THE OPERATING MICROSCOPE IN OPHTHALMIC SURGERY

BY *Richard C. Troutman*, M.D.*

SURGERY OF THE ANTERIOR SEGMENT of the human eye has advanced more in the last two generations than in the hundreds of years during which it has been attempted. These advances have been multifold but, in the main, technical in nature. Relatively little progress has been made in the direction of normalizing the pathologic mechanisms producing the alterations of form or function requiring surgical intervention. The operation for cataract, as an example, is essentially the same in purpose, performance, and intended result as in the nineteenth century. Techniques of anesthesia and akinesia, surgical skills, instrumentation, control of postoperative infection, and inflammatory response have gradually advanced and combined to make this operation one of the most effective in any surgical field. Keratoplasty, though conceived as a technique in the early days of modern cataract surgery, did not come into its own until the third decade of this century. The treatment of corneal distortion and opacification has advanced primarily in the technical surgical field. In a lesser way, surgery for glaucoma and for trauma to the anterior segment have made parallel technical progress.

The use of dissecting microscope magnification to enhance the advancing technical skills of the surgeon is relatively new. In my own training, even the binocular loupe was rarely used in surgery. During the succeeding fifteen years binocular loupes with magnifications of 1.5× to 3× were used with increasing frequency. Paralleling the increasing use of loupe magnifiers was the development of new and finer instruments for anterior segment surgery. Of particular importance is the ready availability of fine sharp needles and of suture materials of smaller diameter and higher tensile and knot strength. These developments have tended to lead to surgical specialization

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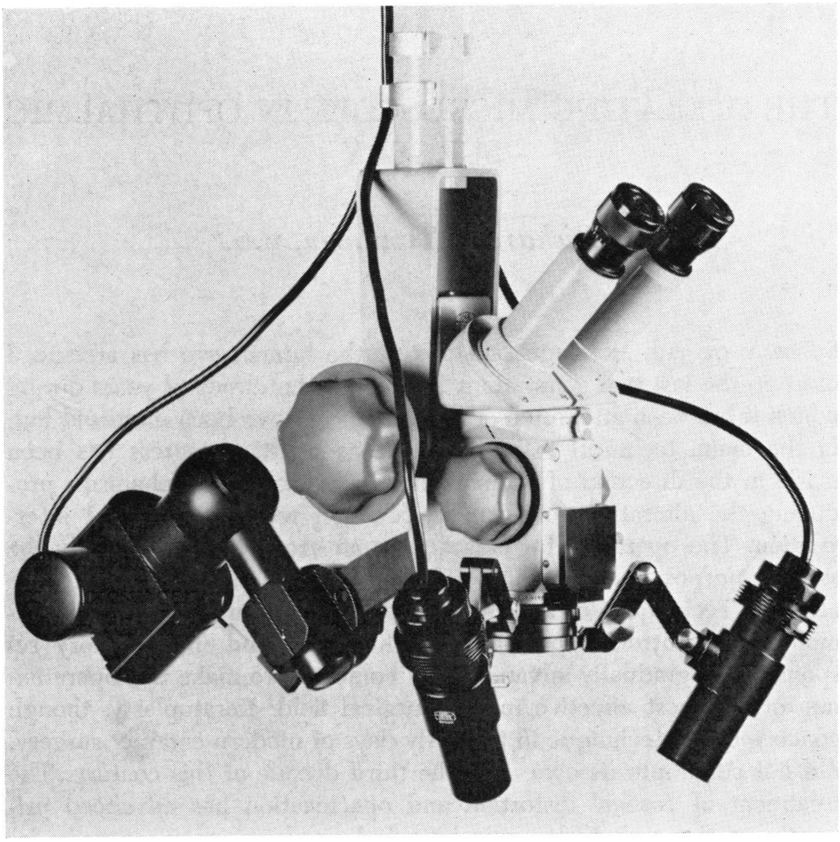


FIGURE 1A. ZEISS OPERATING MICROSCOPE, AUTHOR'S MODIFICATION.
Lateral view, showing slit-lamp illuminator to left.

within ophthalmology thus fostering an even more rapid advance in technique and instrumentation.

As early as 1949 other specialties, faced with similar surgical problems requiring increasing technical accuracy and better visualization of the operative field, began to use higher magnification and finer instrumentation. Most surgeons, who use magnification higher than that which can be obtained by means of a head-supported loupe, have used variations of a basic instrument designed as a culposcope by Zeiss in 1949. The potential of this microscope was soon grasped by otologists and the fenestration operation, which electrified the field of otolaryngology a little more than a decade ago, began to be performed. Significantly, the culposcope was never accepted for its original intent

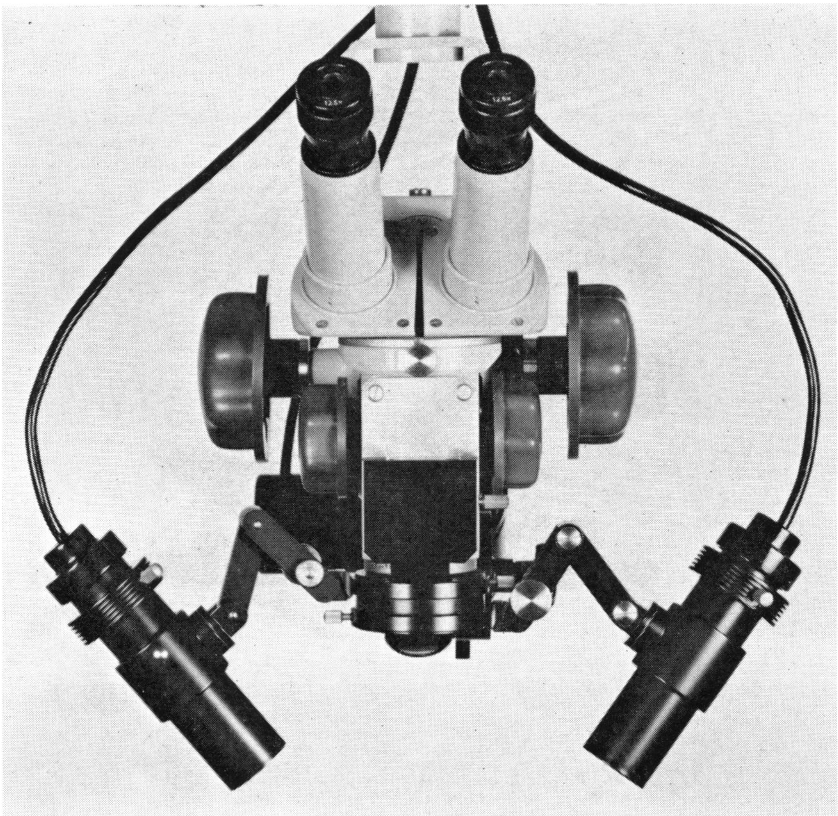
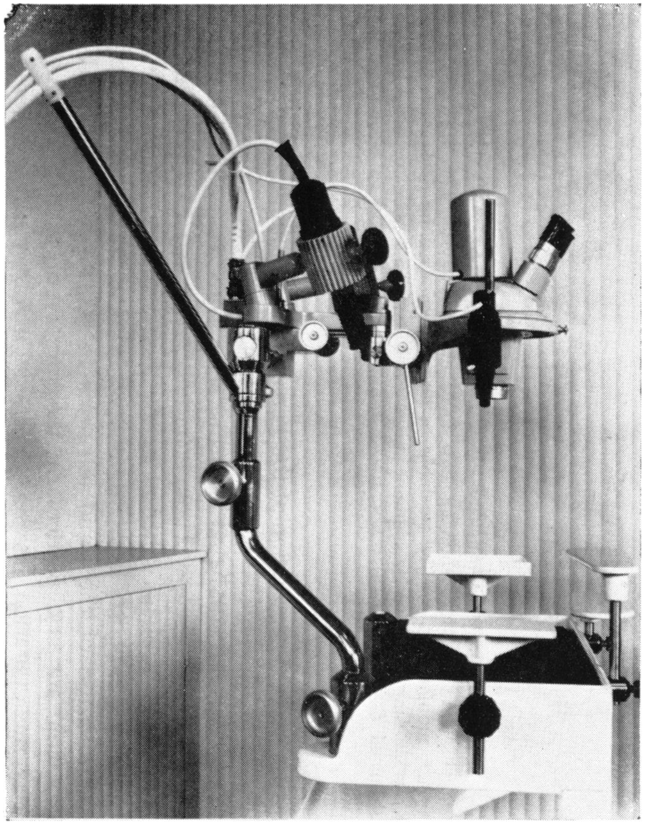
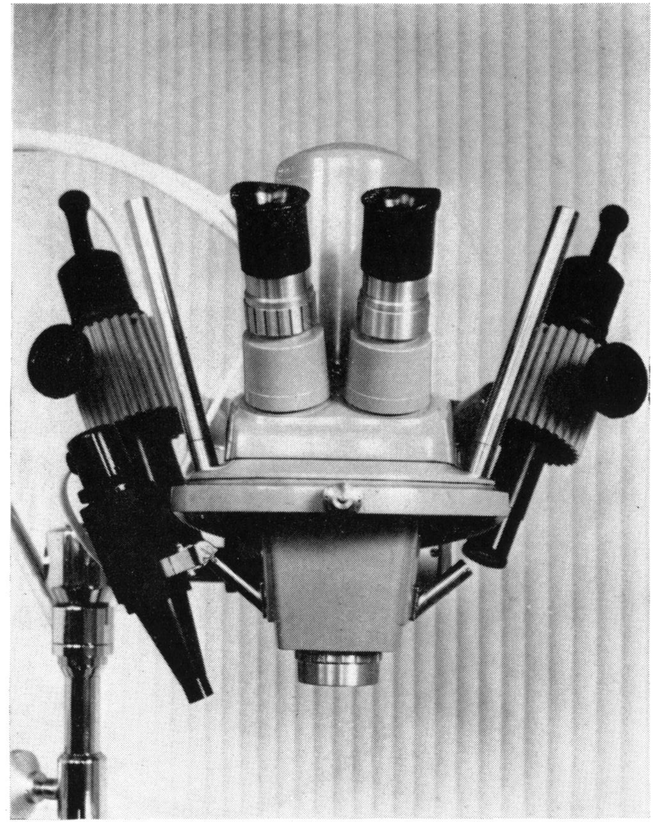


FIGURE 1B. ZEISS OPERATING MICROSCOPE, AUTHOR'S MODIFICATION.
From surgeon's position, showing two incident illuminators. This instrument is compact, mobile, and readily available in its earlier forms. Its design is obsolete for a wide range of anterior segment surgery because of its widely spaced magnifications of 6–10–16–24–40× and the instability of its support in relation to the patient.

because of the introduction of the Papanicolau technique for detection of cervical carcinoma.

It was not until 1957 that I became seriously interested in the use of the surgical microscope. Though initially frustrated I was determined to solve the problems inherent in the then available microscope and surgical instruments. Ophthalmologists in general showed little interest, because of the rapid advances in other specialized fields of ophthalmic surgery, particularly the surgery of retinal detachment. The cornea operation, because of the low numbers and high technical





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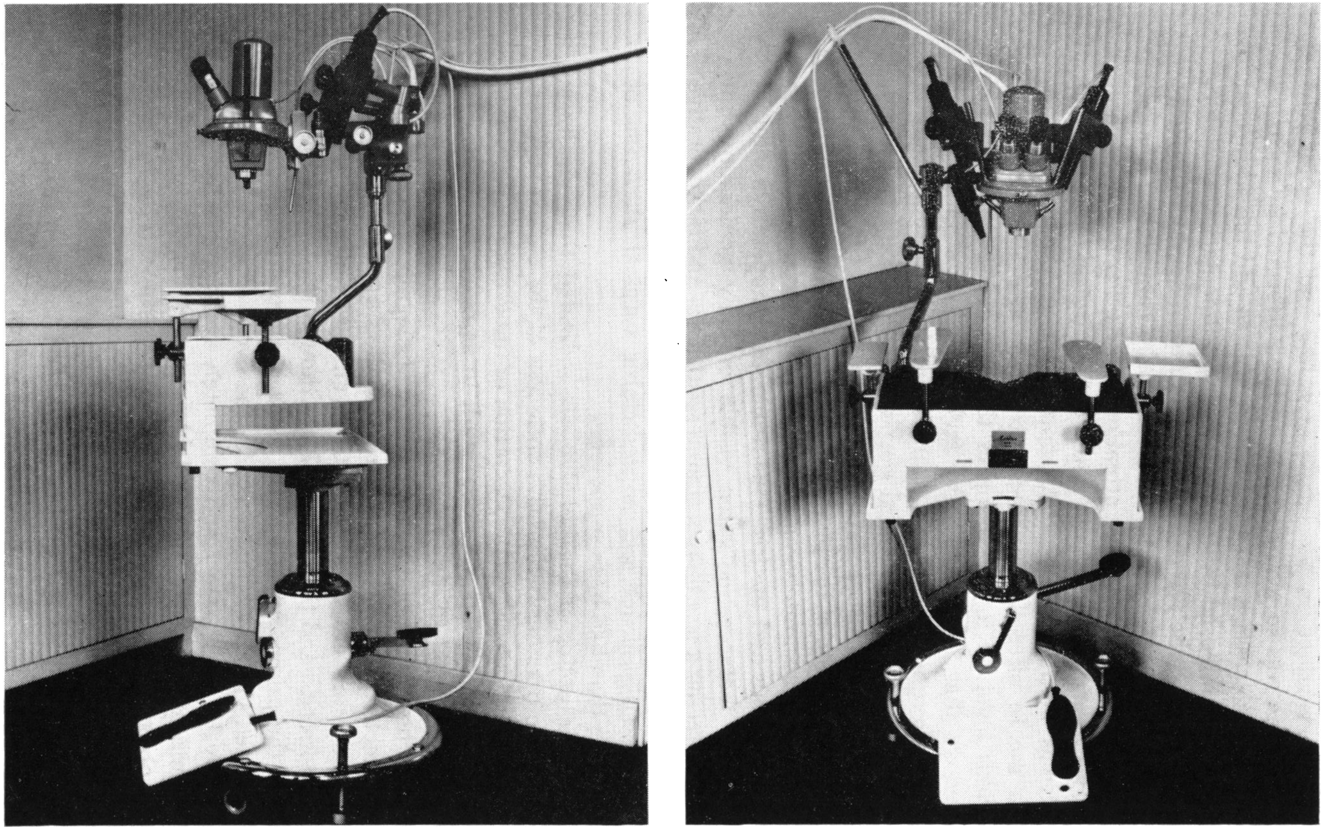

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FIGURE 2. KEELER ZOOM OPHTHALMIC OPERATING UNIT, AUTHOR'S MODEL USING PIERSE HEADREST SUPPORT.

A, left, details of cranked arm suspension from Pierse headrest support; A, right, detail of microscope illumination and manipulation system. B, complete unit showing hydraulic floor support of headrest and microscope unit. This instrument is a complete unit designed to give optimum stability to the operative field. This makes frequent change of focus unnecessary. The Zoom microscope on the other hand provides a continuous parfocal range of magnification from 3.0 to 15.0× which may be selected by the surgeon from a foot control. The surgeon may also change focus and microscope rotation, tilt and lighting by sterilized controls.

skill required, remained in the hands of a few and the ubiquitous cataract operation was so well and adequately performed by so many that it seemed unnecessary and even undesirable to add the additional technical burdens imposed by the primitive instrumentation available.

As familiarity with the use of alpha-chymotrypsin has increased, the fear formerly associated with the removal of the cataractous lens has been diminished. As a result, more attention to the other details of cataract surgery led many to a desire to improve the surgical technique and results. It was in this area that the application of microtechniques seemed to me to offer the greatest potential. Once the shadow of complications involved in disruption of the zonule is removed it becomes obvious that the rest of the technique leaves much to be desired. First there is the problem of the accuracy of the incision and its repair, although for all practical purposes with current techniques early postoperative dehiscence of the incision has been eliminated. Postoperative distortion of the pupil can be traced in a number of cases to inadequate or inaccurate wound closure with improper attention to toilet of the vitreous and the iris. This results in postoperative internal iris or vitreous incarceration often visible only by gonioscopy but inevitably producing a less than optimum result. Pre- and postoperative corneal curvatures have been measured and it can be shown that there is often a more significant and unpredictable surgical alteration of these curvatures than had been supposed.

Studies of the optics of the aphakic eye indicated that, ideally, a central stenopeic opening behind the optic axis of the cornea is necessary for an optimum visual result. Distortion or unnecessary destruction of the normal pupillary aperture can result in as much as 15 per cent reduction in final visual efficiency.

The use of the Zeiss operating microscope at magnification 10× and 16× or the Keeler Zoom microscope provides the surgeon with a better visualized and more exact approach to surgical techniques involving the iris, the vitreous, and the incision. Even though removal of the lens is no longer the prime concern of the cataract procedure, its removal too is facilitated under magnification. In the event of capsule rupture remnants may be more safely and completely removed. When using higher magnification commonly available surgical instruments seem gross and obstruct the reduced field. New instruments have been designed or modified to reduce these objectionable features. In the main they are refinements of existing instruments, miniaturized and angled so as to provide less field obstruction and less trauma to tissue.

They incorporate five design features the author considers essential

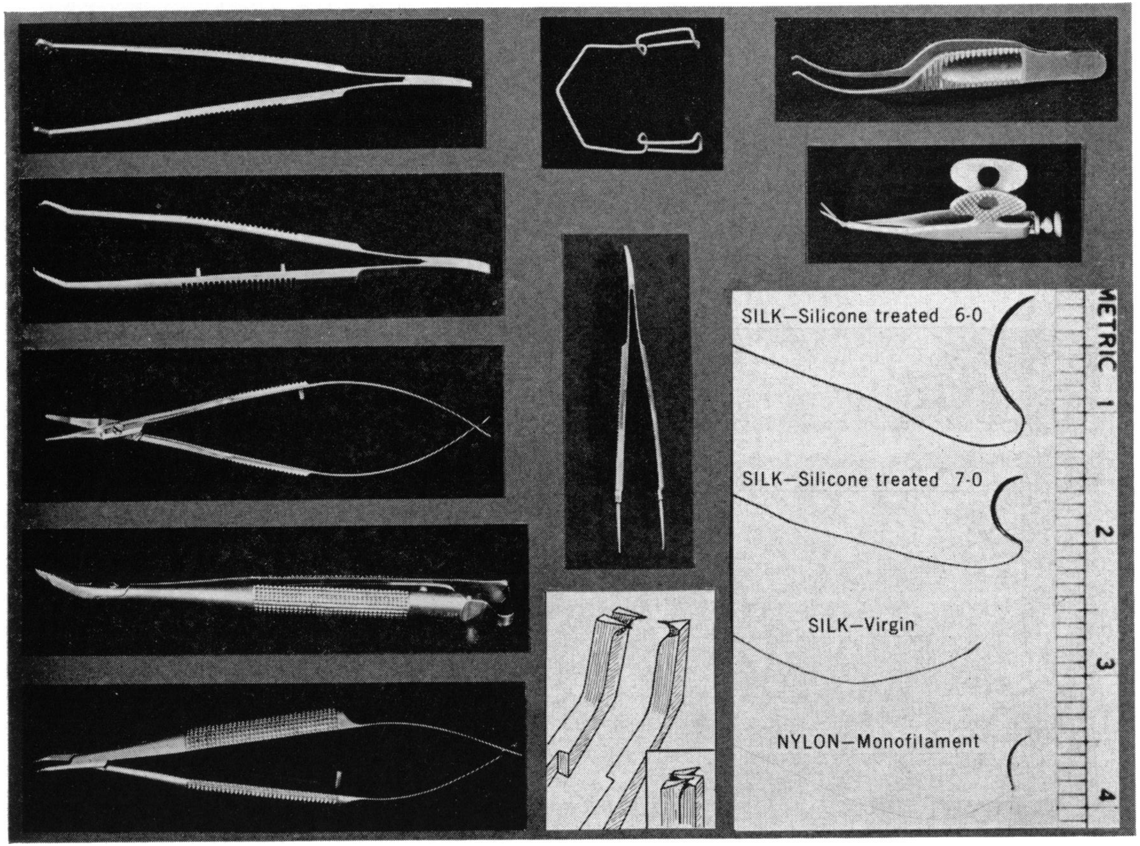

FIGURE 3A

Left, top to bottom, episcleral fixation forceps, angled rectus forceps, conjunctival scissors, angled blade breaker, Barraquer needle-holder —short model. *Center, top to bottom*, Barraquer speculum, Bonn forceps, Detail of forceps tips 0.1–0.15 mm. Bonn (top), Colibri (bottom). *Right, top to bottom*, Colibri forceps, DeWecker Barraquer scissors (modified handle), comparison of standard suture diameter to monofilament perlon suture of Prof. H. Harms.

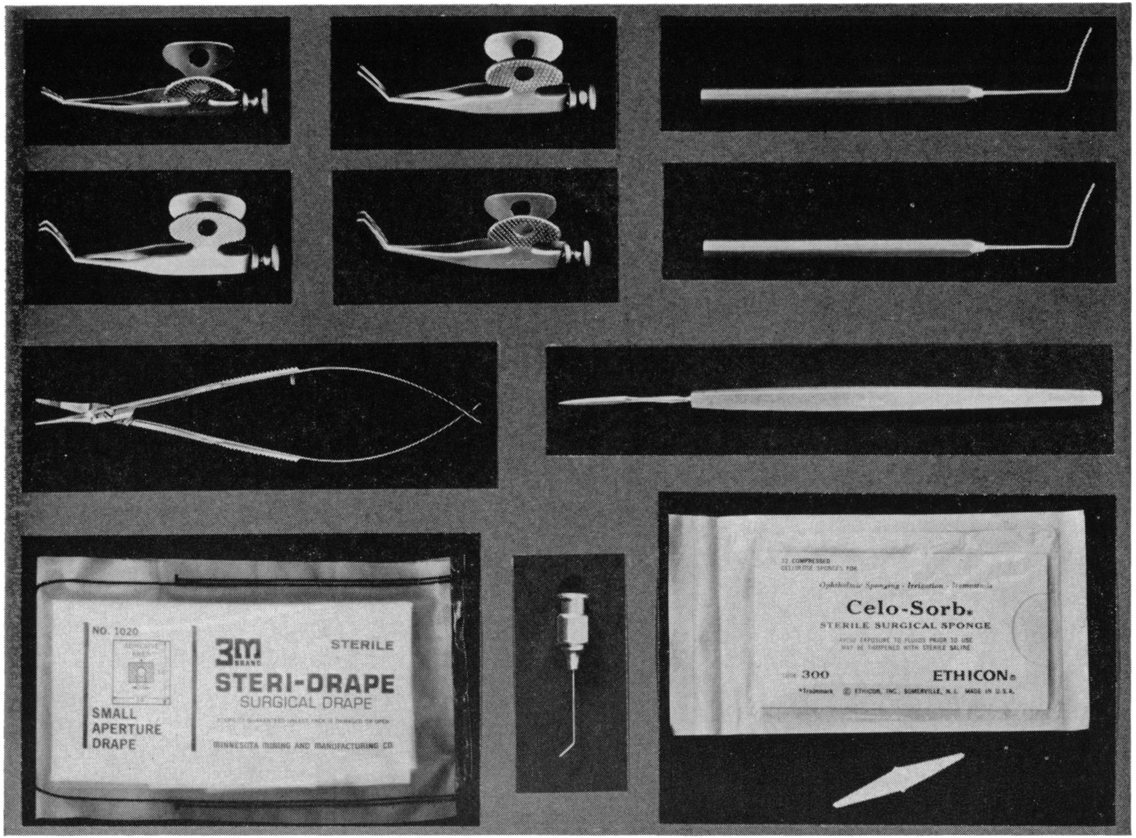

FIGURE 3B

Left, top, 4 forceps modified from Von Mandach pattern. *Right, top,* Barraquer wire spatulas (1 mm.) on new short 6-sided handle. *Center,* instruments of standard length for comparison. *Bottom,* Non–lint-bearing drape and sponge, Air injection cannula 27-gauge.

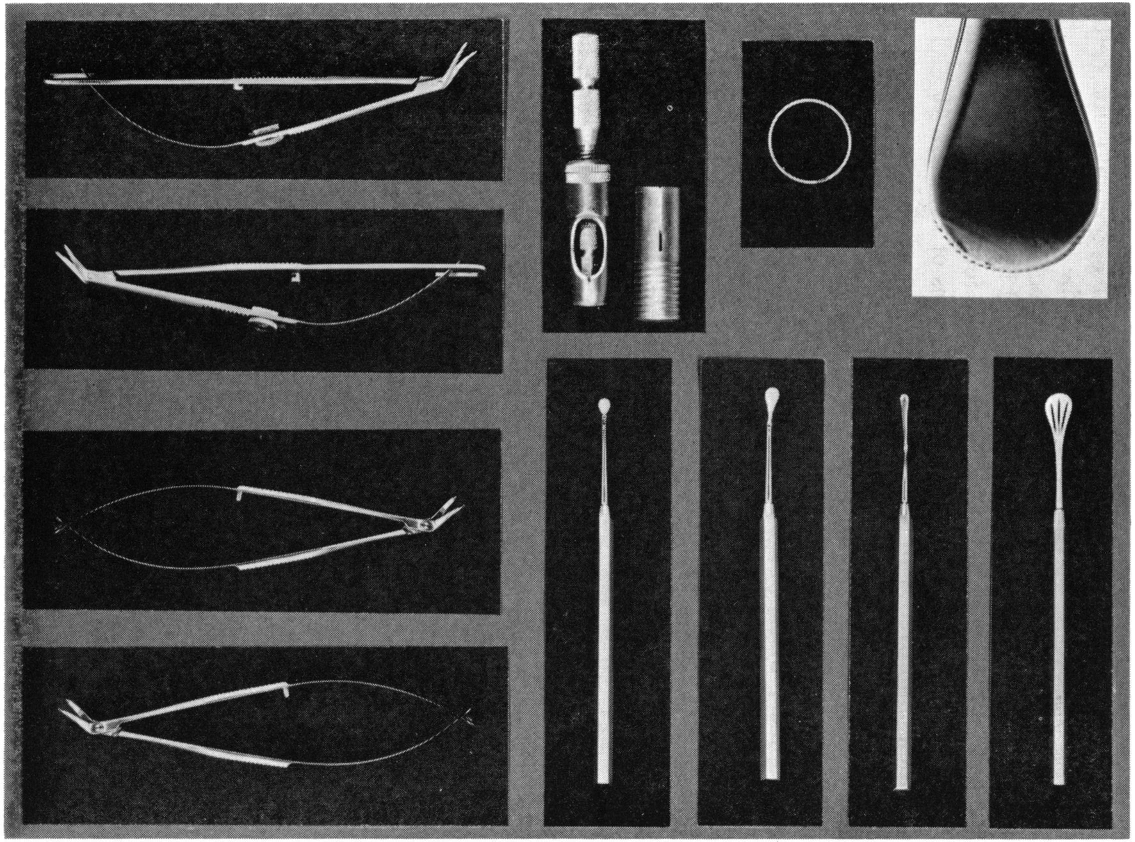

FIGURE 3C

Left, top to bottom, pair cataract section scissors—new model, 1 handle non-flexible to prevent scissors "jump" when making incisions, pair corneal graft scissors—very fine blades. *Right, upper*, Standard Castroviejo trephine, Flieringa ring, detail of splitter–serrated cutting edge.
Right bottom, series of corneal splitters and graft spatula on new short handles.

for microsurgery: (1) *miniaturized* tips—forceps, scissors, and needle-holder; (2) *angled* so as not to obstruct the operative field; (3) *short* so as not to accidentally strike microscope objective during surgery; (4) *strong* to resist damage by torsion accomplished by placing hinge close to tips; (5) *no locks or catches* to prevent sudden small uncontrolled movements which inevitably occur when these are released.

In applying the same critical review to the techniques employed for corneal surgery, it was assumed that as in cataract surgery improvement of technical proficiency could offer an opportunity for better restoration of function. Postoperative loss of the anterior chamber and the subsequent development of anterior synechias remain the prime technical reasons for failure of grafts. Inspired by the Barraquers, who have used the microscope for corneal surgery for more than ten years, I perform all keratoplasty under magnifications of 12× and 16×. The resultant improved suturing caused anterior chambers to remain formed postoperatively and anterior synechias have been almost completely eliminated. The addition of peripheral iridectomy through a separate incision under microcontrol has all but eliminated the common air pupillary block, producing synechias or dehiscence of the wound with iris prolapse, secondary glaucoma, opacification of the graft, and possible loss of the eye. This we believe has been an unrecognized cause of these early complications. What has been identified as "graft sickness" has been significantly reduced through better technical control.

Professor H. Harms of Tubingen introduced me to an excellent monofilament perlon suture, 10-0 in gauge, and a very fine light forceps, the Bonn forceps.

This discussion of microsurgery is not meant to instruct the audience in ophthalmic surgery. It would be presumptuous of me to attempt to instruct my peers in techniques in which they are already proficient. It is not even meant as a plea for you to adopt microsurgery in your own practice. It is designed to present my views as to the usefulness of microtechniques. In my opinion, the accuracy of incision and repair can be enhanced. The better restoration of the form and structure of the anterior segment in both corneal and cataract surgery can eventually serve only to improve the functional result and to reduce the morbidity of ophthalmic surgical procedures. The preservation of nature's stenopeic opening, the pupil, in its normal position in relation to the optical axis can be more easily achieved if the vitreous or any other impediments to pupil shape and position can be better visualized and corrected under high magnification at surgery. Certainly many other operative procedures other than the two I have reviewed today may be benefited by careful use of the operating microscope. There is much room for improvement in instruments for both magnification and surgery and these must be made before all our goals can be realized. Ophthalmic surgery is such a personal skill that each of us should individually evaluate the usefulness of magnification as applied to his own techniques. The microscope puts the familiar in a new dimension. It adds not only to technique but presents a new challenge to the ophthalmic surgeon in our most fascinating surgical field.

DISCUSSION

DR. A. GERARD DEVOE. There is not very much I can say about this paper because I am in complete agreement with just about everything Dr. Troutman has said. I have repeated and made this statement on a number of occasions. The real future of ophthalmic surgery from a mechanical, technical standpoint lies in the use of higher magnification. I personally use the magnification as described by Dr. Troutman in all glaucoma cases, all congenital cataracts, and many times in unripe cataracts.

One point I would like to make, however, is that at the present time, there is no instrument which meets all our needs. The present Zeiss instrument is too clumsy. It cannot be readily adjusted and moved around by the surgeon. Fortunately, however, a number of the large optical companies have at last become interested in this problem and are working on instruments which will be available within five years. When these arrive, we will have an instrument that is much more simple to handle.

It is too much to ask that older surgeons, who have been well trained and do a great deal of their work by proprioceptive touch, undertake these new methods of surgery, but I do think that the younger men, the resident group, and those starting out in surgery should master these techniques, because in the future this is going to be the way ophthalmic surgery is done.

DR. SAMUEL D. MCPHERSON, JR. I would like to congratulate Dr. Troutman on this wonderful contribution. I agree with everything he says. I, too, have not the temerity to suggest that others use the things that we use. However, for several years we have used the operating microscope in intraocular surgery, and for the past two years, we have used the operating microscope with the slit-lamp attachment.

We feel that it is important to have available at the operating table the same instrument with the same magnification that one uses to examine the patient before and after operation.

(Slide) Now, this is the Zeiss slit-lamp on floor stand which is a regular microscope, with 125-millimeter objective and with the Zeiss slit-lamp attachment. We have devised a junction box that you see at the upper lefthand corner that takes the connections from both lighting systems and the foot switch which lies on the floor. Therefore, we can go back and forth from a direct to slit illumination at the time we are operating.

May we have the film, please. (A moving picture was shown.) This is just a very short film showing how we drape this out and use it at the table. This shows the action being adjusted. (Usually this is done before we scrub.) This shows the switching back and forth with the foot switch from direct to slit illumination. We simply tap the switch and we do not have to move anything to do it. The entire instrument is draped out with a sterile stockingette with ports cut in it for the oculars, the objective lens, and the slit prism. A sterile lens cup is put over the opening for the direct light source. We have yet to devise anything to cover the prism. This shows the approximate working distance of the instrument which is five inches, and if one hits anything, it is usually the sterile lens cup. Occasionally, one bumps the prism and has to stop and reglove when this happens. This is with the light from the direct source, showing the approximate amount of illumination that occurs. This is a view of the slit. This is a keratoplasty done with collagen sutures and this is the slit appearance of the cornea at the end of operation.

We have used this device routinely in all of our intraocular surgery for the last two years, and particularly in cataract surgery. (Slide) Here are listed some of the advantages we have observed in the practical use of this in cataract surgery. First, we can monitor anterior chamber reformation. We can tell whether or not the iridotomy is open. We can see what type of wound closure we have. If we need additional sutures, we can add them. Residual capsule and cortex can easily be seen. This instrument has an ultraviolet filter that can be thrown into place. With this cortex is easily visible. And lastly, foreign body removal is greatly facilitated.

Last year Dr. Scheie reported three instances of scrolls of Descemet's membrane which had been left in the eyes at the time of operation. In the past 18 months, we have had this happen four times when we were operating with the slit-lamp, and on each occasion, we have been able to remove them. So, I would like to say again that I do agree with what Dr. Troutman has said, but I would like to add we do feel it is important to have available not only the microscope, but also the slip-lamp attachment.

DR. JOAQUIN BARRAQUER. Twelve years ago my father, my brother, and myself started using the Zeiss surgical microscope, and we found it very useful, especially for suturing corneal grafts. However the slip-lamp attachment was quite cumbersome and not very useful, and we tried to modify this type of microscope.

About a year ago we developed together with Dr. Littmann from the Zeiss firm, a new instrument which complies more satisfactorily with the requirements of anterior segment surgery than the models that had been available in the past (slide). The advantages of this microscope are:

(*a*) its simplicity and reduced size; (*b*) its oblique light source (hammer lamp and slit-lamp) which can be rotated over 270° around the optic axis; (*c*) a slit which can be orientated with regard to any meridian of the globe; (*d*) a working distance of 150 mm. which allows a position of the head similar to that when teleloupes are used, without interfering with the surgical manipulations; (*e*) the elimination of the interchangeable magnifications, since in any case the only really useful magnification is the 10×.

It is of great value in achieving higher precision during certain operative procedures (ab externo incision, interlamellar corneal dissection, placing and extraction of the sutures). It is also useful for the examination of young children under general anesthesia.

The surgeon can view the entire operative field directly by moving his head slightly to the side.

In order to take motion pictures of the operative procedures which are performed under microscopic control we (Joaquin Barraquer and Hans Littmann) have adapted the House-Urban camera to the microscope with the help of a Sonnar f = 2, 5/62 mm. lens. The focus of the microscope, the camera, and the light source coincide in an angle of 17°, covering the same field. The House-Urban camera is very small and weighs, complete with its electric motor, lens, and 30 m. of film, only 1,300 gm. It has exchangeable film magazines. The illumination using the hammer lamp with a 50-watt bulb allows us to close the diaphragm up to 11 (Kodachrome II) which provides a depth of focus ten times higher than the depth of focus of the microscope and perfect definition of all details.

The systems which use the same optic of the microscope to take films through a lateral tube or with a diploscope do not achieve the same precision and clearness as this new equipment.

This slide shows several peripheral iridectomies and a corneal autograft. This was a patient with corneal opacification due to secondary endothelial dystrophy due to an anterior chamber lens, and this is the result of an 11-millimeter autotransplantation with four peripheral iridectomies and removal of the lens.

(Slide) Here we have another case of microsurgery. This is a Fuchs's dystrophy with cataract in a 75-year-old patient. The cataract was removed and at the same time keratoplasty was done. Several peripheral iridectomies were performed. And a good result was obtained.

As Dr. Troutman has pointed out, many of the successes we obtain today are due to technical improvements and, I think, that microsurgery is one of the most important tools in this sense.

DR. TROUTMAN. I would like to thank Dr. DeVoe, Dr. McPherson, and Dr. Barraquer for their very kind discussions.

In my opinion the ideal instrument is far from with us. I lean toward the use of Zoom magnification rather than fixed magnification, as Dr. Barraquer has suggested, because of its greater flexibility. In cataract operations as opposed to corneal graft procedures, it is necessary to change magnification often because of the wider parameters of the operative field.

We are currently working with a microscope designed for commercial use rather than specifically for ophthalmic use. Although it is useful, it is not optimal. One of the advantages of the Keeler unit we are using is the very stable relation between the objective of the microscope and the patient's eye. This head support cum microscope design lessens the necessity for frequent focusing during the operative procedure.

I agree with Dr. DeVoe that the surgeon's hand should be completely free to manipulate the instruments, and we would prefer not to have to use hand controls. However, if you have too many foot controls, it can become even more confusing.

We feel with Dr. McPherson that a slit-lamp is a very important part of the instrument. The new Zeiss instrument has a slit-lamp with a working distance of 200 millimeters and is brighter than the one he showed.

Dr. Barraquer's instrument is a newer Zeiss refinement of the slit-lamp attachment with a 150-millimeter working distance. A slit-lamp attachment for the Keeler unit will be available soon.

The 125-millimeter working distance is too short and, as you saw in Dr. McPherson's motion picture, it is very easy to strike instruments against the objective. The Keeler instrument, as Dr. Barraquer's, has a 150-millimeter objective to eye distance.

This ends my discussion with one exception, and that is provision for motion picture and television attachments. These will be of increasing importance in teaching this new dimension of surgery. Because of restricted field the surgical assistant is of little value and the observer has no adequate view. The prototype Zeiss unit that Dr. Barraquer has shown us is a very important adjunct to the teaching of this new surgical approach.