NEW MAGNETIC OCULAR OBTURATOR, SERIES III, MK. I*† COMPLETELY BURIED, ENUCLEATION MODEL

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THIS is a preliminary report of a new magnetic ocular obturator for use after enucleation of the globe. It is a completely buried implant.

An attempt has been made to bring the research, design, construction, and surgery of the new instrument into continuity with previous models of the post-eviscerative type, some partially buried and some wholly buried within the orbital structure, applying the experience already gained.

For those unacquainted with this line of implant research, a brief classification is given below:

(A) POST-EVISCERATION—INTRA-OCULAR, 1950 ET SEQ.

Series I Peg type, partially buried, non-magnetic, anchored, tantulum wire suturing

Series Ia Auto-scleral type, completely buried

(a) Primary

(b) Secondary, using the original tantulum wiring for shaping and to increase the body of the autogenous scleral implant.

(B) POST-EVISCERATION—INTRA-OCULAR, 1953 ET SEQ. COMPLETELY BURIED

Series II

Mark I Cup type, magnetic, nylon ring suture, tantulum and nylon anchored, dual gold-plated bar magnets

Marks II and III Flat faced, cuboidal, magnetic seed type, gold plated horseshoe magnets, tantulum and nylon anchored using tantulum wire cradle.

(C) POST-ENUCLEATION—INTRA-ORBITAL, 1966

Series III

Mark I Completely buried, hammock slung type, autogenous corneo-scleral graft carapace, magnetic (gold-plated horseshoe magnet), orbital "fix", muscle-action transposition, pseudo-optic nerve anchorage using white silk suture and tantulum basket.

Description

The basic principles underlying the previous implant designs, construction, and retention

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mechanisms have proved sound. In consequence, the new obturator may be said to embody this experience, with certain modifications, as shown below:

- (1) It is almost cuboidal in shape, composed of non-free monomer acrylic resin, with a flat face anteriorly in which the gold-plated magnet is to be seen through the transparent mass in the upper outer anterior quadrant of the implant.
- (2) The anterior face is bisected just *below* the horizontal mid-line by an undercut groove, the ends of which are overbridged by two muscle-retaining bars, one at each end. The intervening open space, for purposes of description, is called the anterior acrylic window, to distinguish it from the internal communicating acrylic window which unites the horizontal anterior groove with the posterior vertical canal on the *medial* side.
- (3) From the superior aspect a wide canal, traversing the substance of the acrylic mass, is seen lying to the *MEDIAL* side of the vertical mid-line of the implant and communicating with the horizontal groove as stated above.
- (4) The metallic magnet is of aluminium-nickel-cobalt and is of the horseshoe type.
- (5) As the obturator also depends upon being completely buried for its safe and proper functioning, an autogenous corneo-scleral graft is united to the implant, anteriorly, by suturing the horizontal extrinsic muscles, exposed in the anterior acrylic window, to the back of this graft carapace or shield.
- (6) On the posterior aspect of the cuboidal-shaped instrument is to be seen an expansile tantulum wire-mesh basket of smallish dimension, intimately "welded" to the acrylic substance on the medial inferior aspect.
- (7) There is a separate implant for each orbit, the right obturator being the mirror image of the left.
- (8) The implant may also be obtained in surgical grade silicone elastomer.

Special Note

The description would not be complete without reference to the role of the tantulum basket. This is part of the novel retaining mechanism and through which a very firm attachment is made with the posterior orbital wall by uniting the basket to the dural covering of the severed optic nerve. This union is greatly enhanced later by the reactive fibrosis within and around the mesh basket—the pseudo-optic nerve. Reactive fibrosis thus ensures a permanent, constant and strong posterior fixation point from which all movements of the implant are taken and ultimately transmitted through the covering tissues to the complementary magnetic prosthesis.

Preparation

Table

All the instruments for enucleation, Spencer Wells forceps, one large, rest small.
 Series III, Mk. I magnetic ocular obturator, right or left orbit as required.
 Ocular snare, iris hook, and iris repositors.
 Sutures: doubly-armed 0000 and 000 silk atraumatic type.
 Fine aneurysm needle or Ethicon corneal needle on 000 silk, atraumatic type.
 Serifines.
 Holding Sutures.
 Tudor Thomas Donor-Graft Stand.
 Pure alcohol.
 Bard Parker knife No. 15.
 Black silk conjunctival sutures.
 Fine rubber tubing.
 Watch glass and penicillin solution.

Anaesthesia

This operation can be performed under a local anaesthetic, but a general anaesthetic is advised. Since this, in all probability, will be of the most modern type, consultation between the anaesthetist and the surgeon with regard to pre-operative medication and sedation is indicated. Adrenalin should not be employed without giving prior notice to the anaesthetist.

Pre-operative Precautions

Apart from the use of adrenalin, mentioned above, and the avoidance of over-medication and sedation, patients who suffer from an allergic diathesis or a specific allergy to acrylic resin should be excluded from the surgical list unless the silicone elastomer model is available. Mentally unstable patients or those suffering from diabetes, exophthalmic goitre, pulmonary phthisis, or other debilitating disease are unsuitable for this surgical method. Under no circumstances should an implant of this type be used after enucleation for tumour of the globe. Absence of infection from teeth, sinuses, and antra should be proved and checked by x ray. Skin lesions of an impetigenous or eczematous nature, with or without asthma, are contraindications.

Theatre instructions should include the wearing of surgical operating gloves, as a foreign body is about to be inserted into the orbit, for which the most rigid prophylaxis against infection should be employed.

When a degenerate glaucomatous globe is enucleated for implant purposes, the precaution should be taken to counteract any potential rise of tension in the "good" eye.

Adequate sterilization of the implant by aqueous "Savlon" for a period of at least 36 hours is recommended. Do NOT use the alcoholic solution of this drug. The standard sterilization is recommended for these implants.

Pre-operative Therapeutics

Antibiotic and steroid therapy should be commenced and maintained for a period of 7 days before operation and continued subsequently, the steroid therapy being reduced gradually. Tab. tetracycline 250 mg. four times a day and tab. prednisolone 5 mg. only twice a day are given. The usual pre-operative attention to the conjunctival sac is carried out. Tab. Becosym are also included in the treatment.

Surgical Technique

Preliminary Remarks

As the operative method requires the firm attachment of the obturator to the dural covering of the severed optic nerve and the setting of an orbital "fix", the threading and the suturing of the horizontally acting extrinsic muscles, and the vertically acting muscles, in their horizontal groove and the vertical acrylic canal respectively, are performed in two stages.

Stage 1.—Having *pre-placed* the silk suture of the dural sheath of the optic nerve in position, the vertical muscles are sutured together. The optic nerve head and its covering are now drawn into the tantulum basket and sutured in position and the basket is closed upon its contents by external pressure on the wall of the basket.

Stage 2.—The horizontally acting muscles are then united by suturing, within the under-cut groove. The two respective sets of united extrinsic ocular muscles are then conjoined by suturing them together, using the acrylic ostia shown for simplifying this procedure (Figs 1 and 2 opposite).

FIG. 1.—Right-sided obturator

- (1) Undercut horizontal groove just below mid-horizontal plane of implant, showing the ostia at each end of the groove formed and completed by the body of the implant and the muscle-retaining bars (4) and (6).
- (2) Tantalum basket, partial view only.
- (3) Acrylic body of implant.
- (4) & (6) Muscle-retaining bars.
- (5) Open space between muscle-retaining bars communicating with the undercut groove in the external acrylic window.
- (7) Gold-plated horseshoe magnet.
- (8A) Vertical canal medial to the mid-vertical plane. A small window communicates with the external acrylic window.
- (8B) Internal communicating acrylic window.
- (8C) Lower opening of vertical canal.

Special Note: For correct insertion of the obturator, the gold-plated magnet must be up and out, the vertical groove being on the medial side and the undercut groove below the mid-horizontal plane.

FIG. 2.—Right-side obturator with rectus muscles in position.

- (1) Horizontal rectus muscles joined through the horizontal groove.
- (3) Acrylic body of implant.
- (4) Muscle-retaining bar.
- (5) Inferior rectus entering vertical canal.
- (7) Gold-plated horseshoe magnet.
- (8A, B, C) Vertical canal, now containing the vertical rectus muscles.
- (9) Superior rectus entering vertical canal.

The role of the autogenous corneo-scleral graft shield (or carapace) has been mentioned above and is discussed below.

Surgery of the Series III, Mark I, Magnetic Implant (Enucleation Model)

(1) Proceed as for enucleation, severing the conjunctiva from its limbal attachment and opening up the tissues about the extrinsic muscles and the posterior orbital tissues by expanding scissor movements, without directly cutting these tissues.

(2) Using 0000 doubly-armed white silk sutures, two whip sutures are attached to each of the extrinsic rectus muscles at their attachments with the sclera—one at the tip of the muscle and one 4 mm. posterior to this.

(3) These muscles are then divided from the globe. The tissues posteriorly and those

within the mid-zone of the muscle cone are carefully separated to expose the superior and inferior oblique muscles.

(4) The superior oblique muscle is first divided from its global attachment. The inferior oblique muscle is then severed from its attachment to the globe and sutured to the overlying external rectus muscle, *from within the muscle cone*, using 0000 white silk suture.

(5) Gentle exploration with curved blunt-ended scissors exposes the region of the optic nerve, but no disturbance of the short ciliary arterial ring is made at this stage, haemostasis being all-important.

(6) The metal wire loop of an ocular snare is now reduced to a size slightly greater than the equatorial circumference of the globe. The loop is gently passed over the globe carefully avoiding entanglement of *any* of the extrinsic muscles within the loop, since an irrevocable position results if this occurs.

(7) For haemostatic purposes as well as for the above-mentioned reason, the metal loop is reduced in size by stages, a short period elapsing after each turn of the screw, so that the loop is moved posteriorly to sever the nerve, clear of any Tenon's capsule.

(8) Finally, the globe is enucleated leaving a perfectly dry socket. Within the ocular muscle cone the severed optic nerve and its coverings are seen as a creamy vermiform structure lying against the muscle wall. The nerve head is gently seized with a small artery forceps, which is used as a retractor when inserting the doubly-armed dural sheath guiding suture.

(9) Using an atraumatic 000 white silk suture, or the dural sheath guiding suture (*vide supra*), the nerve head and coverings are perforated and a firm knot tied in the head of this tissue. The artery forceps is not yet removed. The suture is left uncut. A nylon suture is not recommended.

(10) The enucleated globe is now placed in the Tudor Thomas Donor Graft Stand, held firmly by the assistant, while the circular autogenous corneo-scleral graft tissue, 16–18 mm. in diameter (using a Bard Parker Knife No. 15 for the incision) is taken. The anterior surface of the cornea is gently rubbed with pure alcohol to remove the epithelium, while the posterior surface is cleansed of all adhesive tissue and pigment deposition. The graft is now placed in penicillin solution in a watch-glass.

(11) The union of the superior and inferior recti muscles is now carried out, using the doubly-armed pre-set whip sutures. This is best done by threading the *inferior* rectus muscle through the canal from below until the divided muscle tip shows above the implant, when the suturing is easily completed. The implant is made to slide gently along the sutured muscles into a position where, approximately, the orbital "fix" will finally be set out.

With the completion of these preliminary stages, the union of the implant to the dural sheath of the optic nerve is now possible.

(12) The artery forceps grasping the tip of the severed optic nerve and its coverings is not removed until the dural sheath guiding suture is in its final position and the dural sheath is about to be drawn into the tantulum basket. To accomplish this, each of the atraumatic needles is made to pierce the tantulum basket wall from within outwards, the artery forceps is removed, and a firm tie is made in the suture after drawing the divided nerve head and its coverings into the basket.

(13) The conjoining of these two structures is further consolidated by compressing the walls of the basket, closing it against the tissue coverings of the optic nerve head. A small Spencer Wells forceps is used for this purpose. Reactive fibrosis will ultimately complete the picture, the actual optic nerve atrophies very rapidly to take no further part in the union.

(14) The lateral and medial rectus muscles are threaded into the horizontally-cut groove

beneath the muscle-retaining bars and are sutured together. The ends of the sutures, with atraumatic needles attached, are left uncut for the purpose of uniting the autogenous graft shield to these muscles at a later stage (*vide infra*).

(15) The orbital "fix" is now set up by sliding the implant along the vertically and horizontally acting muscles, until the obturator is in the slightly up and in position from the mid-orbital point, in relation to the anterior walls of the orbit. The crossing of the two sets of muscles is then "fixed" by suturing them together with 0000 white silk suture.

(16) We now come to the final stages of the operation with the positioning of the circular autogenous corneo-scleral graft shield (or carapace) which will cover the anterior face of the implant completely. Using the preplaced sutures within the muscles lying in the horizontal canal (which are seen exposed in the anterior acrylic window (*vide supra*) on the anterior face of the implant), the needles are in turn made to pierce the posterior corneal substance of the corneo-scleral graft tissue without actually perforating it completely. The implant is then completely shielded from the external covering tissues. The sutures are successively tied and cut short, thus uniting the graft shield to the implant body through the media of living tissue.

(17) The triple layer of orbital tissue-conjunctiva, episclera, and Tenon's capsule is now united over the graft carapace, as a double layer, the lower section being drawn up under the upper mass by well-placed black silk mattress sutures tied and cut short, while the free upper edge is sutured by a continuous black silk suture to this same layer inferiorly, to seal off the implant from the surface tissues. Splendid conjunctival holding fornices result from this action.

(18) The lids are united over some fine rubber tubing, ocul. penicillin is inserted in the conjunctival fornices, and a pressure bandage is applied. A radical tarsorrhaphy is not performed.

Post-operative Treatment

The penicillin *tulle gras* dressing and pressure bandage are renewed on the third day and daily thereafter. Ocul. penicillin or its equivalent is introduced into the fornices through the palpebral lid space laterally.

The antibiotic therapy and steroids are continued for 14 days and then gradually reduced over the next 7 days. It is important to keep a good antibiotic cover until the deeper mattress sutures have been removed. The lid sutures may be removed on the tenth day.

Dependent oedema of the conjunctiva is to be avoided, hence the above simple precautions.

A non-magnetic prosthesis can be inserted on the twenty-eighth day after operation, as the fornices are quite clear and deep. A magnetic artificial eye may be inserted from the eighth week onwards (Fig. 3), when any reaction may be expected to have settled down

FIG. 3.—Appearance of a patient in the primary position of gaze. The right prosthesis displays a slightly darker iris ground than that of the normal eye.

completely. Movement of the prosthesis in all directions is excellent (Fig. 4).

FIG. 4.—X rays showing the movements of the implant in the various directions of gaze. The clue to the movements is the anterior grooved face of the cuboid gold-plated horseshoe magnet. The rounded opacity is the tantulum basket, whose lesser movements record the positions of the severed nerve head of the optic nerve.

Summary

A preliminary report on a new ocular implant Series III, Mark I, is given. A schematic classification of previous work places this obturator in its proper perspective. Descriptive details and some ideas underlying construction are presented with a detailed account of the surgical technique.

My thanks are again due to Mr. John Attenborough of Messrs. C. & L. E. Attenborough, Ltd., of Nottingham, who has been responsible for the different prototype "mock-ups", for scientific advice generally on technical points of construction, and for this the final magnetic obturator of the series.

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