good vision with a stationary localized cataract in the periphery of the lens; this patient (Case 34) had a small slender spicule of metal less than 1 c.mm. in size which it was found possible to draw end-on through the capsule making only a small exit wound which rapidly healed, and vision in this eye at the end of 7 months was 6/12 corrected to 6/5. Three patients progressed to mature cataracts after removal of the foreign body and in one of these there is no doubt that the extraction further increased what had been only a localized cataract. Of three patients who became aphakic, two had corrected vision of 6/12 and 6/9 and no deterioration over a follow-up period of 14 and 9 months respectively, while the third (Case 16) had corrected vision of 6/12 up to 4 months after the injury followed by progressive visual loss due to the formation of Elschnig's pearls over the pupil.

Table V shows that the size of the foreign body is not so important to immediate prognosis for the lens as its shape, for all except the one good vision result (Case 34) had irregularly-shaped foreign bodies which tore a large hole in the capsule and caused further damage on removal (Case 7).

TABLE V
FOREIGN BODIES RETAINED IN LENS

Case No.	Eye	Size of Foreign Body (c.mm.)	Visual Acuity (post-operative)	Length of Follow-up (mths)	Remarks
7	R	1	6/12	14	Divergent, aphakic eye
19	L	1	Perception of light	12	Cataract
34	R	1	6/5	7	Localized cataract
38	L	1	Perception of light	4	Cataract
28	L	2	6/9	9	Aphakia
1	L	6	Perception of light	14	Cataract
16	L	9	6/60	16	Aphakia, Elschnig's pearls

(b) *In ten patients the lens was involved without retention of the foreign body within its substance.*—Whether a foreign body passes through the lens or is retained, depends not only upon its size and velocity but also upon the site of entry into the lens. Those particles which passed through the lens did so at its thinner periphery, and this occurred with six foreign bodies under 2 c.mm. in size. Three of them resulted in stationary peripheral opacities and vision maintained at 6/6, the other

three caused the lens to become totally opaque. Four foreign bodies larger than 6 c.mm. caused extensive capsular tears with subsequent absorption of the lens.

Thus from the point of view of visual result, of the seventeen cases of lens involvement, only four patients achieved vision of 6/6 with stationary opacities. The remainder either developed complete opacification (six cases) or became aphakic (seven cases). The latter group all had a prolonged convalescence through the flocculating lens cortex herniating into the anterior chamber and causing some degree of non-infective post-traumatic uveitis which resolved as the cortex absorbed.

(4) *Penetration to the vitreous without lens damage.*—Eighteen foreign bodies entered the vitreous either through the iris and zonule (nine cases) or through the sclera (nine cases). A higher proportion of these achieved good vision of 6/9 or better (50 per cent.) than those in which the lens was damaged during the passage of the foreign body into the posterior segment (30 per cent.). Only ten (19.1 per cent.) of this series of 47 patients suffered penetration of the sclera. The better anatomical protection afforded to the globe behind the cornea accounts for the infrequency of the sclera as a route of entry, and none of the foreign bodies penetrated further back than the equator. Chorio-retinal scarring was subsequently noted in eight cases indicating the site of ricochet at the posterior pole. The average size of the foreign body concerned in deep penetration was 6.3 c.mm. (ranging from 21 to 0.75 c.mm.). In contrast, the foreign bodies penetrating no further than the iris and lens averaged 2 c.mm. in size. Two foreign bodies approximately 250 c.mm. disorganized the eyes at entry to such an extent that each had to be removed with the metal pieces still *in situ*.

COMMENT

I have mentioned magnet trials in the section concerning the non-magnetic foreign bodies, a point which needs amplification. These trials were to prove the magnetizability of a known retained metal foreign body already accurately localized, the magnetic pull being directed along the proposed track of extraction. The trials were not made to prove the presence of a foreign body, a procedure for which I can find no justification. A blind magnet trial made by searching the globe systematically with a magnet, until either the foreign body comes haphazardly forward or the patient feels pain as the foreign body drags across some sensitive intra-ocular structure, is a procedure bound to increase intra-ocular damage and so worsen the prognosis.

A disadvantage of the anterior route method of extraction is the dependence upon the ability of the patient to co-operate fully. Having planned the route of extraction through the circumlental space, it is important, if the giant magnet is to be used, that the patient should be able to gaze steadily in the required directions while the magnet is applied to the eye. For this reason, a ciliary ganglion block is of no help until after the foreign body has

come forward into the anterior chamber, because it induces partial third nerve paresis which destroys the patient's ability to co-operate. Adequate surface anaesthesia is essential and is often of assistance to induce akinesia of the orbicularis muscle. The hand magnet, being more manoeuvrable, is less dependent upon the cooperation of the patient, but is not usually strong enough to draw the foreign body forwards and particularly to extract it from the lens as it is essentially a contact instrument.

Other materials may be carried into the eye with the foreign body and in this series two cases were so complicated. One patient was found to have a fine cilia lying across the anterior chamber after the removal of a foreign body 6 c.mm. in size which had carried it into the eye. The tip of one end of the lash was incarcerated in the corneal entry wound. The convalescence was uneventful, and 18 months later the lash was still *in situ* and the eye showed no signs of irritation. A smaller foreign body 1 c.mm. in size carried air into the vitreous where it was visible as several discrete bubbles adjacent to the metal particle.

SUMMARY

- (1) A personal series of 47 consecutive retained metal intra-ocular foreign bodies is reviewed.
- (2) Foreign bodies which did not penetrate as far as the vitreous and did not damage the lens resulted in visual acuity of 6/9 or better.
- (3) Damage to the lens is critical and adversely affects the ultimate prognosis.
- (4) Small intra-ocular foreign bodies under 4 c.mm. in size retained in the vitreous are readily accessible by anterior route extraction through the circumlental space.
- (5) It is considered that larger foreign bodies should be withdrawn along the track of entry.
- (6) Aspects of aetiology, treatment, and prognosis are discussed.

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