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WAR SURGERY OF THE EYE*

An analysis of 102 cases of
intra-ocular foreign bodies

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THIS paper is an account of 102 cases of penetrating wounds of the eye with retained intra-ocular foreign body treated at a General Hospital from the beginning of General Cunningham's Eighth Army offensive in the Western Desert in November, 1941, to the end of the North African Campaign in May, 1943.

Table I illustrates the classification of the circumstances of the wounds and the units to which the injured soldiers belonged.

Types of Weapon

Table II shows the type of missile which penetrated and remained inside the eye in the four groups of casualty described above.

Fragments of shells, hand grenades and land mines predominate. All cases injured by shell fragments were obviously battle casualties.

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TABLE I

	Inf.	R.A.	R.A.C.	R.A.S.C.	R.E.	R.A.O.C.	R.C.O.S.	R.A.F.	R.E.M.E.	U.S.A.	U.D.F.	N.Z.	Indian	Greek	German P. of W.	Italian P. of W.	Total
Battle Casualty	16	4	6	2	5	—	2	1	1	—	2	2	3	—	3	2	49
Battle Casualty Accident	—	2	2	—	—	—	—	1	—	—	1	2	2	1	—	—	11
Accident Civil	—	1	3	1	—	1	—	1	2	3	1	2	2	—	—	—	17
Accident Stupidity	2	2	1	1	2	1	—	—	—	—	1	1	14	—	—	—	25
Total	18	9	12	4	7	2	2	3	3	3	5	7	21	1	3	2	102

"Battle Casualty" refers to men wounded in the forward areas when in direct contact with the enemy.

"Battle Casualty Accident" is applied to accidental injuries on lines of communication in the theatre of military operations but due indirectly to enemy action, such as the explosion of booby-traps, mines and hidden hand grenades.

The civil type of eye injury "Accident Civil" occurred in men engaged in the repair of vehicles where a hammer and chisel and other implements were used.

The remaining group "Accident Stupidity" concerns the fools who despite warning orders allowed their curiosity full rein in the inept dismantling of hand grenades, fuses and mines, or in boisterous play threw hand grenades near each other. In some instances accidents occurred at demonstrations of land mines. These latter cases formed 25 of this series and in 5 both eyes were blinded. These wasteful casualties, with others due to drunkenness, brawls and road accidents could have been avoided with sensible care.

In the battle casualty group of 49 the highest incidence was in the infantry, then the armoured corps, engineers and gunners, as might be expected.

"Battle Casualty Accident" accounted for 11 and the civil type of accident for 17 of the cases.

TABLE II

	Shell	Hand Grenade	Machine Gun Bullet Casing	Land Mine	Booby Trap	Mortar Bomb	Air Cannon Shell	Air Bomb	Hammer, Chisel, Brass, Tank Track	Fuse, Shell, and Bomb	Bone	Glass	Total
Battle Casualty	24	9	1	6	1	3	3	5	—	—	2	—	54
Battle Casualty Accident	—	4	—	2	4	—	—	1	—	—	—	—	11
Civil Accident	—	—	—	—	—	—	—	—	15	—	—	1	16
Stupid Accident	—	9	—	11	1	—	—	—	—	3	—	—	24
Total	24	22	1	19	6	3	3	6	15	3	2	1	105

Hand Grenades.—The Italian hand grenade caused 22 of the penetrating wounds of the eye with a retained intra-ocular foreign body. Nine cases were battle casualties, four were due to unavoidable accidents on lines of communication, and nine due to stupid playing with the grenade. I understand that these grenades were originally designed to scare the Abyssinians. They are painted red, are roughly oval and have been likened to a child's money box. The casing is made of aluminium alloy and there is a central pin of similar non-magnetic metal. Around this central pin there is wound a wire which breaks up into fragments about 3.5 to 4.5 mm. long. This wire is magnet-positive and so may be extracted from the eye. The grenade explodes with some violence, but does little damage when its minute fragments penetrate the skin of the lower extremities, thus producing a subcutaneous peppering. On this account troops have treated these grenades as a joke and used to throw them at each other in sport; cast stones at the grenades scattered over the ground and take them into their tents to disassemble. One man came into hospital with five concealed in his battle-dress blouse having already injured himself by exploding one during his engineering investigation of its component parts. The grenades were also used in training exercises in house to house fighting. A sergeant threw a grenade downstairs, and watched it explode. Fragments penetrated the lens of each eye.

Mines and Traps.—The proportion of land-mine wounds in the battle casualty accident groups is about the same as for hand grenades. Out of the 19 soldiers wounded by land mines 11 were injured during demonstrations. Among these were 10 Gurkhas from an accident which produced 83 casualties in which there was

a total of 22 men with eye wounds. Of the 10 more serious cases referred to us, three had penetrating wounds of both eyes. In seven of these the site of penetration was in the cornea. This was probably due to the fact that the men were grouped in a circle round the mine at close range, their eyes directed on it at the time it exploded.

The majority, 67 per cent. of the booby trap injuries occurred on the lines of communication and not in the forward areas.

Mines and "booby" traps used against men, vehicles, tanks and railways consist of a prepared charge operated by a push or pull igniter. To some mines the enemy attaches additional igniters intended as anti-lifting devices. In buildings, traps may be worked by opening a door or a window, moving loose boards and objects in a room, raising the lid of a stove and such like. The trap may be at some distance from the point of initiation, such as a trip wire or other push or pull device. One poor fellow lost both eyes whilst burying a dead man in whose clothing a trap had been placed.

Around base camps objects resembling fountain pens and cigarette lighters were scattered on the ground. These contained charges sufficient to produce a traumatic amputation of one hand, the loss of some fingers of the other and a penetrating wound of one or both eyes. These objects were probably distributed by enemy agents.

In the field pull-wires attached to movable parts of an abandoned vehicle or to material forming part of a road barrier set off a mine or trap and caught the unwary. Booby traps are also concealed in petrol tins, motor tyres, in abandoned rifles, and egg and stick grenades may be made dangerous to use by the substitution of a short delay igniter in the place of the usual type.

Head and eye injuries were caused by the "S" (Shrapnel) mine. This mine is cylindrical in shape, 5 ins. high, 4 ins. in diameter and weighs approximately 4 kg. The cover rests on two steel cylinders and in the annular space between these there are 350 steel balls, the loading of the mine. At the lower end of the central steel tube there is a short steel tube containing compressed powder to act as a delay; about 4.5 secs., in discharging the mine. When the igniter works this sets off the charge in the recess below it, the soft metal plate holding this is blown out and the base of the mine and cylinders are projected into the air.

After another short delay, sufficient to allow the main charge to rise 3 to 5 ft. in the air the detonators are fired and the explosion of the main charge occurs. The height to which the mine rises depends upon the nature of the ground and the density of the camouflage layer. Emerging above the ground level, lightly covered by

sand and camouflage, and attached to the igniter are three diverging prongs of stout wire about 4 cm. long, the antennae, and it is upon these that the soldier treads as he passes over the mine. When long trip wires are used the mine is anchored by four securing pegs. The trip wires are placed 4 ins. above the ground level, 21 yds. long, run in opposite directions and have supporting pegs every 7 yards.

The "T" (Teller) mine was used much by the Germans in the Western Desert and North African Campaign. It resembles a flat, circular cake 12.75 ins. in diameter, height 3.25 ins., total weight 19.25 lbs. The base is flat and the cover dome-shaped. These are laid 5 to 10 yards apart. Road barriers are sometimes made by a pressure bar 1.5 metres long resting on two Teller mines and camouflaged.

Evacuation

The foremost eye unit in the field was No. I Mobile Ophthalmic Unit commanded by Major G. C. Dansey Browning, R.A.M.C., from November, 1941, to March, 1943, and then by Major Moffat from March till May, 1943. It operated with a C.C.S. in action, and later in times of military quiescence it was sometimes attached to a Corps Field Ambulance. The surgical work which it undertook was done in a tented operating theatre of a C.C.S. Good work was effected in the surgical toilet of prolapsed intra-ocular contents and the placing of a conjunctival flap over a penetrating wound. The technical difficulties under which the surgeon laboured, as I saw it, were inevitable to every field unit. The lighting was overhead, a petrol tin as reflector to the contained electric light bulbs, the whole suspended by string between the uprights of the tent. The height of the table was fixed, too high to sit and too low for the average man to work in comfort standing. The base of the table was of the light frame work necessary for folding, packing and transport and this together with the sandy foundation on which it rested and the more vigorous manoeuvres of the general surgeon in a combined operation with the eye specialist promoted movements of the table and patient likely to embarrass the latter in his work.

The use of the giant magnet must have been unsatisfactory. It is of the portable pattern, heavy and difficult for the theatre orderly to hold steady at the required site. Unless it is fitted with flexible terminals for introduction into the lips of a scleral wound it is useless for the majority of cases. The variations and vagaries of the current passing into the magnet probably accounted for some failures to extract intra-ocular foreign bodies which we were afterwards able to remove in hospital. There is no diathermy apparatus.

These deficiencies, the time factor in periods of stress and the fact that all the eyes containing war missiles in the vitreous which came to this hospital seemed clinically to be no worse off for their retention up to twelve days, or longer in some cases, caused me to feel that it is better not to attempt this work in a C.C.S. The ideal is air evacuation. At present I understand that eye cases are third in priority for an ambulance aeroplane.

Three General Hospitals in this theatre of war are equipped with giant electro-magnets. At this General Hospital there is Mellinger's magnet, at another hospital the Solus modification of Haab's magnet and at another hospital a portable magnet. Many of the wounded were evacuated first to general hospitals without a magnet and sometimes without an eye specialist. In some instances the wounded man had passed through four hospitals before he reached us. This accounts for the high proportion of cases referred to us from this source and for the delay in receiving surgical attention.

Twenty-eight came in convoys from the field and at the time of the retreat to Alamein some of these came direct from the Regimental Aid Posts without having passed through the Field Ambulance or C.C.S. Four came from the "field" through No. 1 Mobile Ophthalmic Unit, and four had been through this unit and thence to a general hospital from which they had been referred to us. Sixty-four, the majority, were sent by other General Hospitals. Some of these afforded examples of the defects of specialisation for they had remained one to two months in special centres such as orthopaedic and chest and had received no attention to the injured eye. This lesson applies to us as well, for it is essential to make a careful general examination and to have a sound knowledge of general surgical principles in the treatment of wounds and burns. Fifty-eight per cent. of this series had multiple wounds, many of these of a character which did not merit a demand on the time of the surgical specialist.

Time Taken in Evacuation.—This depended on the military situation, the nature of the terrain over which the wounded had to be collected and evacuated. It was naturally longer during a progressive advance and shorter in retreat.

In the November and December battles in 1941 for the relief of Tobruk, the capture of Benghazi and its subsequent loss the casualties arrived four to eleven days after wounding, an average of seven days. During the German-Italian attack in May, 1942, up to the loss of Tobruk the average was six days; in the retreat from Tobruk to Alamein in the later part of June, four to one day; in General Montgomery's offensive at Alamein in October and November, 1942, one to three days, the majority two days. In this battle some Italians in the southern part of the line reached us in four

days. From January to March, 1943, the time of evacuation was four to six days, and from April to May, an average of 10 days.

Course of Evacuation.—In the autumn of 1941, No. 62 General Hospital replaced No. 4 Australian General Hospital at Tobruk. The eye specialist of the latter had been killed. From October to December wounded from the Tobruk perimeter in the "break out" action were evacuated by sea from Tobruk to Alexandria. Wounded from General Cunningham's desert assault were brought back through the "wire" along the Libyan-Egyptian frontier to No. 1 Mobile Ophthalmic Unit, at this time stationed at Mersa Matruh and attached to No. 8 (S.A.) C.C.S. Parts of this line of evacuation, particularly on the Egyptian side of the frontier were studded with mounds growing camel thorn and the passage was exceedingly rough.

After the relief of Tobruk in December, 1941, and from then till May, 1942, all wounded were taken first to No. 62 General Hospital in Tobruk thence the seriously hit travelled by sea to Alexandria and the base hospitals. "Sitters" went by road to Mersa Matruh whence there was good air evacuation to the base.

During the first phase of the German-Italian attack in May, 1942, casualties were sorted, and as many as possible dealt with, at No. 62 General Hospital, until the fall of Tobruk. Conditions for careful surgical work in the No. 62 General Hospital became increasingly difficult owing to the large number of casualties, inadequate water supply and other adversities. Four enamel bowls of water served eight operating tables and were charged once an hour. The surgeon broke the crust of blood, sand, dirt and soap suds on the top and washed as best he could beneath this. Specialists helped in dealing with the general surgical cases. There was little time or facilities for anything but the immediate essentials of eye surgery.

All the eye casualties from Bir Hacheim and those which occurred during the retreat after the fall of Tobruk went by road to Mersa Matruh and thence to the base. Mersa Matruh fell. From Alamein the wounded went directly by road to the nearest base hospitals in Alexandria and Cairo. From June 24 to July 6, 1942, No. 1 Mobile Ophthalmic Unit remained close to Berg El Arab and was re-fitted. On August 28, this unit was attached to the No. 200 Field Ambulance at Ikingi Mariut and received the few eye casualties resulting from Rommel's abortive push. From then onwards it remained at Gabanyet (Berg El Arab) in the medical concentration area until the battle of Alamein. Air evacuation from this area was poor. The road through it was rough and despite slow and careful driving the ambulances bumped considerably.

FIG. 3. Map of North Coast of Africa.

On November 2, 1942, No. 1 Mobile Ophthalmic Unit moved up to Gerawla whence road and rail evacuation to the base continued. On November 16, 1942, it went to Tobruk from where road, rail and air evacuation was slow and difficult.

In December, 1942, from Agedabia some casualties were taken by air to the base. Later in December some wounded were evacuated by sea from Benghazi. No. 1 Mobile Ophthalmic Unit operated at Benghazi at this time. In January, 1943, No. 4 General Hospital opened at Barce and No. 10 C.C.S. at El Adem. From the action at "Marble Arch" casualties were sent by air to Benghazi and from there to the base.

On January 16, No. 1 Mobile Ophthalmic Unit moved to Tamet to deal with casualties from the Tripoli battle. Air-borne cases went to No. 4 General Hospital, No. 10 C.C.S. and back to the base.

February 26, 1943, No. 48 General Hospital opened in Tripoli. In the Mareth Line operations, No. 1 Mobile Ophthalmic Unit were at Ben Gardana and thence casualties went by road or rail to Tripoli. Until the end of the campaign the hospitals at Tripoli, particularly No. 48 General Hospital and No. 2 General Hospital, sent back to the base by air selected cases with retained intra-ocular foreign bodies, retinal detachments and those requiring plastic operations.

Clinical Facts

Table I shows the type of casualty and the unit to which the wounded were attached, and Table II the nature of the missile causing the wound.

The size of the missile was measured radiographically in antero-posterior and lateral views. In cases where the foreign body was extracted this measurement was checked. The results in this series are as follows:—

Maximum diameter less than 1 mm.....	17
1 to 2 mm.....	13
2 to 3 mm.....	24
3 to 4 mm.....	14
4 to 5 mm.....	13
5 to 6 mm.....	3
6 to 7 mm.....	3
over 7 mm.....	2

Of the last, those over 7 mm., one was 12 x 8 x 4 mm., and the other 9 x 2 mm. The fragments which penetrated the eye from booby trap explosions were too small to show radiographically. These were seen with the corneal loupe and the slit-lamp, and

FIG. 4.

FIG. 5.

FIG. 6.

when the media are clear, are visible on ophthalmoscopic examination. Fig. 4 shows the shape and size of the war missiles, Fig. 5 the metal fragments in the civil type of the injury, and Fig. 6 those resulting from stupid accidents, removed by the giant magnet. The numbers refer to the size of the foreign bodies in millimetres.

In one case there were three foreign bodies extracted from one eye by the magnet and in another two. These were extracted, in each case, through one scleral incision.

Age.—The age incidence is as might be expected:—

20 to 30 years	85
31 to 40 years	13
Over 40 years	4

Eye affected.—The right eye was wounded in 41 cases, the left eye in 34, and both eyes in 30. In this last group both eyes were wounded by shell fragments in 11 cases and three of these were totally blinded; seven as the result of land mine explosions, of whom one was blinded; two had both eyes penetrated by fragments of an aerial bomb; and one man was accidentally wounded in both eyes by the explosion of a bomb fuse.

SITE OF PENETRATING WOUND.

(1) *Through the Cornea.*

Upper temporal quadrant	9
Upper nasal quadrant	14
Mid-line between these quadrants	1
Corneo-scleral junction on nasal side	1
Lower nasal quadrant	21
Lower temporal quadrant	7
Mid-line between these quadrants	3
	—
Total,	56
	—

(2) *Through the Sclera.*

Upper temporal quadrant	3
Upper nasal quadrant	2
Lower nasal quadrant	17
Lower temporal quadrant	19
Mid-line between lower nasal and temporal quadrants	1
	—
Total	42
	—

(3) *Multiple.*

Centre of cornea and upper nasal quadrant of sclera	1
Cornea, upper and lower nasal quadrants of sclera	1
Cornea, nasal and temporal sclera	1
	—
Total	3
	—

(4) The site of penetration was not seen in nine cases.

These figures show the high incidence of wounds in the nasal half of the cornea, particularly the lower nasal quadrant, and in the lower quadrants of the sclera.

Uveal Prolapse.—Prolapse of the uveal tract through a penetrating wound occurred in 29 cases. In two of these it was bilateral and in one the iris was prolapsed in both eyes, and in the other the ciliary body was extruded. The incidence of prolapse of the component parts of the uveal tract and the nature and size of some of the missiles which caused the penetrating wound is set out below :—

(1) *Iris*—13 cases.

Hand grenade	3
Shell, both eyes affected	1
Land mine "S" mine	3
Aerial bomb	2
Booby trap, Bakelite 1.5 x 1 x 0.5 mm.	1
Hammer chip	1
Brass 4 x 3 x 2 mm.	1
Glass	1

(2) *Ciliary body*—9 cases.

Shell, bilateral 4.5 x 3 x 3 mm.	1
3.5 x 1 x 1.5 mm.	1
3.5 x 2 x 0.75 mm.	1
Hand Grenade 5 x 1 x 0.25 mm.	1
2.5 x 1 mm.	1
5.5 x 1 mm.	1
2 x 2 mm.	1
Land mine	2

(3) *Choroid*.—7 cases.

Shell	3
Shell fuse	1
Land mine	1
Hand grenade	1
Booby trap	1

In one instance a fragment of aerial bomb had penetrated the cornea and produced an iris prolapse. This soldier had not passed through the Mobile Ophthalmic Unit and had been left nine days without attention during evacuation. The iris was coated with yellow exudate, there was adjacent keratitis and the eye was soft. Abscission of the prolapse and wound toilet was followed by panophthalmitis.

Traumatic Cataract.—Traumatic cataract occurred in 50 cases. It was associated with penetrating wound of the cornea in 41 of these, in three of which it was bilateral and in six the lens opacity was localized at the equator, the corneal wound being peripheral and vision affected slightly.

It followed a scleral wound in four instances in two of which the lens opacities were localized and peripheral.

In five cases cataract occurred in wounds which affected both the cornea and sclera in the same eye.

Vitreous Haemorrhage.—Vitreous haemorrhage was severe when the wound was through the ciliary body and generally when the missile was 3 mm. or larger. However, in some instances quite a small missile 1 x 0.75 x 0.25 mm. caused a severe vitreous haemorrhage doubtless owing to the fact that it had traversed a relatively large vessel.

In cases where a vitreous haemorrhage was associated with a penetrating wound of the cornea the site of this was near the ciliary body. The following table shows the incidence of vitreous haemorrhage, severe and slight, associated with the site of the penetrating wound.

Vitreous Haemorrhage	Corneal Wound	Scleral Wound	Wound not seen	Total
Severe ...	7	20	4	31
Slight ...	7	9	2	18
Total ...	14	29	6	49

It is evident that the highest incidence of vitreous haemorrhage occurs, as might be expected, in association with scleral wounds.

Vitreous Prolapse.—Occurred in four scleral wounds and one corneal wound. In these cases evacuation to the base had taken four to six days. On surgical exposure of the site of the scleral wound adhesions were found between the prolapsed vitreous and the adjacent sclera, Tenon's capsule and the subconjunctival tissues.

Retinal Detachment.—Retinal detachment was associated with an intra-ocular foreign body four days after injury in a case where a fragment of Breda shell cap 2 x 2 x 0.5 mm. had penetrated the sclera in the lower nasal quadrant between the ora serrata and the equator. In another case it occurred six weeks after a fragment of land mine 2 x 1.5 x 1 mm. had penetrated the sclera on the temporal side in the horizontal meridian and at the equator.

Vision.—Visual acuity depended in the main on damage to the lens and to vitreous haemorrhage.

(1) *Cataract.*

Severe	Perception of light	56
	Hand movements	17
	Counts fingers	1
	1/60	1
Slight	6/18	3
	6/12	1

(2) *Vitreous Haemorrhage.*

Severe	No perception of light	6
	Perception of light	15
	Hand movements	19
	Counts fingers	5
Slight	6/60	3
	6/12	4
	6/9	2

(3) *Cataract and Vitreous Haemorrhage.*

No perception of light	2
Perception of light	2
1/60	1

(4) *Endophthalmitis.*

Doubtful or no perception of light ...	4
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(5) *Panophthalmitis.*

No perception of light	1
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(6) *Retinal detachment and vitreous prolapse.*

6/36	1
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(7) *Macular contusion.*

Perception of light	2
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In nine cases visual acuity was not obtained. Four of these had serious multiple injuries and were confined to bed, one was unconscious and four were Indians whose subjective response was judged to be inaccurate.

Associated with wounds in other parts of the body.—Fifty-eight soldiers in this series had wounds in other parts of the body. These were multiple in all cases due to land mines, hand grenades, booby-traps and mortar bombs, and the majority were so in shell wounds and those due to aerial bombs. Twenty-five of the 58 had injuries of a major character such as compound fracture of the skull, jaws and limbs, intracranial wounds and foreign bodies retained in the brain; meningitis, severe burns of the face, hands, and trunk; haemothorax; pneumonia; gas gangrene; severe involvement of the accessory nasal sinuses and traumatic aneurysm of the angular artery. One death occurred, a L/Cpl. admitted to hospital from the field within 24 hours of wounding. He had multiple compound fractures of the metacarpal bones of both hands and penetrating wounds of both eyes from fragments of an Italian hand grenade. He died from fat emboli 20 hours after admission to hospital.

Thirty-three cases I have classified as minor multiple injuries and these consist of scalp wounds; fractures of the orbit; ruptured tympanic membranes; small burns; fractures and amputations of fingers and toes; relatively small peppered wounds of the face and soft parts of the limbs and trunk.

Fragments of Italian hand grenades have relatively low powers of penetration. These produce multiple spatter wounds of the legs, rarely the thighs, the forearms, neck, face and one or both eyes. The fragments passed through the skin into subcutaneous tissues and were seldom deeper. A few serious injuries to hands resulted from soldiers catching the grenade, fingers were lost, the palms severely lacerated and burnt and even traumatic amputation at the wrist occurred.

The victims of land-mine explosions had their faces burnt and tattooed with powder. In the case of sappers employed in mine lifting, blast blinded both eyes causing scleral ruptures and severe intra-ocular haemorrhage. Both ear drums were often perforated in men who were near a land-mine explosion.

Booby-traps picked up by soldiers caused the loss of the hand holding the device and often some fingers of the other hand. The face was burnt by the flash of the explosion and one or both eyes injured, one eye generally more severely than the other.

Localization of the intra-ocular foreign body.

(1) *Ophthalmoscopic.*—In 17 cases the foreign body was seen by the ophthalmoscope. In seven of these it was extracted by the posterior route (through the sclera), five by the giant electro-magnet and two by forceps under ophthalmoscopic control. In the remaining 10 cases the foreign bodies were non-magnetic. These were less than 0.5 mm. in most instances, showed no evidence of adjacent inflammation and so were left.

(2) *X-Ray localization*.—In 38 cases X-Ray localization of the foreign body was made.

Brigadier C. W. Graham introduced a simple method which in the absence of elaborate X-Ray localization is of practical value. It is as follows :

The eye is anaesthetized with cocaine and when much inflamed 2 or 3 minims of novutox are injected into the episcleral tissues at the limbus at 12, 9, 3 o'clock. A silver ring of a size chosen to fit exactly the corneo-scleral junction is stitched in position by sutures of 000 silk passing through the conjunctiva at 12, 9 and 3 o'clock respectively. A drop of ol. parolein is instilled into the eye and a pad moistened in the oil is applied to the closed lids and bandaged in position. When possible the patient sits during the X-Ray examination. In some cases other wounds prevent this. During the first exposure he is directed to look with his uncovered eye forward and for the second to look downwards. For this purpose conspicuous marks such as red discs or lights 5 cm. in diameter are placed on the wall for sitting cases and on the ceiling for lying cases at the two points in which fixation of the eye is necessary during exposure. Each exposure is half the normal. To obtain a postero-anterior view of the orbit free from the dense shadow of the petrous part of the temporal bone the head is tilted slightly so that the occiput is down and the face up, the petrous shadow then falls over the antra. In an accurate postero-anterior radiograph the silver ring shows as a perfect circle and in the lateral as a linear shadow.

Interpretation of Radiographs.—The diameter of the silver ring is known and its measurement is checked on the X-Ray film. Any radiographic magnification is noted. This has never been more than 1 mm. and when present allowance must be made for this fact. When an anode film distance of 30 inches or more is used parallax magnification of the ring is negligible and a schematic eye of 24 mm. drawn on the film is accurate enough. In the lateral view a line is drawn posteriorly from the centre of the ring and at right angles to it for about 22 mm. The upper and lower limit of the ring is used in turn as the centre of a circle whose radius is 12 mm. (*e.g.*, half the average length of an eye, 24 mm.), with a pair of dividers set at 12 mm. the horizontal line is intersected by arcs described from the above centres. The point of intersection on the horizontal line is now taken as the centre of a circle with 12 mm. radius and this is described on the radiograph. A similar procedure may be done with the silver ring in the second position, that is looking down. Likewise in the postero-anterior view a circle of 12 mm. radius is described around the centre of the silver ring. The ring is known to be at the limbus and so measurements may be taken from this on both the postero-anterior and the lateral radiographs.

Movement of the foreign body is the essential diagnostic feature. If the relationship of the silver ring image to the foreign body is unaltered in the first and second positions it may be presumed that the foreign body is moving with the eye. The radiographs with the schematic eye marked upon them will indicate also the position of the object with regard to the centre of rotation. If the foreign body is in front of this it will apparently move with the ring, if behind against it, that is a foreign body in the posterior half of the eye will lie at a higher level in the second position where the ring has rotated downwards.

The shadow of the foreign body might fall within the circles described and yet be outside the eye. This point is settled by the movement of the foreign body which is absent when it is extra-ocular. There is, however, an exception to this in the case of a foreign body in Tenon's capsule where slight movement may take place, but this is rarely as great as in the case of an intra-ocular foreign body. In such cases therefore if the foreign body shows a new relationship to the ring in the second position it is probably outside the eye. When the foreign body is clearly outside the limits of the circles described then it is certainly extra-ocular. The size of the foreign body is carefully measured on the radiograph. This will determine the length of the scleral incision necessary for its extraction.

Operation

Intra-ocular foreign bodies due to the fragmentation of war missiles are generally lowly-magnetic or possess no magnetic properties at all. The fragments are irregular in shape, have ragged edges and a rough granular surface. Figs. 4 and 6 show the war missile foreign bodies extracted in this series. The size of the foreign bodies is from less than 1 mm. to 12 x 8 x 4 mm. Fig. 4 illustrates foreign bodies due to civil types of injuries such as occurred in using a hammer and chisel. These foreign bodies are relatively smooth flakes and are roughly oval in shape.

The posterior route in my opinion is the method of choice in extracting war missiles and also I think it is so for the majority of types of foreign bodies which lie behind the lens. The reasons for this are as follows :

(1) The war missile foreign bodies are so lowly magnetic that they are not brought forward by the anterior route technique of using the giant electro-magnet. Indeed, in a routine preliminary test with the magnet before the operation was started only one in this series gave a positive response. Had I been satisfied with this test 20 war missiles would not have been extracted. All these were delivered from the eye by the giant magnet through the posterior route.

(2) The posterior route allows access to the sclera at some site of election. In principle this should be as near to the foreign body as possible. In this series it was never necessary to make the scleral incision behind the equator and indeed such is probably undesirable on account of the greater technical difficulty of accurate scleral suturing than is the case between the equator and the ora serrata. Also the thin sector of visual field defect owing to surface diathermy might be appreciated subjectively whereas when sclerotomy is pre-equatorial this passes unnoticed by the patient.

(3) Extraction of ragged-edged and rough-surfaced foreign bodies by the posterior route inflicts less damage on the eye. The dragging of such a foreign body over the ciliary processes, through the suspensory ligament and then between the iris and lens capsule would inevitably hurt these structures seriously. The removal of any foreign body over 3 mm. in size by the anterior route risks iris entanglement and the unpleasant complications which follow this.

The size of the foreign bodies is carefully measured in three dimensions from radiographs taken in the antero-posterior and lateral positions. Radiographic magnification may be assessed by measuring the shadow of the ring and comparing this with the known size of the ring sutured to the corneo-scleral junction. This magnification is seldom more than 1 mm. The scleral incision is made 1 mm. larger than the assessed size of the foreign body. This sufficed in all cases except one in which the foreign body had a ragged flange which was not evident on X-ray examination. In order to deliver the foreign body through the scleral wound this had to be enlarged from 3.5 to 4.5 mm.

Pre-Operative Preparation.—About 24 hours elapses from the time the patient enters hospital to operation. During this time he has adequate sleep, good food, general cleansing of his body and radiographic localization of the foreign body. Local treatment consists in irrigations of the eye thrice daily with lotio oxycyanide of mercury 1/10,000 and the instillation of sterile guttae atropine 1 per cent. Recently we have used 2 drops of penicillin thrice daily and on the eve of operation albucid solution 2.5 per cent. One hour before operation luminal gr. 1 is given, the eye irrigated with sterile normal saline and 2 drops of albucid soluble 2.5 per cent. instilled. The eye is covered by a sterile pad. Any infected wounds of the face are sealed off by an appropriate dressing. To date when such wounds have existed we have had no intra-ocular infection after operation.

In the operating theatre the lids are swabbed with cetyl pyridinium bromide, a clear colourless fluid of low surface tension, which saponifies on shaking, is non-irritant to the conjunctiva and lethal

to staphylococci and streptococci in 1-10 million outside the body and 1-10,000 in serum.

A surface anaesthetic, cocaine, preferably pantocain is instilled. A speculum is inserted and the giant electro-magnet swung into position for testing. We have used Mellinger's magnet. We had no alternative, but I think it is easier to manipulate for posterior route extraction than Haab's magnet. Many patients, fifty-eight in this series, had other wounds which necessitated the recumbent position during operation. It would be interesting to compare the technique using Haab's magnet from above, accurately counterpoised, and fitted with flexible terminals for introduction into the lips of the scleral wound. I fancy that some of the technical difficulties in adjusting the terminal to various positions of a scleral incision and the maintainence of adequate illumination during this procedure would be appreciably more than is the case with Mellinger's magnet.

The magnet terminal is applied to the sclera as near the foreign body as possible. Thence it may be moved to the site chosen for scleral incision, this is preferably at the ora serrata. In one case Mellinger's magnet was a disadvantage. The soldier had a compound fracture of the lower jaw which had been wired. The lower part of his face was much swollen. In adjusting the magnet part of the wiring of the jaw broke. In cases where the foreign body is seen with the ophthalmoscope this instrument is used to note any movement of it after application of the magnet. In three out of six such cases the foreign body was noted to have moved at the most 2 to 3 mm., but in these the patient had felt no pain on magnet testing. In the other three cases there was no apparent movement seen by ophthalmoscopic examination, but in these the foreign bodies were promptly extracted on opening the sclera and introducing the magnet terminal into the wound. The giant magnet is then removed. One terminal of the diathermy is attached to the patient's arm.

Instruments.—Giant electro-magnet; operating lamp; diathermy apparatus; spirit lamp; speculum; blocked 1 into 2 toothed conjunctival forceps; 2 pairs fixation forceps, 2 into 3 teeth; 2 c.c. hypodermic syringe, 2.5 cm. and 5 cm. needles; spring scissors, strabismus scissors; de Wecker's scissors; strabismus hook; probe to be heated in spirit lamp for haemostasis; diathermy terminals; sutures 2 000 black silk conjunctival sutures; 1 No. 1 white silk traction stitch; 1 scleral suture, 000 silk on a special atraumatic needle; Arruga's capsule forceps; iris forceps; 2 iris repositors, 3 fine scleral hooks; Bard-Parker knife No. 15 blade; Graefe's cataract knife; Desmarre's retractor; Arruga's retractor; 1 bull-dog clip or muscle clamp; plain forceps; muslin swabs, held in pressure forceps; needle holder. A single sterile

face-piece with an opening for the eye is applied over the head. The use of towels impedes the placing of Mellinger's ring magnet around the head and face. No towel clips are used because these would be dragged into the magnet.

Anaesthesia.—In all cases except a German prisoner of low intelligence it was possible to operate under local anaesthesia. The co-operation of all British soldiers was indeed admirable. After instillation of a surface anaesthetic and 2 drops of adrenalin chloride a lid speculum is inserted.

Over the site elected for sclerotomy the conjunctiva is picked up with 1 into 2 toothed forceps and a sub-conjunctival injection of 3 to 4 minims of novotox 3 per cent. is made. The needle is then passed posteriorly into Tenon's capsule and behind the equator where 1 c.c. is injected. The needle is then turned so as to inject 0.5 c.c. into each of the adjacent recti muscles upon which traction will be made during operation. This technique is adequate in most cases. In a few where there was vascular congestion an injection of 1 c.c. was made also into the region of the ciliary ganglion.

Incision.—For the purpose of this description the site of election for sclerotomy is the 4 o'clock meridian at the ora serrata in the left eye. The surgeon picks up the conjunctiva with the 1 into 2 toothed conjunctival forceps 5 mm. behind the limbus in the 4.30 o'clock meridian and the assistant does likewise 3 mm. posterior to and opposite the surgeon's grasp of the conjunctiva. With spring scissors the conjunctiva and subconjunctival tissues are incised down to the sclera between the two forceps. One blade of the scissors is then passed beneath the conjunctiva upwards and laterally, a curved incision about 5 mm. is made. A blade is then passed beneath the conjunctiva downwards and laterally and a curved incision also 5 mm. in length is made. The tongue-shaped flap of conjunctiva, episcleral tissue and Tenon's capsule thus fashioned is reflected by the assistant's forceps whilst with a few snips of the spring scissors and a few strokes with a muslin swab the surgeon exposes cleanly the sclera. Bleeding points are checked by the application of a probe point heated in a spirit flame.

Two conjunctival sutures are now inserted into the edge of the conjunctival flap, one above and the other below and equidistant from the apex of the curve. These are then passed through the sterile muslin face-piece which covers the head and when the conjunctival flap is held reflected to an appropriate degree these sutures are tied. Clamps are not used for this purpose because they would be caught up in the magnet.

The lower margin of the external rectus muscle is now exposed by a few strokes with a muslin swab, and a traction suture of No. 1 white silk is inserted into the lower 3 mm. of the tendon,

The suture is tied at its extremities about 6 cm. from its insertion into the muscle and the knot is then fixed in a bull-dog clip or a muscle clamp to facilitate traction. The traction suture may be clamped in the head drappings in an appropriate position, such as over the medial end of the eyebrow, or held by the assistant.

Surface diathermy is now applied to the sclera at the site chosen for sclerotomy, in this case the ora serrata and just posterior to this. One application of the blunt diathermy terminal makes a zone of coagulation about 3 to 3.5 mm. in diameter so that one or two such applications are all that is generally required. A current of 90 milliamperes is applied for five seconds. The advantages of the diathermy are (1) it prevents any bleeding from the sclera and choroid when these structures are incised and so eliminates the risk of intra-ocular haemorrhage; (2) the aseptic choroido-retinitis induced at this site assists in the closure of the hole made in these membranes for extraction of the foreign body and this may be a factor in preventing post-operative retinal detachment; (3) it is easier to incise the hardened sclera after surface diathermy than it is normally.

The sclera is now incised with a Bard-Parker knife (No. 15 blade) in the antero-posterior axis through the diathermized area. To do this the surgeon changes the position of his stance or seat (I sit down when operating), so that he is placed in the axis of the scleral incision, that is, either behind and to the right of the patient's head or below and to the left whichever he prefers in the case of the left eye. The belly of this little knife is placed on the sclera and is run to and fro for the desired extent, that is 1 mm. more than the estimated size of the foreign body (see Fig. 7). When about two-thirds of the sclera has been cut through two fine scleral hooks are taken (see Fig. 8) and the points inserted into the sclera at each end of the incision. These are held by the assistant and afford the best method of steadying the eye during the insertion of a scleral suture. The scleral suture is of 000 white silk on an eyeless needle which is held in a fine needle-holder. The needle is then passed through the sclera 1 mm. above and parallel to the incision postero-anteriorly and then 1 mm. below and parallel to the incision antero-posteriorly for 2 mm. respectively. In doing this the point of the needle is first engaged in the sclera 1 mm. above the posterior end of the incision by placing it almost vertically and dipping it in for about 0.5 mm., then the shaft of the needle is depressed a little as it is passed for 2 mm. through the sclera to the point of emergence. Delivery of the needle is helped by placing a fine scleral hook on the sclera around the emerging needle point and with this exerting gentle counter-pressure as the needle is brought out. A similar manoeuvre is done in passing the needle through the sclera 1 mm. parallel to and below the scleral incision thus completing the

FIG. 7.

A flap of conjunctiva, episcleral tissue and Tenon's capsule is reflected in the lower temporal quadrant. Fixation forceps are applied to the tendon of the external rectus muscle. A No. 15 Bard-Parker knife incises the sclera where two applications of surface diathermy have been made.

FIG. 8.

Scleral hooks are inserted into the anterior and posterior ends of the scleral incision. The scleral needle is passing through the outer half of the sclera parallel to the incision.

mattress suture. The suture is then pulled through so that about 6 mm. of the free end is left out above, so that the apex at the loop at the anterior end is 3 mm. in front of the incision and the lower end of the suture is cut about 25 mm. long. The free ends and the loop of the suture are now moistened with saline and placed on the sclera clear of the incision.

The scleral hooks are removed from the anterior and posterior ends of the wound and are now placed in the middle of the upper and lower lips of the scleral incision respectively. The assistant

FIG. 9.

A mattress suture has been inserted through the superficial layers of the sclera. Fine hooks retract the edges of the scleral wound, whilst a cataract knife completes the incision through the deeper layers of the sclera to expose the uveal tract.

holds one and the surgeon the other. Gentle traction is made to open the wound and expose the deeper layers of the sclera which are now divided down to the choroid with a few strokes of a cataract knife (see Fig. 9).

On exposure of the choroid the hooks are removed so is the clamp from the traction suture. The latter is to avoid entanglement in the magnet. The theatre orderlies have the magnet ready to move into position. The position of the eye and the head are so adjusted that the scleral wound lies uppermost, and vitreous thus gravitates from it. For instance in the case under discussion, the left eye with the scleral incision in the 4 o'clock meridian at and just behind the ora serrata, the eye is turned upwards and medially and the head inclined slightly to the right. The assistant

holds the traction suture in this position whilst the surgeon passes the point of a cataract knife through the choroid incising it the length of the scleral incision.

The magnet covered with a sterile towel is then swung into position. The assistant maintains traction. The surgeon takes a non-magnetic scleral hook in one hand and the magnet terminal in the other. The current is turned on and the magnet field generated. The hook assists in opening the lips of the scleral wound into which the magnet terminal is introduced. It is necessary that the terminal should enter the wound otherwise a ragged foreign body may become impacted in the adjacent intra-ocular membranes and not become attached to the tip of the terminal. A click is often heard as the foreign body makes contact with the magnet terminal. In some cases where the foreign body is lowly magnetic several attempts may have to be made with the larger terminals before it is extracted. In one case the foreign body came out at the fourth application of the magnet.

In one case a fleck about 2 mm. long, of greyish white exudate was delivered attached to the foreign body. In some cases there escapes about one to two minims of clear straw-coloured fluid resembling the sub-retinal fluid in retinal detachment. It is, I think, probable that this is produced from the choroid as a result of diathermy application. In one case where a scleral incision 6 mm. long was made for the extraction of a foreign body 5 mm. in length vitreous entered the wound in the wake of the foreign body. As the scleral suture drew the lips of the scleral wound together the vitreous gravitated back into the eye and none was lost. Indeed in no case has there been any vitreous loss.

Immediately the foreign body is removed the theatre orderlies shut off the current and swing the magnet clear of the patient's head. With a pair of Arruga's forceps the surgeon draws gently on the longer strand of the scleral stitch until the loop is flush with the sclera and the edges of the scleral wound are co-apted precisely. Very rarely are tags of choroid in the wound. If this is so these are stroked into place with an iris repositor. Then the suture is tied, the knot being placed at the posterior end of the incision. The sclera is swabbed gently. The stitches holding down the conjunctival flap are released, clamped and held by the assistant so as to facilitate suturing of the conjunctival incision. This is closed by a continuous, key pattern stitch. A warmed drop of sterile atropine 1 per cent. is instilled into the eye and this is followed by two drops of albuclid 2.5 per cent. An eye pad moistened in liquid paraffin and covered by a shield is secured over the eye by two strips of elastoplast. In hot weather a bandage adds to the patient's discomfort and so is dispensed with.

On return to the ward the patient is placed in a position in which

there is the minimum pressure of intra-ocular contents into the wound. In the case discussed above he lies on his right side with his head on two pillows. Aspirin gr. xv is given immediately he is settled in bed. Some post-operative pain begins one hour after operation and continues one to two hours.

Post-Operative Treatment.—The dressing is removed 48 hours after operation. The lid margins are swabbed with warm normal saline. A drop of warm sterile atropine 1 per cent. is instilled. No pad is placed over the eye but a strip of gamgee is laid along the infra-orbital margin to absorb any tears and the eye covered with a shield.

On the third day the conjunctival stitch is removed under cocaine or pantocain surface anaesthesia. The patient is allowed to sit up in a chair on the eighth day. The scleral stitch is left buried beneath the conjunctiva and Tenon's capsule and in no case has it given rise to any trouble.

Complicated Cases.—In cases where the entry wound is through the cornea and there is iris or lens capsule prolapse, a conjunctival flap is fashioned in an appropriate position and reflected. The intra-ocular foreign body is removed by the posterior route. After this the iris or lens capsule prolapse is abscised and any necessary toilet given to the wound and the anterior chamber. The conjunctival flap is then sutured in position covering the sclerotomy and the penetrating wound. In a few cases it is necessary also to suture the corneal wound when this is larger than 5 mm., and particularly if it extends into the sclera.

In one case a foreign body 6.5 x 2.5 x 0.5 mm. had penetrated the sclera of the right eye in the ciliary region at 12 o'clock and lay between the iris and the lens on the nasal side. A quick preliminary test with the magnet showed that any attempt to remove this by the anterior route would be disastrous to the iris. A conjunctival flap was fashioned to cover the scleral wound at 12 o'clock, which was then cleaned and closed by two sutures. The foreign body was easily removed through a scleral incision at the ora serrata just below the lower margin of the internal rectus muscle.

In the majority of cases the scleral entry wound is closed by the time a soldier reaches a base hospital. If the wound is under 3 mm., has no prolapsed uveal tissue and is apparently closed and well shut off by surrounding fibrous tissue I have left it alone. Rarely is there a knuckle of prolapsed uvea or vitreous covered by a cap of fibrous tissue. In some cases surface diathermy is applied around the edge of the wound and causes it to contract. The prolapsed intra-ocular contents covered by the fibrinous cap are cut off. The wound is enlarged to the extent necessary to extract the intra-ocular foreign body.

An associated retinal detachment with a ragged tear through

which the foreign body had passed necessitated the application of surface diathermy so as to include the edges of the tear. Sub-retinal fluid is, of course, drained when the choroid is incised and post-operative posture is planned as in case of retinal detachment.

Results

Table X shows the results in this series of attempts to extract the intra-ocular foreign bodies by a magnet, or if this failed by forceps introduced into the eye. In 73 the posterior route was tried and in 32 the anterior. The numerical discrepancy, 105 in a series of 102 patients is due to the involvement of both eyes in three cases.

TABLE X

		Shell	Hand Grenade	Machine Gun Bullet Casing	Land Mine	Booby Trap	Mortar Bomb	Cannon Shell (Air)	Hammer and Chisel, Brass	Bomb or Shell Fuse	Bomb (Air)	Total
Posterior Route	Magnet Extraction	5	3	—	5	—	1	3	9	—	5	31
	Non-Magnetic Forceps Extraction	—	1	—	—	—	—	—	—	1	—	2
	Non-Magnetic Not Extracted	13	8	1	10	1	2	—	4	—	1	40
Anterior Route	Magnet Extraction	1	3	—	1	—	—	—	3	—	—	8
	Non-Magnetic Forceps Extraction	—	—	—	—	1	—	—	—	—	—	1
	Non-Magnetic Not Extracted	6	7	—	3	4	—	—	—	2	1	23
Total ...		25	22	1	19	6	3	3	16	3	7	105

The majority of war missile intra-ocular foreign bodies were fragments from shells, hand grenades and land mines. About a third of these were extractable by the posterior route. The figures for the anterior route are probably too small to be of conclusive value. This method of extraction was only possible for foreign bodies in the anterior chamber and the lens.

The chance of extracting fragments of cannon shell and aerial bombs by the posterior route appear to be relatively good.

VISUAL RESULTS

(1) *Improved*.—In 23 cases vision improved. Seven of these had cataract which was extracted by operation and afterwards vision with glasses was 6/6 in one case, 6/9 in two, 6/24 (and probably

better) in two Indians who would not admit to seeing more than this; 6/36 in one case and the final result unknown in another. In only one of these was a magnetic foreign body extracted, in another a fragment of bakelite was picked out from the anterior chamber with forceps and in five the intra-ocular foreign body was non-magnetic and was seen in the vitreous with apparently no inflammatory reaction around it. These were fragments of aluminium alloy.

Six had intra-ocular foreign bodies which were successfully extracted by the giant electro-magnet. The vision recovered to:—

6/5 in one case.

6/6 in three cases.

6/9 in one case.

6/24 (and probably better, an Indian) in one case.

In the remaining 10, which contained non-magnetic intra-ocular foreign bodies vision improved from

Perception of light to 6/18 in one case.

Perception of light to 6/24 in one case.

Counting fingers to 6/18 in one case.

Hand movements to 6/60 in one case.

Counting fingers to 6/9 in one case.

Counting fingers to 6/5 in one case.

6/24 to 6/12 in one case.

6/18 to 6/5 in one case.

6/12 to 6/5 in one case.

6/9 to 6/6 in one case.

(2) *Vision Remained the Same.*—There was no change in the visual acuity in 47 cases. Seventeen of these had an intra-ocular foreign body successfully extracted by the giant electro-magnet. The remaining 30 retained a non-magnetic foreign body. There were no post-operative complications in any case in this group, and they have all kept the injured eye to date.

(3) *Vision Became Worse.*—In four cases vision became worse. In one of these a retinal detachment was present four days after a fragment of Breda shell detonator 2 x 2 x 0.5 mm. had penetrated the eye. The intra-ocular foreign body was extracted by fine forceps under ophthalmoscopic view, the retinal detachment was replaced but later this recurred and together with a vitreous haemorrhage reduced visual acuity from 6/36 to hand movements in the nasal field.

In another case some weeks after extraction of an intra-ocular foreign body by the giant electro-magnet a vitreous haemorrhage occurred and the eye ultimately became soft. In two other cases, which contained a non-magnetic intra-ocular foreign body, late vitreous haemorrhage spoiled vision.

Complications necessitating Excision or Evisceration.—Evisceration was done in seven cases. In two of these the eye was hopelessly disorganized. Five developed panophthalmitis, in two a magnetic intra-ocular foreign body had been extracted and one of these cases had an iris prolapse of nine days duration before receiving surgical attention. In the remaining three cases of panophthalmitis the intra-ocular foreign body was non-magnetic.

Seven eyes, all containing non-magnetic intra-ocular foreign bodies began to shrink and were excised. Six eyes were thought to be potentially dangerous for sympathetic ophthalmitis and so were excised. Four of these had had a magnetic intra-ocular foreign body extracted (in one case this had been 4.5 x 3 x 0.5 mm.) and in two the retained foreign body was non-magnetic. In five cases it seemed that iridocyclitis was checked and cleared within seven to 10 days of the administration of one or two intravenous injections of T.A.B. vaccine, 25 millions. Within 48 hours of injection the ciliary congestion subsided and the numbers of keratic precipitates, carefully counted daily, were reduced and eventually disappeared. In all these cases useful vision was saved.

It is too early yet to know whether this therapeutic measure and its delay should be recommended. It is probable that some surgeons fearing the danger of sympathetic ophthalmitis excised eyes unnecessarily and at the same time as relieving themselves of any further anxiety, they have taken from the patient an eye which might have recovered a fair measure of sight. A difficult problem in which courage, worry and possibly folly may become intermingled. We have not yet an infallible test which will indicate liability to sympathetic ophthalmitis.

Sulphonamide Therapy.—In many cases I found it difficult and indeed impossible to assess the value of treatment with drugs of the sulphonamide group administered during evacuation and in hospital.

Twenty-one patients received sulphonamide therapy by mouth and into a vein. Of these 15 had sulphanilamide; two sulphanilamide for two days and then sulphathiazole; one sulphapyridine and three had sulphadiazine.

Sulphadiazine intravenously was certainly of value in the treatment of patients with an orbital abscess and meningitis, and it is probable that two lives were saved by this drug.

Of the 15 who had sulphanilamide five improved during treatment. It was impossible to assess whether the improvement was due to surgical toilet of the wound in all five cases and extraction of the foreign body in four of these or to the sulphanilamide. In one case, an officer with a retained fragment of hand grenade, endophthalmitis was present on his admission four days after wounding. Vitreous prolapse through a scleral wound was cut

off, the wound closed by suture and covered with a conjunctival flap. The endophthalmitis subsided but six weeks later it was evident that the eye was going to be sightless and shrink so it was removed. Two of the four mentioned above recovered useful vision (one of these 6/9), a third showed some shrinking of the injured eye and in the fourth, an officer from whose ciliary body a fragment of hand grenade was extracted by the giant electromagnet, the eye became red, painful and blind five and a half months after wounding and was excised.

In four cases sulphanilamide seemed to have no effect. Subsidence of inflammatory signs was slow in all these, two recovered good vision, in one the eye ultimately shrank and in the other excision was necessary.

In three others the course would probably have been quiescent despite sulphanilamide. All of these had punctured wounds of the cornea and traumatic cataract caused by small non-magnetic foreign bodies, and settled down well.

In one case sulphanilamide administered eight days after wounding did not check the process of endophthalmitis and two weeks later excision was necessary. In another case it had no effect on cyclitis which subsided after an intravenous injection of T.A.B. vaccine, 25 millions. In another case of a severely damaged eye, 16 days without appropriate surgical attention, sulphanilamide was of no use.

Two patients were treated by sulphanilamide and sulphathiazole. One of these had his eye excised six weeks after wounding. Both eyes of the other patient were severely contused and had multiple penetrations from the blast of a booby trap explosion. The inflammatory state of the eyes subsided but these shrank and became blind.

Sulphapyridine failed to check panophthalmitis in the eye of a sergeant whose iris prolapse was eight days old when he reached hospital.

Sulphanilamide was more commonly used than the other sulphonamides in the field units and a dose of 2.5 gm. morning and evening was in most cases aimed at. Movement, enemy action, changes of orderlies and other difficulties were the cause of irregularities in administration of the drugs. A number of wounded were given a supply of sulphonamide tablets and told to take these at regular intervals during their journey to hospital. Sleep, loss of interest, forgetfulness and unconsciousness produced failure in co-operation.

Major Dansey Browning working in No. 1 Mobile Ophthalmic Unit treated some of his surgical cases with albucid drops 2.5 per cent. and others with sulphonamide ointment 5 per cent. Generally it was not until the patient had reached hospital that regularized sulphonamide therapy could be given.

Summary

This paper is a review of 102 cases of intra-ocular foreign bodies evacuated to one of the hospitals serving the Eighth Army in its North African Campaign from November, 1941, to May, 1943.

An analysis is made of the type of casualty sustained, the nature of the missile, the site of penetration, intra-ocular complications and the incidence of multiple wounds. About 30 per cent. of war missiles have low magnetic properties. When these are situated behind the lens the posterior route of extraction through a scleral incision is the method of choice. The technique of this operation is described in detail.

Visual results and complications are discussed.

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ORBITAL CELLULITIS IN A BABY CAUSED BY ACUTE OSTEOMYELITIS OF THE MAXILLA*

BY

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IN 1939 Asherson published a paper entitled "Acute Osteomyelitis of the Superior Maxilla in Young Infants." In it he reviews the whole literature, comprising, together with his own, 42 cases of infants under twelve weeks of age.

He draws attention to the fact that orbital cellulitis in young children, which used to be regarded as being caused by an acute inflammation of the antrum, is in reality an osteomyelitis of the maxilla, with secondary involvement of the antrum, because it is characterized by the formation of fistulae and sequestra.

He shows that the staphylococcal infection is in the maxillary bone, involving the tooth socket of the upper deciduous, unerupted, first molar. The socket is at this age actually larger than the antrum, to which it is closely related. Any infection of

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