INTRA-OCULAR LENS

William Arendshorst

~ 1975

Anatomy of Eye

(1) Cross-section pictures

(2) 9-0 nylon suture

(3) Cataract lens in spectacle frame

(4) Ridley's implant – p. 11 – Manual

(5) Strampelli – p. 7 – manual

(6) Barraquer – p. 13 – manual

(7) Choyce – p. 267 – manual
p. 34

(8) Epstein – p. 26 – Manual
(Collar button)

(9) Capeland lens. – p. 34 – manual
Maltese Cross

(10) Binkhorst – 4 loop – + iris clip – p 34 Manual

(11) Binkhorst Fedorov – 90° loops – p. 34 "

(12) Lens most commonly used – p 34 – Manual

(13) Iridocapsular lens of Binkhorst p. 34 "

Intra-Ocular Lens

I believe it was during my first few years as a member in this club that I presented a paper "The History of Cataract Extraction." If you recall, it was accepted with mixed emotion. Tinkering with the eyeball sometimes can provoke untoward symptoms. I sincerely hope that none of you will be bothered by my talk tonight. Times have changed and so have many aspects of ophthalmology, including the business of removing the cataract and treating the aphakic eye. Aphakia means without the lens. And a-audience, I guess, means no audience.

To help you further in understanding the problem of cataract (1) I've drawn these simple diagrams of the anatomy of the eye. Removal of the cataract was done in the days before Christ but it was done in a most crude manner. Often behind a hidden maneuver, e.g. a mud pack, a sharp knife needle was used to engage the cataractous lens. Then employing a quick downward movement, the lens was completley dislocated into the vitreous and the knife needle withdrawn. The cataract was left in the vitreous and the eye usually ended with a variety of complications including hemorrhage and infection + loss of the eye. This method was called "couching" and was used for centuries. Itinerate ophthalmic surgeons used the method into the 1800's.

However as eye anatomy became more thoroughly understood and as better techniques including ascepsis developed, the idea of taking the entire lens out was conceived and about 1753 Jacques Daviel sently to the Royal Academy of Surgery of Paris a most important paper in which he reported 115 planned cataract extractions with 100 successes. Daviel used the extracapsular, method whereby the back capsule of the lens was left in the eye and most of the lens material was washed from the eye. Between that time and the present, the changes have been remarkable: Ascepsis is a must; a clean sharp two-step incision at least 160 degrees in extent; a trypsin derivative enzyme to lyse the minute zonular ligments that keep the lens in place; a -35 degree

freeqing probe to get a firm attachment to the lens; nylon sutures (2) of smaller guage than human haif; and finally the use of the opera ting microscope. These improvements in technique have resulted in good visual results in over 98% of cataract operations.

At the present time cataracts are the leading cause of blindness and more than 400,000 persons in the United States alone, most of them elderly, undergo surgery for removal of ~~diseased lenses in their eyes~~ their cataract each year.

Rehabilitation of the patient is not completed by just getting a perfedt aphakic eye. As you know, with the lens removed the eye has lost about 45% of its focusing power and somehow if the eye is going to have useful vision, this lost ability has to be restored. Removal of this portion of a highly specialized organ is but halfway to the cure. Vision can be restored by fitting the proper (3) lens in front of the eye in a spectacle frame and this has been the accepted way for about the past century. However during the last 20 years, the contact lens was pefected and it was then applied to the cataract problem. It has been very successful but is not the peffect answer. Obviously, the ideal solution would be to replace the diseased lens. From this point of view, the history of intraocular implants is basically the history of cataract, cataract surgery and the correction of the visual defect of aphakia. You will be surprised to learn that that well-known 18th century character, Casanova was in fact the first person to record the suggestion (in 1776) that an artificial magnifying lens (of glass) might be inserted into the eye, so that patients could be made to see clearly once more after removal of their cataracts! So Casanova's idea is fittingly a bicentennial one.

a bicentennial item

Although he was better known for his selfless desire to please as many ladies as possible during his markedly heterosexual carrier, and although he originally intended to be a phyiician, he ~~eventually trained for the law~~ ended up being a lawyer. He lived during the period when Jaeques Daviel revolutionized

eye surgery by the introduction of planned cataract extraction, as was mentioned earlier in this paper. The idea was apparently not followwed up for there is no record of further thinking along this approach until 1940 when a glass pseudophakos was suggested as a replacement for the natural lens. Then in the late 1940s, interest reawakened in England.

(4) Dr. Harold Ridley of Moorfields and St. Thomas"s Hospital in London replaced a mature cataract with an artifical lenticulus (plastic, not glass or crystal) after extracapsular extraction. The results were published in 1951. His lenticulur was inserted behind the iris and in front of the posterior lens capsule, so as to occupy the position of the anatomical crystalline lens. It worked best when this lens was introduced at the same time that the cataract extraction was performed. and its use was limited to those cases where the posterior capsule was left intact. By 1964 Ridley had given up using his original posterior chamber lens for 2 main reasons: (1) the high incidence of late dislocations (13%) and (2) failures from glaucoma etc (10%). In our country the annual academy meetin of ohphthalmology, in the middle 1950s it had been decided that insufficient time had elapsed since the first implantations to draw reliable conclusions as to the efficacy of the procedure. It was strongly recommended that lens implantations in humans be suspended for 5 years so that follow-up data might be collected and reliable conclusions be drawn.

Ridley's work created much interest and many surgeons tried to duplicate his resulsts, but very few of them enjoyed the degree of success that Ridley had achieved. Placing an implant in front of rather than behind the iris as Ridley had done offered certain theoretical advantages:

(1) The implant, if it were of the correct length, would be much more securely placed and less likely to dislocate than would a posterior chamber lens.

(2) If used to correct aphakia, the implant could be inserted after

~~anterior chamber angle supported lnes~~. Eventually more than 80% of these lenses had to be removed, some 20% causing sight-destroying complications. (7) Dr. Hhoyce of England with a sphisticated anterior chamber lens avoided corneal tough and did not have a siggle case of corneal deteriation in 225 eyes followed for up to 6 years. Other many lenses ~~styles~~ fell into disfavor and were abandoned in the mid 1959's. Ophtha lmologie in the united States such as R. Troutman of Manhatten Eye and Ear implanted lenses of the Strampelli type and geve up all implantations by 1960 due to complications that were too great & frequent.

Binkhorst ~~in~~ Epstein in Holland (now were getting somewhere) & Epstein continued ~~his~~ (8) work on the iris-supported lens, Epstein used an iris supported collar stud lens as early as 1953 but did not repeat it until 1959. (9) Later he developsed the Maltese cross lens which was modified by Galin and Jaffe and used in the U.S. under the name of the Copeland or iris plane lens. (10) Here 2 leaves are anterior to the iris & the 2 leaves at right angles to the others are behind it. In 1957, Binkhorst developed the iris-clip lens. With modefications, this lens has been in use since 1958. The lens has 4 loops — actually 2 pairs of loops (11) orientated 180 degrees apart. These loops receives support from the iris & extends from a lens body that is in front of the pupil. Fedrov in 1964 modified the iris-clip lens with the anterior & posterior loops 90 degrees apart & in 1968, he introduced another version with 3 posterior loops and 3 antennae-like extensions that lie anterior to the iris.

Throughout this evolution, the importance of lens fixation was appreciated. Thus Binkhorst suggested in 1967 that intracapsular implants be classified according to the method of fixation as: (a) anterior chamber fixation, (b) iris fixation, (c) iridocapsular fixation; and (d) capsular fixation lenses. # under anterior chamber fixation lenses (Strampelli & Choyce) are ~~supported~~ by a haptic part that extends to the anterior chamber angle. The optical part is always located in the anterior chamber.

(b) Iris fixation lenses (Binkhost ~~Ridley~~ Epstein and Federov) possess a haptic portion that is supported primarily by the iris diagragm. The optical part may lie in the anterior chamber, in the pupillary area, or in the posterior chamber. (c)Iridocapsular fixation lenses (Ridley Binkhost Federov) achieve support from the iris diaphragm and the posterior lens capsule. The optical part may lie in the anterior chamber or in the posterior chamber. (d) Capsular fixation lenses (Federov) rely entirely on the lens capsule for support.

From this array of available lenses, six are being implanted, on a relatively broad scale in the U.S. at the present time. These are (12) the Binkhorst iris clip lens, the Federov type 1 lens, the Federov type 2 lens, the Binkhorst iridocapsular lens, the Epqtein-Copeland iris planwe lens, and the Worst medallion lens. There is too much detail involved in describing these lens and in discussing the advantages of one lens over another. so we will skip over this and leave the choice of the best implant ~~Much of this hinges on the individual preference of the~~ to the individual surgeon. I will attempt to describe ~~the~~ an example of an iris fixation lens that is called the Worst Medallion lens. Worst first introduced this with iris fixation in 1969. It has been modified by him in a variety of ingenious ways and is currently used with a stitch trough the iris or with a platina-iridium clip model. It has a biconvex optical ~~optic~~ portion of polymethylmethacrylate, and a thin peripheral extension of the same meterial that is designed for placement anterior to the iris. The latter contains two holes for the iris stitch and, in the clip models, an antenna-like wire projection. From the posterior lens surface 2 supramid wire loops extend directly posteriorly and then in a postero-lateral direction. The overall posterior diameter is about 8.0 mm and the lens is designed for use in conjunction with intracapsular or extracapsular cataract extractions.

~~When~~ A successful lens implantation depends first of all on a perfectly executed cataract extraction. ~~The advantages of a successfully implanted lens are quite apparent~~ Then if the lens is implanted well, & the eye heals well, we can expect several distinct advantages over the other modes of aphakic correcting devices. There ~~was~~ is in general great patient satisfaction even in the cases where central visual acuity ~~was~~ is not ideal. ~~But~~ In large series of patients visual acuity

the cataract extraction had been performed and after the eye had recover from the operation. This would reduce the surgical ~~trauma~~ trauma inflicted on the eye ~~but~~ and would also permit an evaluation of the amount of correction that the implanted lens would require to give the best vision. With the posterior chamber lens (which had a standard optical power), if the eye were highly myopic (near-sighted) or hypermetropic (far-sighted) before the operation, this would not usually be known to the surgeon, and the patient might still require a substantial myopic or hyrermetropic spectacle correction before optimal visual acuity could be achieved.

(3) The introduction and removal or replacement of an ante ior chamber impla nt should be technically easier to perform and accompanied by less trauma to the delicate intraocular structures, than is possible with either the poste ior chamber lens or iris-supported implants.

Disadvantages of the anterior chamber implant are, firstly deterioration of the back-side (endothelial) of the cornea because of contact with the implant (prosthesis); and secondly the abnormal changes induced by the ends of the implant in the angle between the cornea and iris as well as those of the iris itself.

A number of European surgeons were working simultaneously on the (5) possibility of an anterior chamberimplant. Of these, Strampeli of Rome was probably the first to succeed. Many modifications of this lens (6) were designed and used. Barraquer in Barcelona ~~took up~~ enthusiastically accepted these one-piede fixed-length acrylic implants and ~~enthusiastically~~ inserted a large number of Strampelli type implants. He even treated large numbers of binocular myopes (without removing the crystalline lens) by inserting implants with a concave correction moulded on the central optical part of the anterior chamber implant. Neither Strampelli nor Barraquer, nor indeed any Continental or American surgeon used implants other than methyl-methacrylate. By 1961 however after seven years of experience, Dr. Barraquer permanently discontinued the implantation of these anterior chamber lenses because of the increasingly high incidence of complications, ~~with the~~

who have had lens implantation

patients, visual acuity has been reported as 20/30--73%; 20/40--85% and stereopsis--76%. These may not appear to be very ideal but it most be remembered that this vision is with a low correction in a normal spectacle frame and with an essentially normal visual field none of which are true after the conventional cataract removal. & correcting glasses.

As with all procedures in medicine that begin to approach the ideal, the incidence of complications increases. Such things as post-operative persistent corneal swelling and eventual corneal deterioration, post-operative hemorrhage, persistent post-operative inflammation inside the eye, deterioration of the central retina are all in higher percentage than following the normal cataract extraction. In the future, there will be continued improvements in the implant and in the technique to lower the possibility of these complications. The most recent trend is to combine the extracapsular cataract extraction with ~~the~~ lens implantation. (13) in which case, the posterior capsule of the lens is intact & support the implant. Further it is believed that the lens should not be used in patients under 67 years of age, nor should it be used in the second eye of a patient until after the lens has been present and well tolerated in the first eye for 5 years in ~~a younger patient~~ patients between 67 & 80 years of age, or at least 1 year in patients over 80 years of age. Then of course ~~there~~ There are many medical ~~contraindications~~.

~~One of the problems that has arisen is whether~~ A legal question has been considered. Do the lens ~~is~~ a drug or a device? Each has laws governing its use and manufacture. Although the lens material has not had the usual laboratory and animal testing ~~the~~ given a new drug is subjected to, it has been used in thousands of cases during the last 10-15 years. In California further manufacturing of the lenses has been discontinued until state regulations have been met. The future will be interesting!

There has been much controversy concerning the use of the intraocular lens. Some surgeons believe that the lens hasn't been tried for a long enough period that it hasn't been in the eye long enough to be properly evaluated. Certainly an inert material - polymethyl methacrylate - has been found so that this problem is solved; the other problem of lens fixation may not be ideal & will be perfected, ~~most~~. The Worst medallion clip lens is the most recent attempt to give effective long period fixation and without undue trauma.

MEDICINE

New Lens for Cataracts

Cataracts are the leading cause of blindness, and more than 400,000 persons in the U.S.—most of them elderly—undergo surgery for removal of diseased lenses in their eyes each year. Following the operations, such patients usually must wear extra-thick glasses or contact lenses. But a growing number of ophthalmologists are beginning to replace cataract-clouded lenses with permanently implanted plastic substitutes—and with impressive results.

The normal lens of the eye consists of crystal-clear gelatinous protein encased in a capsule and lying behind the circular, colored iris. Because it is naturally pliable, the lens can automatically lengthen or shorten in order to focus at varying distances. Cataracts develop when the lens protein undergoes changes in molecular structure that cause it to lose its pristine transparency and gradually become opaque. The process can be caused by exposure to radiation or certain toxic chemicals. But usually cataracts occur, like the graying of the hair, as a natural part of the aging process.

Distortion: While cataracts almost always affect both eyes, they may develop at quite different rates and only the lens in the most advanced state of disease is removed at the initial operation. Although such surgery is simple and safe, the aftermath can be troublesome. The thick spectacles worn by cataract patients magnify images by 25 per cent and seriously impair peripheral vision. When a patient still has one normal eye, the distortion produced by the spectacle lens makes useful binocular vision impossible. A contact lens produces far less distortion and permits adequate peripheral vision, but many patients, particularly the aged, find them a nuisance to care for and uncomfortable as well. The artificial plastic implant, however, provides vision of a quality that nearly matches the natural lens and is just as unobtrusive.

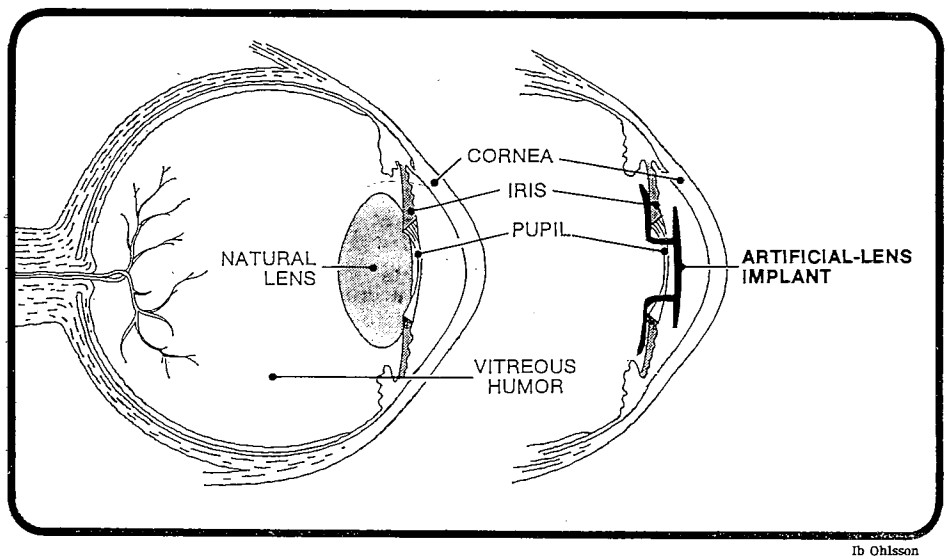
During the past 25 years, plastic lens substitutes have undergone gradual development and refinement, chiefly in Europe. The ones most often used by U.S. eye surgeons are models designed by Drs. C.D. Binkhorst and Jan Worst, both of Holland, or Dr. Svyatoslav Fyodorov of the U.S.S.R.

Early versions of the artificial lens were implanted behind the iris and made to rest on the membrane between the posterior chamber and the vitreous humor that fills the eyeball. These lenses often produced inflammation from rubbing against the tissues behind the iris and sometimes became dislocated, falling back into the vitreous humor. The newer versions, however, clip on in front of the iris and don't present the problems the earlier lenses did. The Binkhorst lens, for example, is equipped with two thin loops. The lens is placed in front of the iris while the loops are inserted through the pupil and bent into place behind it.

The new implants occasionally become dislocated, especially if the iris becomes too widely dilated, permitting the loops to slip back through the pupil, but the problem is easily corrected. Since the lens cannot change shape for focusing as a normal lens can, it is designed either for distance or close-up vision. The patient wears the appropriate conventional glasses to compensate.

Since the long-term effects of the lens implants have not yet been thoroughly investigated, most surgeons restrict their use to elderly patients and almost never put implants in both eyes. Even so, researchers estimate that 10,000 to 15,000 implant procedures will be done in the U.S. this year. And some ophthalmologists are beginning to use implants in children who have developed cataracts in one eye due to injury. After further trial and development, many eye specialists think the lens implants will become even more widely used to restore near-normal sight.

—MATT CLARK with DEWEY GRAM in Chicago



Ib Ohlsson

Sight-saving surgery: Natural lens (left) is removed and replaced by plastic one

Intraocular lens implants:

Intraocular lens implants, now done by only a handful of U.S. ophthalmologists, are likely to show a sharp upsurge in the very near future. In the past six months, 60 ophthalmologists have been trained in the technique by Dr. Henry Hirschman's group in Long Beach, Calif., and about 100 in all are now prepared to do the operation. Indeed, in a recent presentation, Dr. Hirschman recommended that any cataract patient in good health be considered for an implant before a conventional cataract removal is laid on.

But other authorities feel that neither the technique nor the current generation of plastic lenses has been fully evaluated and that only people with senile cataracts should be considered for implants. "We feel this is still not proved," says New York's Dr. Richard C. Troutman, chairman of the American Academy of Ophthalmology's cataract committee. "We think a patient still has a better chance of seeing the rest of his life after a normal cataract operation. What he does by accepting a lens implant is take a calculated risk that he's not going to live long enough to develop late complications."

The Hirschman group has seen comparatively few complications thus far in some 700 implantations since 1968. Reporting at this year's AMA meeting in Chicago, he said that of the first 400 patients he has followed, 85% have 20/40 vision or better and virtually none of the visual problems associated with conventional cataract extractions. These, he noted, include dependence on eyeglasses that magnify objects 30% to 35%, produce spatial disorientation, and reduce the useful visual field by about two thirds. Contact lenses are better in that they magnify less than 10% and the wearer's visual field remains normal. However, Dr. Hirschman added, only about half the patients are able to wear contact lenses, and many of those who try are forced to give them up.

Reviewing results with patients who had a conventional cataract operation in one eye and a lens implant in the other, he reported that their overall vision was as good as it had been before the cataracts developed and that their visual acuity and spatial sense were better in the eye with the implant. He likened the lens implant procedure to rehabilitating a bedridden patient who would be able to walk on crutches with standard rehabilitation methods but could run with a more innovative one.

The first intraocular lens implant was done in England by London surgeon Harold Ridley, who inserted a lens made of methyl methacrylate into the eye of a patient at St. Thomas Hospital in 1949. It was the same material used for the cockpit canopies of Spitfires–Dr. Ridley had seen bits of the material lying inert in the eyes of fighter pilots who had had them since the Battle of Britain nine years earlier.

Those early lenses were abandoned when complications developed in more than 25% of the cases. A second generation, the Strampelli one-piece angle-supported anterior-chamber lens, came into use in 1952–"a primitive and crude device by today's standards," Dr. Hirschman said. The present third-generation lenses, supported by the iris, began with one designed by Dr. Edward Epstein of Johannesburg, South Africa. Several modifications of this lens have been used by Dr. Norman Jaffe of Miami, who has implanted some 400 lenses since 1968.

The lens used by Dr. Hirschman and others is an iris-supported lens developed by Dr. C. D. Binkhorst of Terneuzen, the Netherlands. Measuring 5 mm in diameter and 0.5 mm in thickness, the lens has been attached almost as many ways as there are ophthalmologists doing the operation. Dr. Binkhorst sutured his four-loop iris-clip lens (pairs of loops gripping the iris) through the iridectomy, so that when dilated, the lens did not ride up and tended to remain stable and centered. More recently he has favored a two-loop iridocapsular lens. Other versions in use include the Federov lens, modified by Dr. Jan Worst, another Dutch ophthalmologist who studied with Dr. Binkhorst, and the medallion lens, designed by Dr. Worst.

Dr. Hirschman feels that reluctance among ophthalmologists to accept implant proponents' recent claims of good results with modified lens designs is due to an inherently parochial attitude. But Dr. Troutman, who was a discussant of Dr. Hirschman's AMA paper, said, "I'm seriously concerned about the widespread introduction and use of the intraocular lenses, particularly when they're used almost routinely in young patients and bilaterally, as by Dr. Hirschman. Even in Holland, where the procedure has been well accepted by patients and ophthalmologists, fewer than 10% of the cataract patients have implants."

Dr. Hirschman countered that the Dutch ophthalmologists skilled in the procedure are devoting most of their practices to this type of cataract surgery. He said some 80% of all cataract