COMMUNICATIONS

INTRA-OCULAR ACRYLIC LENSES*

10 YEARS' DEVELOPMENT

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INTRA-OCULAR acrylic lenses have now been in use for over a decade and their employment in some form or other seems generally to be accepted as an integral part of present and future ophthalmic surgery. They have undoubtedly led to a wider appreciation of the many disadvantages of aphakia, and in uniocular cataract they offer a degree of visual restoration never possible before. As is to be expected with an innovation in any scientific or mechanical sphere, considerable difficulties are inevitably encountered and changes must be made during the period of development. The many designs for intra-ocular acrylic lenses which have been and still are being produced show not only that interest in the subject is growing but that the ideal pattern of lens has not yet been devised.

Posterior Chamber Lenses

When the idea of artificial lenticuli was first conceived in 1948, it was decided, in spite of some evident disadvantages, to place the lens in the natural position rather than in the anterior chamber. Though the mechanical shortcomings of the posterior chamber situation were evident, an attempt was made to copy nature as closely as possible both anatomically and optically. At that time it was feared that a lens resting in the angle of the anterior chamber would inevitably give rise to corneal opacity.

Looking back over the past 10 years, it is apparent that the posterior chamber artificial lenticulus has, for the time at least, fallen out of favour. That is not to say, however, that good and lasting results have not been obtained by its use. Surgeons who have devoted great attention to the choice of case, the surgical minutiae, and, not least, to the aftercare of patients, have reported series of cases in which the results have been very satisfactory. Nevertheless it must be admitted that the combined operation of even a perfectly performed extracapsular extraction followed immediately by the insertion of a foreign body is a severe ordeal for an eye. Furthermore, extraction of the lens leaving behind nothing but an intact posterior capsule and peripheral tags of anterior capsule is by no means always a simple procedure, and it has long been known that extracapsular extractions without lens insertion give rise to anaphylactic iridocyclitis if lens fibres are left for

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absorption into the aqueous. Sometimes, after a combined extraction and acrylic lens insertion, an alarming iridocyclitis occurred and the danger of post-operative reactions, possibly of considerable severity, undoubtedly influenced many surgeons against the employment of the original intra-ocular acrylic lens.

A further and more serious criticism of the original posterior chamber operation is the inherent instability of the lens, the support for which relies on an intact posterior lens capsule and zonule behind and an iris with normal musculature in front, supplemented in most cases by some degree of adhesion between the posterior surface of the iris and the lenticulus. Nevertheless, if a posterior chamber lens is inserted and properly centred after an efficient extracapsular extraction in an eye with a normal iris and an intact zonular-capsular bulkhead, not only is the visual acuity satisfactory but almost natural sight is restored. In short if the eye is free from inflammation and the lenticulus is in perfect position, its rim being visible through the peripheral iridectomy, a good and apparently permanent result can be expected. Unfortunately this operation, like others, is not without its troubles.

Post-operative Treatment and Early Complications

Some slight traumatic inflammatory reaction is general and indeed possibly beneficial, because it may stabilize a well-positioned lens by causing broad posterior adhesions between it and the posterior surface of the iris. For this reason topical hydrocortisone ointment is generally withheld until the fourth post-operative day but may be started earlier if required. Iridocyclitis of moderate degree may be due to incomplete removal of soft lens matter by thorough anterior chamber irrigation. Severe post-operative iridocyclitis sometimes with hypopyon may be caused by inadequate removal of lens sterilizing solution, a serious error which can be eliminated by adequate care and the use of modern sterilizing methods (F. Ridley, 1957). Fortunately local and, if necessary, systemic corticosteroid therapy is highly effective in dealing with this alarming but aseptic chemical inflammation.

When the patient leaves hospital about the 12th day after operation, there will be a deposit of fibrinous exudate on the anterior surface of the lens which precludes good visual acuity. Normally this deposit undergoes gradual absorption during the succeeding 6 to 8 weeks but, if the pupil is allowed to constrict beyond the optimal 3.5-mm. diameter, the exudate may become organized into a fibrinous membrane. This result of inadequate aftercare is prone to develop after the patient has returned home for, though the same medicaments which have proved satisfactory in hospital may be prescribed, they may not later be applied efficiently. Ideally, every case should be kept under observation for 3 to 4 weeks so that the precise mydriatic requirements may be assessed, but as a rule 0.5 per cent. atropine drops, in conjunction with hydrocortisone ointment twice daily, proves adequate if the pupil size is correct at the time of discharge.

If an organized pupillary membrane has formed, it may require division with a needle knife or, in late cases in which the membrane is tough, with two such instruments, one being inserted from the temporal and the other on an angled mount from the nasal side. The two points pierce the membrane close together and are then separated. This minor operation is almost always successful for the lens surface beneath the membrane is generally clean.

Though 6/9 is regarded as a satisfactory degree of visual acuity and even 6/4 not unknown, some eyes fail to attain this standard on account of capsular opacity or cortical remnants behind the lens. These opacities are generally due to surgical errors and do not frequently increase later. If necessary, however, the posterior capsule can be incised under direct observation through the pupil by means of a needle knife passed through the pars plana. This operation, which must carry some risk but has not in our hands given rise to trouble, has been thought necessary in less than 2 per cent. of cases.

Late Complications

The cause of late complications can generally be traced to bad surgery or inadequate aftercare. Anterior dislocations have been rare and, unless traumatic, are due to overdilatation of the pupil or imperfect centring of the lens with the development of irido-capsular adhesions leading to local retraction of the iris. Through the distorted pupil the lens rim becomes visible and later the lenticulus may dislocate into the anterior chamber. In the early stages an attempt may be made to recentre the lens and raise the iris over its edge, but firm adhesions soon develop and usually render full replacement impossible. A lens lying free in the anterior chamber and resting against the cornea must be removed by a simple operation to prevent irreversible dystrophy.

Posterior dislocation of the lenticulus has been in our experience a more frequent and serious complication and is considered by far the most important disadvantage of the posterior chamber lens. The lenticulus cannot slip into the vitreous if the zonule and posterior capsule are intact, and it is still uncertain if these structures ever give way spontaneously or as a result of pressure of the lens. It was soon found that insertion of a posterior chamber acrylic lens after deliberate intracapsular extraction was followed in the majority of cases by dislocation and this procedure was abandoned. It is easy, however, to damage or even tear out the delicate posterior capsule accidentally when attempting extracapsular extraction, and for this reason it is important to cut the anterior capsule with a cystitome all round the edge of the dilated pupil before removing the central area with capsule forceps. If any capsular tag remains it must not be torn out but should be carefully cut off with iris scissors. These technical modifications have greatly improved the prospects of good and lasting results, for since they were introduced there have been few posterior dislocations. Fortunately, a dislocated

lenticulus, though most distressing, is less serious than a dislocated human lens, and does not generally set up chronic uveitis and cause glaucoma, but in one case a dislocated lenticulus wore a hole in the retina, causing detachment. In some eyes in which this posterior dislocation occurred, normal visual acuity was restored with a cataract glass. Extraction of a lenticulus from the vitreous chamber is a difficult procedure which we have not attempted though others have reported cases.

Another late complication only recently becoming evident is iris atrophy from pressure by the rim of a badly-centred lens. If this is severe, extraction of the lenticulus is advisable and in suitable cases it may be replaced with an anterior chamber lens.

Glaucoma has not been a common sequel but may be primary or secondary to low-grade uveitis. Loss of the anterior chamber generally indicates an aqueous obstruction in the iris plane. If the lens is adherent to the iris and the peripheral iridectomy becomes blocked, an iridotomy through the iridectomy may be enough to relieve the tension; other types of glaucoma are treated on general lines and if necessary by a drainage operation.

There has been one case of sympathetic ophthalmitis in a series of about 750 operations. Fortunately, with steroid therapy and simple extraction of the inflammatory cataract, visual acuity of 6/60 to 6/36 has been retained.

There have been three cases of retinal detachment, one of which followed a blow on the eye.

Discussion

In spite of the complications discussed above, the majority of cases, even some of the earliest series, continue to be satisfactory. It is not possible to assemble all the patients, and many indeed must by now have died, but it would appear that the present results are rather better than those of our cases of several years' duration which were re-examined in 1956 (H. Ridley, 1956). It was reported then that operations performed in 1951, 1952, and 1953, still provided after an interval of 3 to 5 years visual acuity of 6/12 or better in about half the cases, 6/9 in one-third, and 6/6 in one-quarter with the aid of low-power spectacles, compared with 6/9 in two-thirds and 6/6 in one-third initially (H. Ridley, 1956). It must be remembered, in comparing visual results, that unocular cataracts often have an uncertain background and that posterior segment lesions may be discovered in single-stage operations only after the lens has been inserted, whereas in two-stage operations no intra-ocular lens would have been used and the case therefore rejected from the series.

In spite of the high proportion of good and lasting results, with which the patients are usually most satisfied, the posterior chamber lens operation has revealed some disadvantages, the immediate drawbacks being principally the technical difficulty and the rather severe post-operative reaction, and the late drawbacks being dislocations and retraction and atrophy of the iris.

Anterior Chamber Lenses

With a few notable exceptions, most ophthalmic surgeons who perform the acrylic lens operation at the present time prefer an anterior chamber implant such as was originally devised by Strampelli (1954). This has several advantages. The combined operation can more easily be performed in two stages, thereby simplifying the technique and making the operation less severe on the eye. An anterior chamber lens does not require the support of an intact posterior capsule and can be used after intracapsular extraction. Its precise optical requirements can be calculated when the eye is aphakic, so enabling a "bespoke" lens to be ordered. In the event of later trouble it is easier to remove or even exchange the implant for one of different size or pattern. On the other hand there are disadvantages. The most important of these is the danger to the corneal endothelium and the delicate structures in the angle of the anterior chamber which are not well adapted to withstand pressure or contact. Too small a lens will twist or turn on its axis and one too large may distort the globe and damage structures in the angle. Either misfit may produce considerable astigmatic errors and a mobile lens, if left in the eye, is likely to produce a gradual but apparently irreversible corneal degeneration, the earliest sign of which demands immediate removal of the implant.

The design for an anterior chamber lenticulus presents quite a difficult mechanical problem. The ideal implant should be comparatively easy to insert. To remain stable in position it needs to be an exact fit in the angle whilst causing minimal pressure on or distortion of sensitive structures. It must on no account touch the cornea at any point, and for optical and cosmetic reasons should lie close to but just clear of the iris. From the purely mechanical aspect a lens based on an equilateral triangle would seem ideal, for the inherent stability of this structure has been recognized since the time of Euclid.

Very many designs of anterior chamber implants have already been produced. The original Strampelli design with subsequent modification has been most generally employed and can give very good results. It is simple to insert through a small incision but, since it is a rigid implant, great care must be taken to ensure a close fit in the anterior chamber, the precise width of which is not easy to measure. In view of this difficulty, several surgeons (Barraquer, 1956, 1957, 1958; Dannheim, 1957; Leib and Guerri, 1958; and others) have devised non-rigid implants with bases which are in varying degrees flexible. All of these are complicated and present constructional difficulties and they must be somewhat fragile. If truly flexible they cannot be as stable as a well-fitted rigid implant, and to achieve adequate fixation the flexible haptic must press into the anterior chamber angle.

In an attempt to achieve maximal stability with minimal pressure, an implant based on tripod support has been designed (H. Ridley, 1957), and this

has recently undergone minor but important modifications. The ideal equilateral triangle has not been employed because of the large incision which would be required for insertion, but a broad-based isosceles design has been used which gives adequate protection from tilting or turning without requiring firm fixation in the angle. The original pattern was a simple structure, but the new model (Mark II) has been made thinner and the tips of the haptic legs have been flattened (see Figure) to lessen the danger of pressure on the corneal periphery and to keep the lenticulus close to, but just clear of, the iris. This position, being nearer the nodal point of the eye, minimizes aniseikonia. Such an implant is comparatively easy to insert and, if properly fitted, cannot tilt, though it may turn a few degrees in the convalescent stage before becoming stabilized in its final position.

FIGURE.—Design of tripod anterior chamber lens, Ridley Mark II ($\times 4$).

Anterior Chamber Implant Insertion (Two-Stage)

An eye is generally in its best condition to receive an anterior chamber lens several weeks after extraction of the cataract when it has completely recovered from the first operation. Insertion of a tripod anterior chamber implant into an aphakic eye is not difficult but requires attention to detail. The intra-ocular pressure should be low, and complete miosis is desirable, but in traumatic cases not always possible.

The haptic of the lens selected should be 1–1.25 mm. greater than the transverse diameter of the cornea. At least one pre-placed corneal suture is required to control the section while the upper leg of the implant is being set,

and the author prefers a half-depth corneal mattress stitch inserted before the section is made. A von Graefe knife section from 10 to 2 o'clock is made; it is important that this should not be limbal and a conjunctival flap, desirable as it is, must be sacrificed in favour of a peripheral corneal lip under which the top leg of the implant can be set. The lens, grasped by special forceps, is introduced and is slid with a slight side-to-side movement over the face of the iris. Care is required to prevent one of the lower legs of the implant entering the pupil, especially if the cataract extraction was intracapsular. When the lower legs appear to have reached the periphery of the cornea, the upper leg will still be 2-3 mm. outside the section, and the surgeon may be tempted to remove it and try one of smaller size. It will be found, however, that, by pulling on the scleral half of the mattress suture and simultaneously pushing the upper leg of the implant downwards and backwards, the implant will slip into a fair position. At this stage the mattress suture is tied and other simple corneal sutures are placed on either side of it. An iris reposer or spatula is then passed through one edge of the section and over the upper limb to ensure that it is truly in the angle and not resting on the upper lip of the corneal section. Finally, a small iridectomy or iridotomy is made through each end of the section, for if this is not done the pressure of the lens on the iris may lead to pupillary-block glaucoma. Air or Ringer solution is injected into the anterior chamber to press the iris into position. The post-operative reaction is usually not severe and local steroid therapy can be employed as the occasion demands.

Anterior Chamber Implant Insertion (One-Stage)

It is evidently a more severe and difficult operation to combine extraction with lens insertion, though it is in many respects desirable and avoids a second period of hospitalization. Single-stage operations, particularly those including intracapsular extraction, are not recommended unless the surgeon has considerable experience of intra-ocular acrylic lens surgery and its after-care. Complete miosis after extraction is essential if it is proposed to proceed forthwith to insert the implant, and injection of isotonic 0.5 per cent. pilocarpine into the anterior chamber will usually effect this. When an anterior chamber lens is inserted after extracapsular extraction, the posterior capsule need not be opened, for a capsulotomy can, if necessary, be performed later without displacing the lens, which incidentally acts as a guide to the optimal position for the aperture.

Anterior Chamber Lenses and Injured Eyes

Many of the eyes which require acrylic lens surgery have become aphakic as a result of trauma. In these cases, associated damage to cornea or iris may indicate some modification of technique or even the use of a specially-designed lens. A good visual result may be obtained even if vitreous is in contact with the back of the lens.

Conclusions

Though increasing numbers of surgeons throughout the world are employing intra-ocular lenses, mainly in unioocular aphakia for which their indication is strong, initial disappointment has tended to discourage others. There is no doubt that posterior chamber lenses, though they restore the true anatomy and optical system of the eye, are prone to give rise to complications unless care is taken in the selection of cases and exceptional attention is paid to surgical minutiae and post-operative treatment. The technical requirements of intra-ocular lens surgery will always be high and, whilst single-stage operations involving combined cataract extraction with acrylic lens insertion are still to be recommended only to surgeons who are not only skilful but well-experienced in the use of intra-ocular prostheses, there seems no longer any good reason to discourage others from two-stage or even three-stage techniques: the first stage being extracapsular extraction, the second insertion of an anterior chamber lens, and the third, if necessary, capsulotomy. The rigid tripod lens, recently modified, though a little more difficult to insert than some others, has the virtue of remaining in position without touching the cornea with minimal pressure in the angle of the anterior chamber.

Intra-ocular acrylic lenses seem now after 10 years to have found a permanent place in ophthalmic surgery and their successful use gives great satisfaction to both patient and surgeon. Their future development is a stimulating experience in which many can usefully join.

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