TEN YEARS' EXPERIENCE WITH SCLERAL LENSES

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IN THE FALL OF 1959, Mr Frederick Ridley came to the United States from Great Britain and presented his experiences with molded scleral lenses.[1–6] The concept was not new; in fact, the methods had been available to the practitioner for many years. Ridley, however, utilized several new techniques that were to re-evoke interest in this type of lens. In the past, molding materials had been uncertain. Translation of the mold to a stone mold and a finished plastic lens was not completely dependable. The actual fitting techniques and adjustment necessary for a large lens with a scleral flange were usually trial and error. Ridley introduced a systematized method of fitting these lenses.

Up to this time most scleral lenses were manufactured with a specific clearance over the corneal area. This space was filled with either tears or a fluid. Thus, practically all scleral lenses were of the fluid type. Ridley introduced the concept of a lens that was parallel to the surface of the globe in all respects. This meant that the posterior surface of the completed shell could not be modified. The final treatment of the posterior surface of the lens was simple hand buffing. Because the lens was of the neutral-fitting variety, no posterior surface could be placed on the lens over the cornea and no correction could be built into the posterior surface of the lens. This type of lens presented a new therapeutic approach to the clinician, because the neutral-fitting scleral lens could be utilized to treat certain conditions of the cul-de-sacs and corneal surface.

Ridley presented a finished product that was uniformly high in quality and workmanship. When Ridley returned to England in the fall of 1959, we followed him to learn more of his method and techniques. On our return to the United States in December of that year we entered into the clinical experiences which are to be related here. It should be noted that the basic techniques for the manufacturer of a molded scleral lens were already available and only needed

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sophistication. In fact, the method for manufacturing a scleral shell over an evisceration with cornea retained is essentially the same as that utilized for the neutral-fitting scleral shell. This method had been in use since early in 1940.

METHOD

THE MOLD

Taking the mold of the anterior surface of the globe and cul-de-sacs is the first and most vital part of the entire procedure. Proper molding trays and molding materials are essential. A standard molding set is utilized. The usual molding material is Jeltrate, manufactured by L. D. Calk; it is packed in a sterile, sealed vacuum can. A drop of local anesthetic is applied to the cul-de-sac. A trial fitting of various sizes of impression trays is attempted. An impression tray should not stretch the cul-de-sac in any dimension nor should it be so small that impression material could not be placed in the deepest portions of the cul-de-sacs. The Jeltrate is mixed with a small amount of water in a rubber molding cup with a spatula. When the proper consistency has been obtained and no lumps or air bubbles are evident, the material is placed in a disposable 5-cc plastic syringe. The tip of the syringe is then applied to the impression tray and the impression material is transmitted to the cul-de-sacs (Figure 1). Since sterile impression material can be obtained, it is entirely feasible to mold the anterior surface of the globe and cul-de-sacs under surgical conditions. It is essential that the position of the globe be slightly down and in. The reason for this is the need for the mold to be

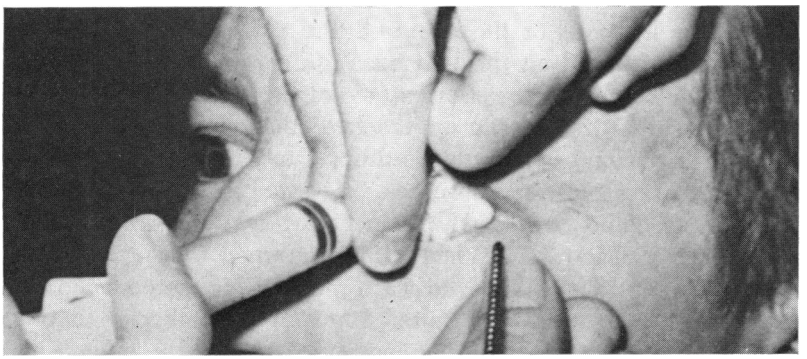

FIGURE 1

The Impression: molding material is forced from a plastic syringe through the molding tray and over the entire surface of the globe.

shorter on the nasal side than on the temporal. This allows a better position of the corneal section and a more functional fit. The impression material is pushed into the cul-de-sacs until material comes back through the holes in the impression tray without stretching the tissues. When the impression material has "set up" (Figure 2), the lids are gently manipulated and the impression tray is gently rocked back and forth to free it from the anterior surface of the globe. Immediately upon removal of the impression cast it is examined for completeness, that is, the entire cul-de-sac should be encompassed (Figure 3). The position of the corneal section is extremely important and if it is not properly centered, slightly to the nasal side, the mold must be remade.

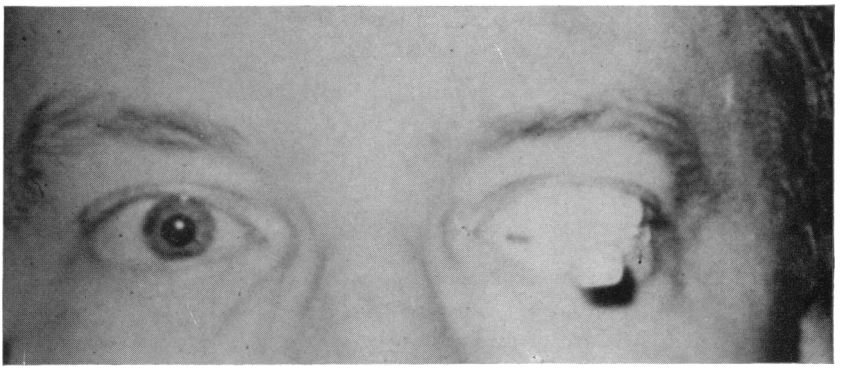

FIGURE 2

"Setting Up": the impression material is in place and several minutes are allowed for the material to harden.

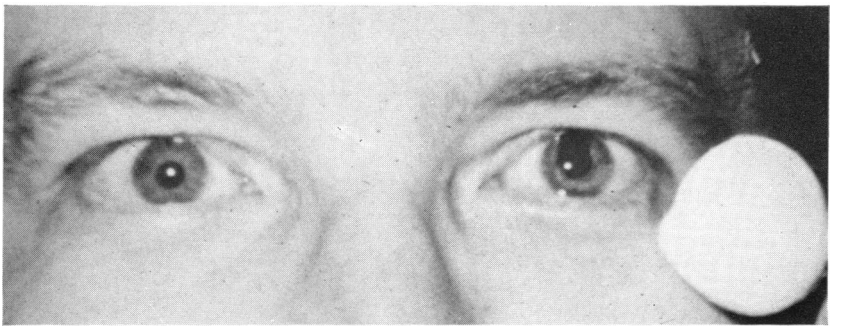

FIGURE 3

Removal of the Mold: the mold must be carefully examined, ensuring that the cul-de-sac is completely filled.

THE STONE MOLD

An adequate mold is then translated into a cast stone mold (Figures 4A and 4B).

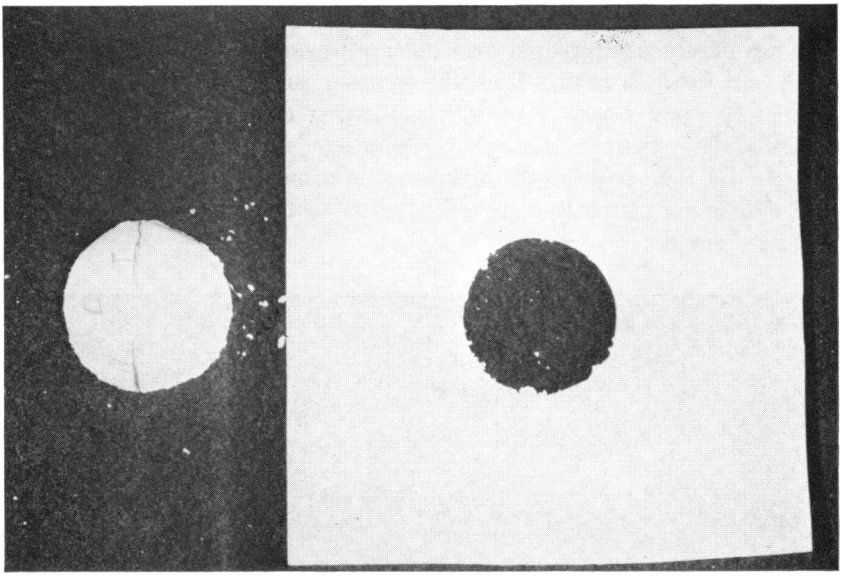

FIGURE 4A

The Stone Mold: the mold of the anterior segment is then translated into a cast stone mold.

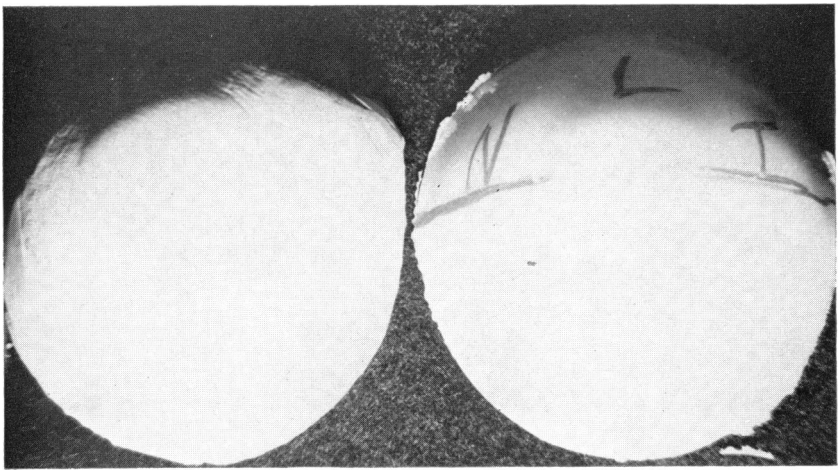

FIGURE 4B

On the left is the original mold. On the right is the stone mold.

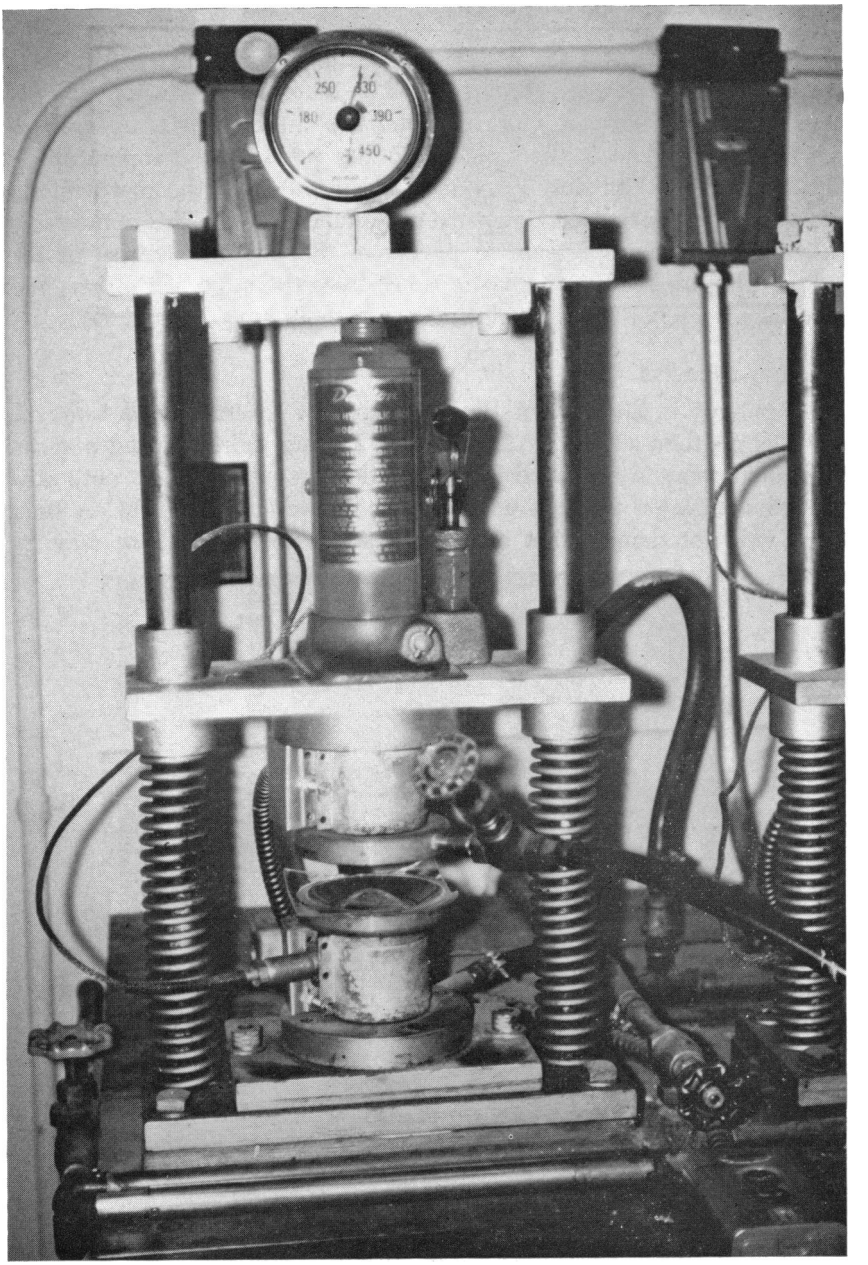

FIGURE 5

The Press: under controlled conditions of heat and pressure a methylmethacrylate plate is forced down over the stone mold.

THE PRESS

The stone mold is then placed into a press. The particular press utilized in this process (Figure 5) was designed by Mr John Crawford of the American Optical Company around 1941. A methylmethacrylate plate is then placed in the press. The temperature is raised to 290°. Utilizing 50 pounds of air pressure, the methylmethacrylate plate is forced down over the stone mold. This reproduces a very accurate impression in plastic of the anterior surface of the globe (Figure 6). Excess plastic is cut from the edge of the lens and the lens is prepared for the fitting process (Figures 7A and 7B).

FITTING THE LENS

The patient is first taught the technique of insertion and removal. The lens is then allowed to "seat" itself. During short wearing periods, liquid fluorescein is placed in the cul-de-sacs superiorly to note flow of tears between the lens and anterior surface of the globe. A tight lens will not demonstrate good fluorescein flow and there may be

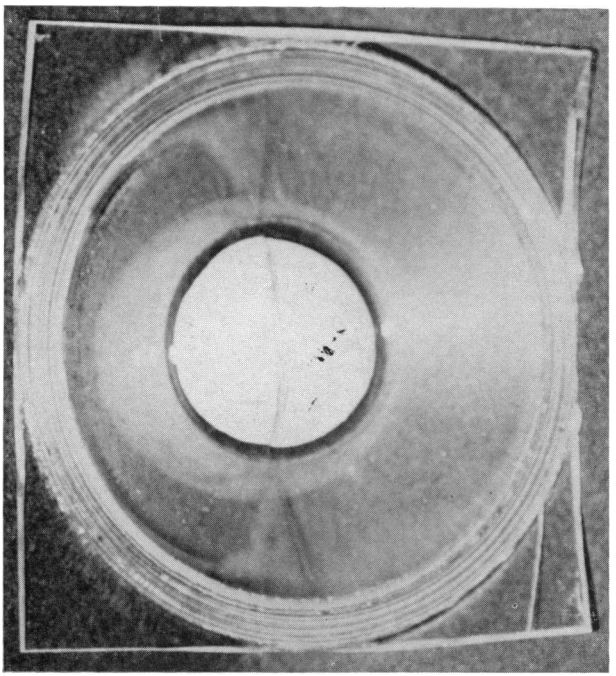

FIGURE 6

The methylmethacrylate plate is molded to the shape of the anterior surface of the stone mold.

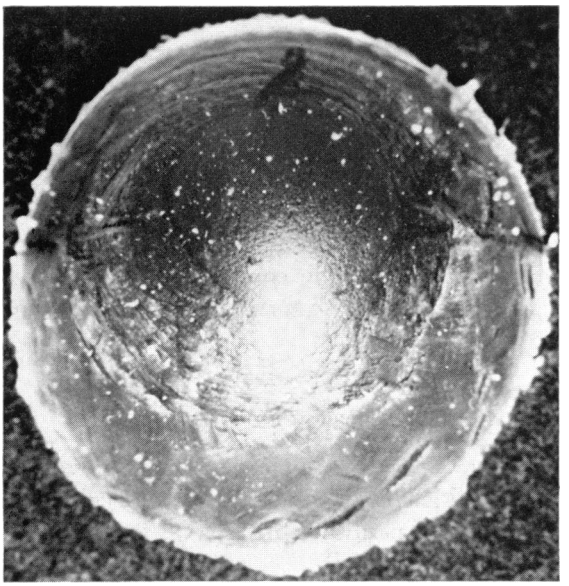

FIGURE 7A
A cosmetic cover shell before finishing.

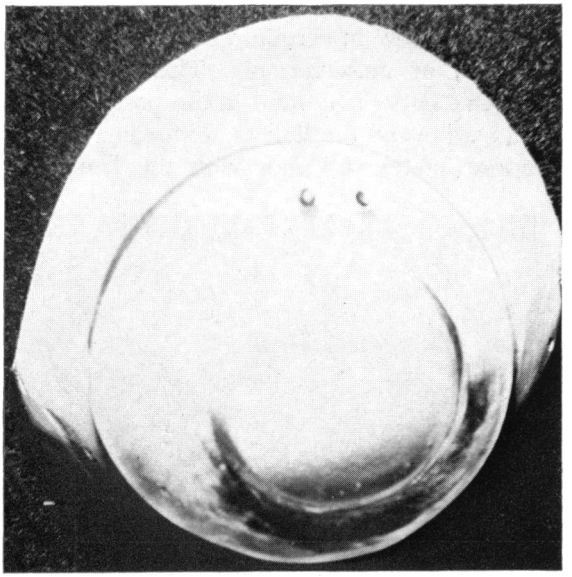

FIGURE 7B
Neutral-fitting lens over stone mold.

blanching of the conjunctival vessels. Inadequate flow or "touch" over the cornea may necessitate minimal modification or "relieving" over this surface. Occasionally, inadequate tear exchange is improved by a channel cut in the inferior portion of the scleral flange to the corneal area. Lenticular holes may be drilled in the corneal surface as a result of inadequate flow and persistent air bubbles. If inadequate flow is obtained over the corneal surface, a new lens is molded. It is imperative that, as the wearing time is increased to periods of up to four hours, the corneal and anterior surface of the globe be evaluated at regular intervals, especially when the anterior surface of the globe is not intact.

TYPES OF LENSES

Over the years, five basic types of lenses have evolved (Figures 8, 9, and 10): (1) scleral lens with optical power, (2) fluid type of scleral lens, (3) flush-fitting or neutral-fitting scleral lens, (4) cosmetic cover shell, and (5) evisceration shell.

RESULTS

THE REFRACTIVE OR POWER LENS

This lens is generally used in certain aphakic patients, juveniles with monocular aphakia, or anisometropia. This lens is also used for sports purposes. One curve is ground in the posterior surface, extending over the cornea beyond the limbus, approximately 1 mm. Corneal clearance is approximately 0.1 mm with the final clearance being

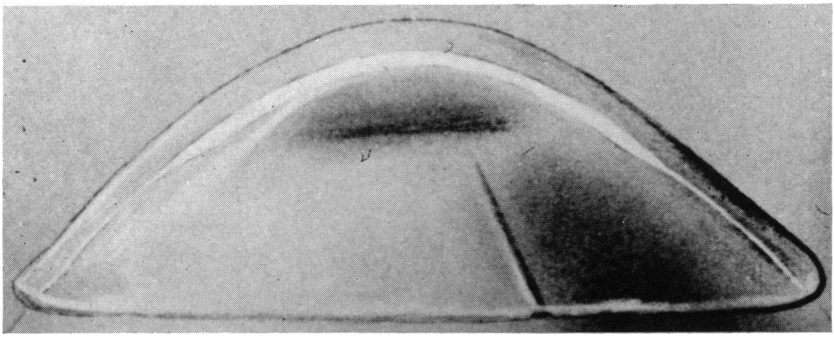

FIGURE 8

Scleral Lens with Optical Power: note channel. There is slight clearance over the cornea.

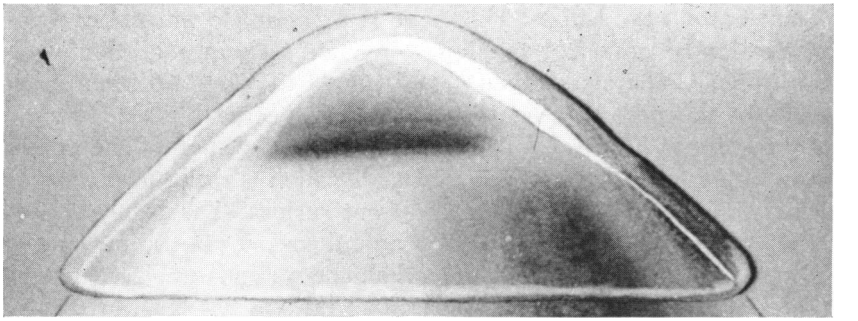

FIGURE 9

Fluid Type of Scleral Lens: this lens is most commonly used for keratoconus. Note the increased clearance over the corneal surface.

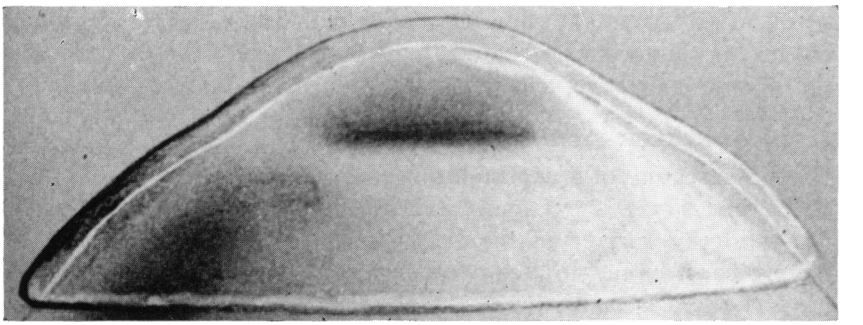

FIGURE 10

Flush-Fitting Lens: note that the space between the lens and the anterior surface of the globe is everywhere equal.

about 0.1 mm. The lens is about 1 mm thick for regular use or high minus correction and 1.5 mm with the high plus corrections. Often a channel is necessary and the channel is usually placed down and in. Lid pressure is less in this area but the channel may be placed in any zone where there is some fluid movement. Because of the high cost of fitting and manufacturing these lenses they are not generally recommended for patients except under special conditions (most commonly in young people).

FLUID TYPE OF SCLERAL LENS

The fluid type of scleral lens is usually recommended in the treatment of keratoconus. This lens is somewhat less than 1 mm thick. One curve is cut over the corneal surface. This curve is approximately

1 mm beyond the limbus. The curve is necessary to prevent pressure in the limbal area and to allow adequate clearance of the whole limbal zone. The lens is then manufactured to allow a 0.4-mm space between the posterior lens surface and the corneal peak. There is approximately 0.2 mm of clearance between the apex of the cornea and the posterior lens surface. No modification is made in the scleral flange. The lens is ground on the front surface. The results in our series of keratoconus cases were reported in 1969 at the meeting of the American Academy of Ophthalmology and Otolaryngology.[7] Suffice it to say that the fluid type of scleral lens has been used satisfactorily in most of our cases of keratoconus. A few cases have been treated with regular corneal lenses. The wearing time is not as long as that usually noted with corneal contact lenses. The majority of the patients have had adequate visual function for follow-up periods of up to 15 years. The fluid type of scleral lens is the treatment of choice for keratoconus when adequate visual acuity can be obtained, the disease is inactive, and corneal clearance can be maintained.

FLUSH- OR NEUTRAL-FITTING SCLERAL LENS

The basic feature of a neutral-fitting lens is that the posterior surface of the lens is everywhere equidistant from the anterior ocular surface. The posterior surface of the lens cannot be modified or polished, merely hand buffed to clean the surface. If no correction is to be used, the lens is made approximately 1 mm thick. If a low-powered correction is required the lens is made to a 1.5-mm thickness. The lens is ground on the anterior surface. A high plus correction requires a slightly thicker lens, 1.8 or 2 mm. When such a thick lens is required, the anterior surface of the scleral flange is then cut to a thickness of 1 mm. No modification is made on the back surface. This neutral-fitting lens is usually utilized for therapeutic purposes. In general terms, it is utilized to re-establish the integrity of the corneal and conjunctival surfaces and maintain the separation of palpebral and bulbar conjunctivas.

Vascularizing Keratitis

Case 1. A 53-year-old white male was first seen on 26 May 1959, with a diagnosis of vascularizing keratitis. Vision was 4/200 in the right eye and 18/100 in the left eye. There was slight, vascular, superficial infiltration of the right cornea. The left eye showed circumferential superficial vascular infiltration of 25 years' duration (Figure 11). Approximately 1.5 mm of clear central cornea remained. On 9 June 1959, a limiting lamellar keratectomy was performed on the left eye. The postoperative course was

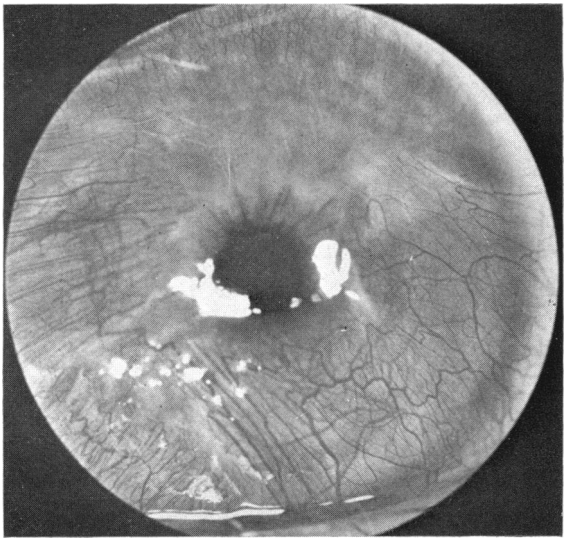

FIGURE 11

Vascularizing Keratitis: left eye, Case 1. The right eye has a similar though less severe process although the eye is amblyopic (preoperatively).

uneventful except for persistent corneal edema with stain. On 16 January 1960, a scleral neutral-fitting Ridley lens was molded. The mold was remade on 12 February 1960. Slight corneal staining was noted on several occasions. During this period the lens was maintained in place to patient tolerance. By 4 April 1960, vision had improved to 20/100, there was no stain, and the lens was left off except at night. On 29 November 1961, the patient had slight central intermittent staining. Wearing time had been increased to 10 hours. With a power of −1.25 the patient had 20/20 vision. By January 1962 the patient could discard the scleral lens entirely with no activity. The right eye remained inactive. The patient retained 20/20 vision with a contact lens (Figure 12) through January 1969 and would wear a regular glass for reading vision when it was desired. The right eye remained amblyopic.

Stevens-Johnson Syndrome

The severe corneal changes and symblepharon that occur in Stevens-Johnson syndrome respond to treatment with flush-fitting scleral lenses. Under operating-room conditions the symplepharons are separated using Stevens scissors and conjunctival forceps. The separation is made over the globe extending over the insertions of the rectus muscles. No attempt is made to suture any conjunctival surface to

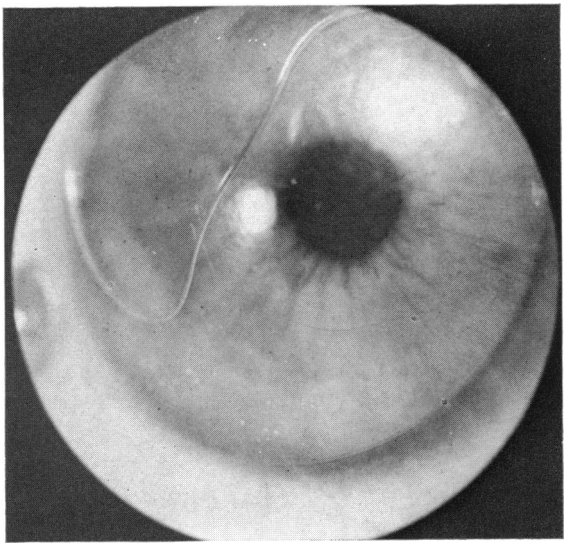

FIGURE 12
Case I. May, 1960, vision 20/40 with scleral lens in place. Postoperative.

its underlying tissues. The usual molding technique is carried out utilizing sterile Jeltrate. On the afternoon of the same day the lenses are placed in the cul-de-sacs of both eyes. No patches are used and both local and systemic antibiotics are given. The patients do not usually complain of much discomfort. The lenses are not moved unless mucous secretion and debris completely occlude vision. After a period of several weeks, during which time the lenses have been kept in place, a reformation of the cul-de-sacs will be noted. Usually the corneal disease will be significantly quieter and there will be notable improvement in vision. Short periods of removal of the lenses can be attempted. When it becomes apparent that the disease is in a quiescent state the lenses may be removed. If corneal changes persist, the lenses must be kept in place, being removed only when necessary for cleaning. In several cases some return of tear secretion has been noted.

Case II. A 14-year-old white female was first seen in July of 1961 with a history of Bright's disease and ensuing Stevens-Johnson disease. External examination revealed almost total symblepharon of both eyes (Figure 13A). On 25 July 1961, lysis of symblepharon with molding of scleral lenses was performed under pentothal anesthesia. Lenses were placed on the same day, with an uneventful postoperative course. On 9 January 1962, vision

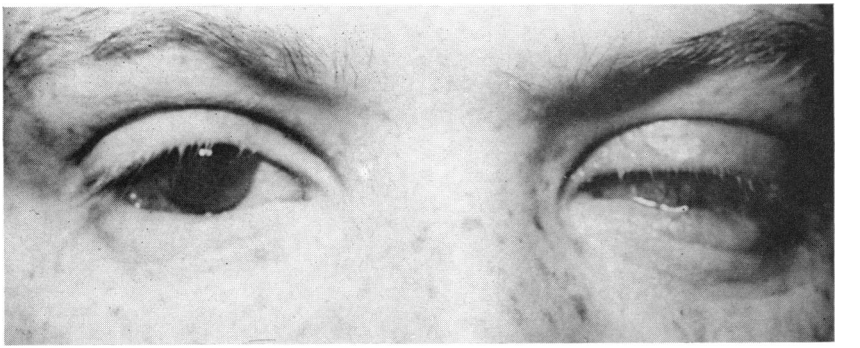

FIGURE 13A
Stevens-Johnson Disease: almost total symblepharon treated with scleral lenses, Case II.

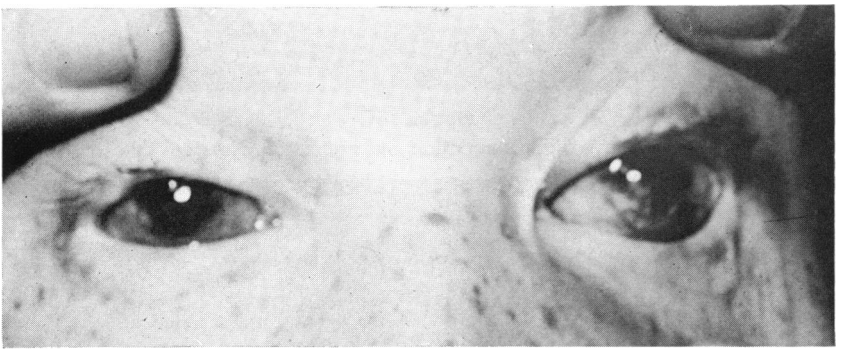

FIGURE 13B
Case II. After lysis of symblepharon.

in the right eye had improved from 5/200 to 20/100. Vision in the left eye had remained the same, at light perception and projection, but the cul-de-sacs were adequately maintained (Figures 13B and 13C). A lamellar keratectomy was performed on the left eye on 10 January 1962. The postoperative course was uneventful. However, because the eyes seemed to be responding so well to therapy a local physician attempted corneal lenses. This was followed by corneal perforation of the left eye. Corneal transplants were attempted on 21 February 1962, 13 July 1962, and 11 June 1964, without result. The left eye eventually went on to phthisis bulbi. The right eye retained 20/100 vision with J_1, with a corneal contact lens (Figure 13D). The cul-de-sacs were retained when last seen on 6 May 1968.

Case III. A 13-year-old white female was first seen on 8 June 1966, with a history of onset of Stevens-Johnson disease in July 1964. Vision

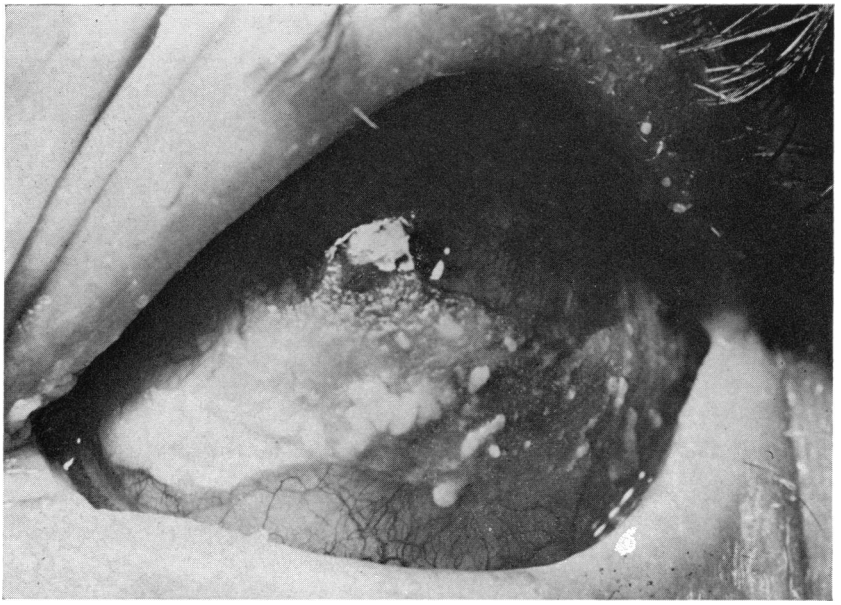

FIGURE 13C
Case II. Left eye, light perception and projection. Note cul-de-sac.

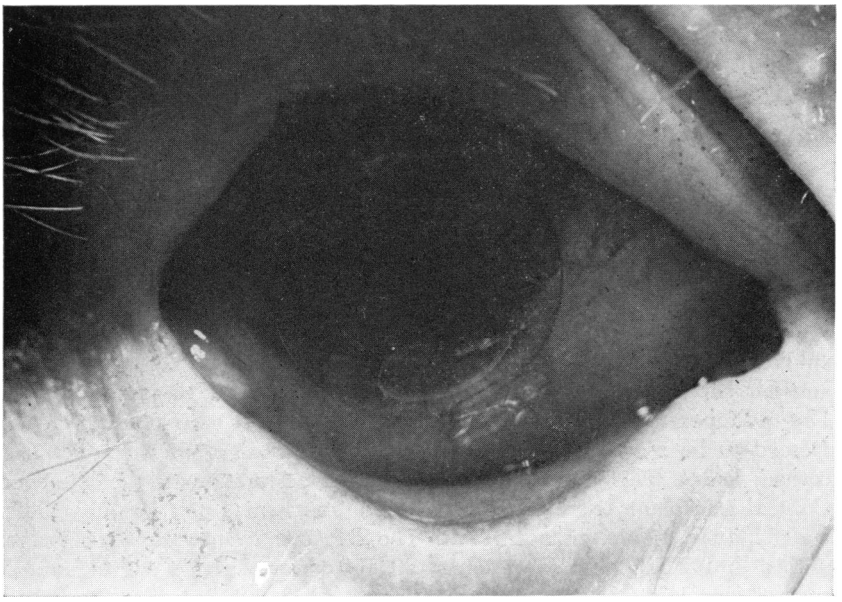

FIGURE 13D
Case II. Right eye, corneal contact in place. Vision 20/40, which was maintained, J_1 though distance vision dropped to 20/100.

was 20/50−2 in the right eye and 20/50+2 in the left eye with correction. External examination revealed almost total symblepharon in both eyes. Both corneas showed moderate to marked involvement with vascularization and clouding on slit-lamp examination. The anterior segments did not appear to be involved except for the conjunctiva and corneas. Ophthalmoscopic examination was normal for both eyes. On 10 June 1966, the cul-de-sacs were opened in the usual style, using scissors and forceps, and molds were taken with the patient on the operating table. The postoperative course was uneventful except for some continuation of corneal activity in the right eye (Figure 14A). The left eye has remained quiescent. When last seen on 9 March 1970, vision was 20/100 with a scleral lens in the right eye (Figure 14B), and 20/30 with a scleral lens in the left eye (Figure 14C). Slit-lamp examination reveals some continuation of

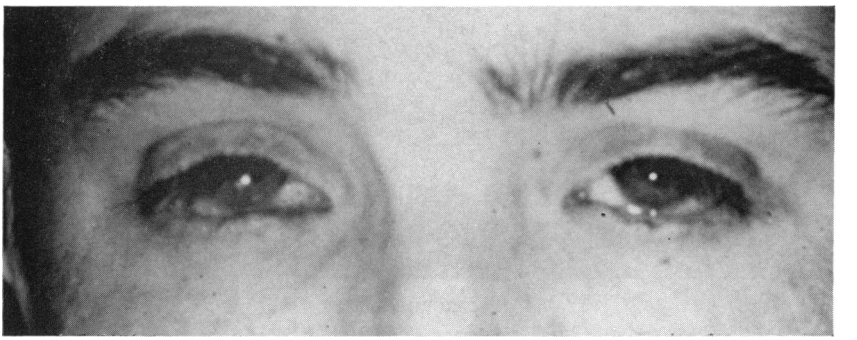

FIGURE 14A
Case III. Approximately one year after lysis of symblepharon. Right and left eye.

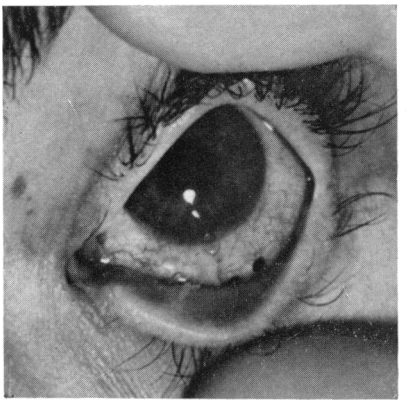

FIGURE 14B
Case III. The left eye remained quiescent. January 1969 through May 1970, vision 20/30.

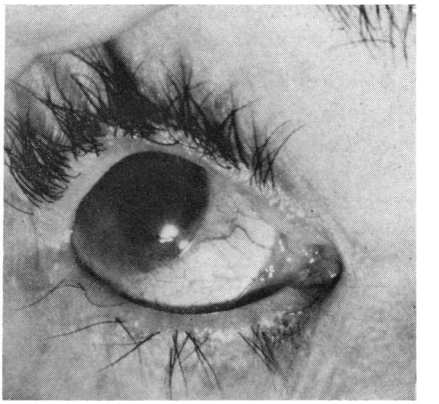

FIGURE 14C
Case III. Right eye, slight recurrence of corneal activity. Vision 20/100.

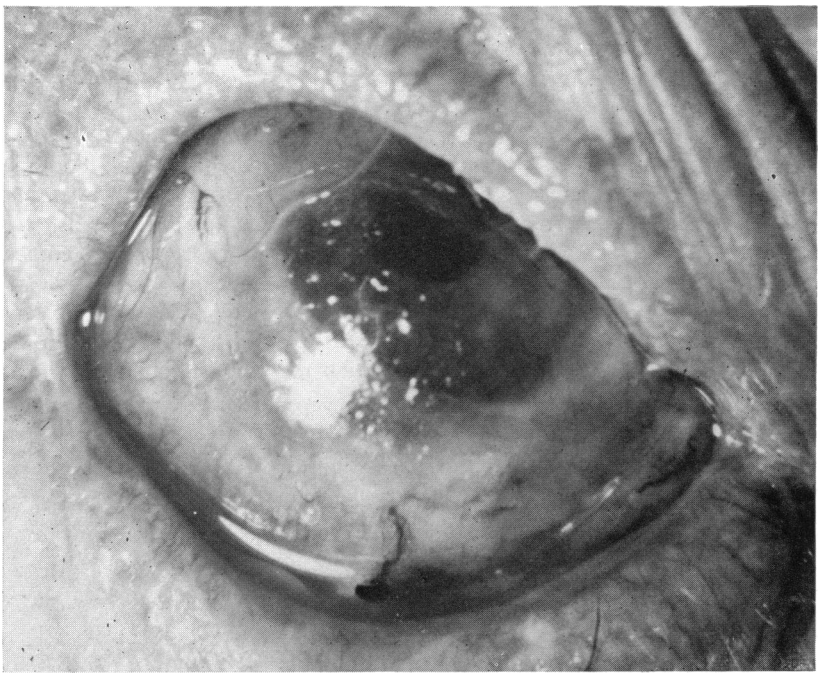

FIGURE 15A
Case IV. May 1967, postoperative. Right eye, vision 20/200.

corneal vascularization in the right eye; the left eye appears quiescent. There were a few wild lashes noted in the lower lids. The remainder of the ocular examination gave normal results.

Case IV. A 53-year-old white female's vision had been reduced since age 12, following measles. She had multiple lid procedures for the resultant symblepharon, spastic entropion, and trichiasis of both lids. Both cataracts have been removed. Vision was light perception and projection for both eyes. External examination revealed trichiasis with spastic entropion and symblepharon of both upper and lower lids. Corneal scarring with vascularization was noted in both eyes. On 27 July 1954, a Hotz-Anagnostakis procedure was performed on both upper lids. The patient was not seen again until 2 May 1967, at which time corrected vision was 20/100 for the right eye and 20/50 for the left eye. On 9 May 1967, lysis of symblepharon with molded impressions of both anterior cul-de-sacs was made and lenses were placed the same day. The postoperative course was uneventful. When last seen on 7 March 1970, vision was 20/200 in the right eye and 20/30−1 in the left eye (Figures 15A and 15B). The patient has no complaints as long as the scleral lenses are maintained in position.

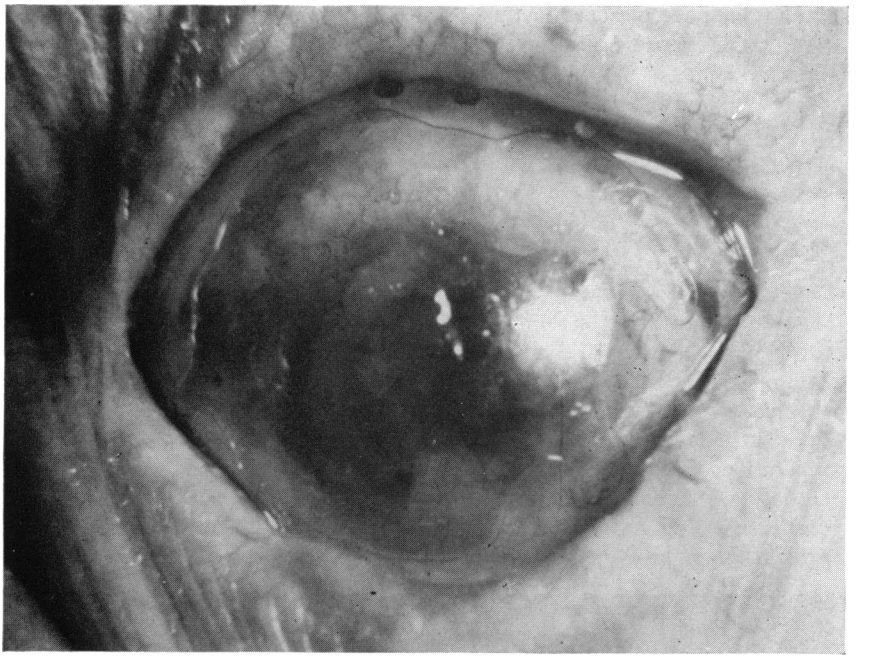

FIGURE 15B
Case IV. Left eye, vision 20/30 — 1 with an aphakic correction in both eyes.

A number of other cases of Stevens-Johnson disease have been treated as noted. Most have responded well to therapy.

Ocular Pemphigus

Four cases have been attempted. Three of the four cases were unsuccessful. The fourth case was that of a patient who had a minimal amount of symblepharon, which was treated as noted above. The patient also had severe trichiasis and the lenses maintained control of the cul-de-sacs and of lash touch. The patient has been followed for some years with improvement in visual function and comfort.

One patient removed her lens almost immediately after discharge from the hospital and the cul-de-sacs closed down completely in a matter of days.

Case V. A 77-year-old white female was first seen with light perception in both eyes and far advanced ocular pemphigus. The patient had had cataracts removed about eight years previously with no complications. However, she had noted loss of the conjunctival cul-de-sacs with increasing discomfort over several years.

Ophthalmoscopic examination revealed an abnormal disk in the left eye, with primary optic atrophy. The right eye was not visualized. On 18 January 1966, a full-thickness 9-mm lamellar graft was placed. The postoperative course was uneventful except for the insertion of a scleral lens in the immediate postoperative period. Since that time multiple operative procedures including keratoprosthesis and replacement of scleral lenses have been attempted, on each occasion to no avail. When last seen on 18 March 1970, there was essentially no cul-de-sac in the right eye (Figures 16A, 16B, and 16C). The left eye was as previously noted.

Case VI. A 68-year-old white male was seen because of bilateral pemphigus with almost complete symblepharon of both eyes. Vision was reduced to light perception in both eyes. External examination revealed almost complete symblepharon in both eyes (Figures 17A, 17B, and 17C), although the history indicated that a keratoplasty had been performed on the left eye. No evidence of this could be seen on examination. In May 1967, a separation of symblepharon with molding of scleral lenses was performed on both eyes. The postoperative course was uneventful, except that the lenses dislocated one month later. Two attempts were made to restore the cul-de-sacs in the right eye; the last on 13 August 1968, at which time a kerato-

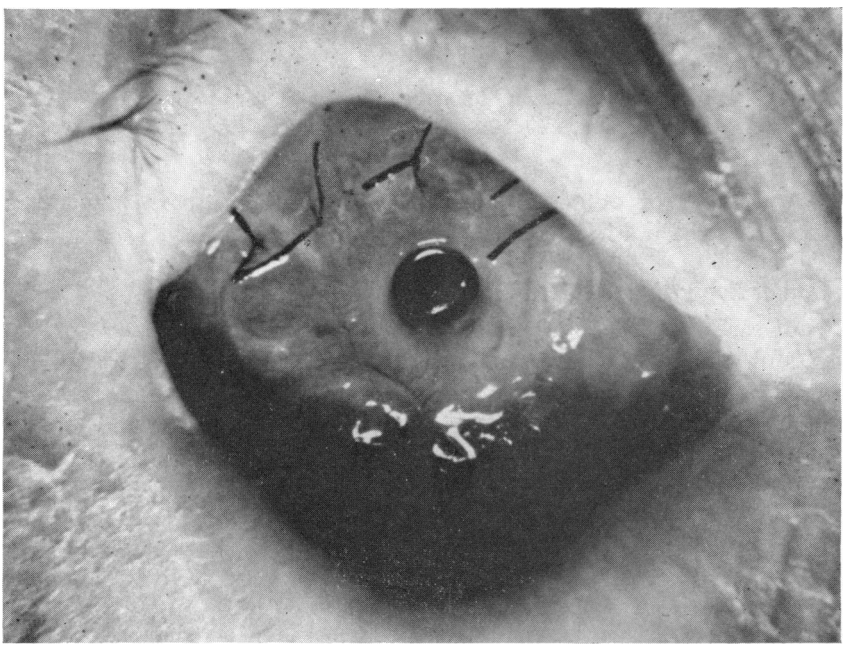

FIGURE 16A

Ocular Pemphigus: summer 1964 – placement of scleral lens over keratoprosthesis. Vision: objects and color. Case v.

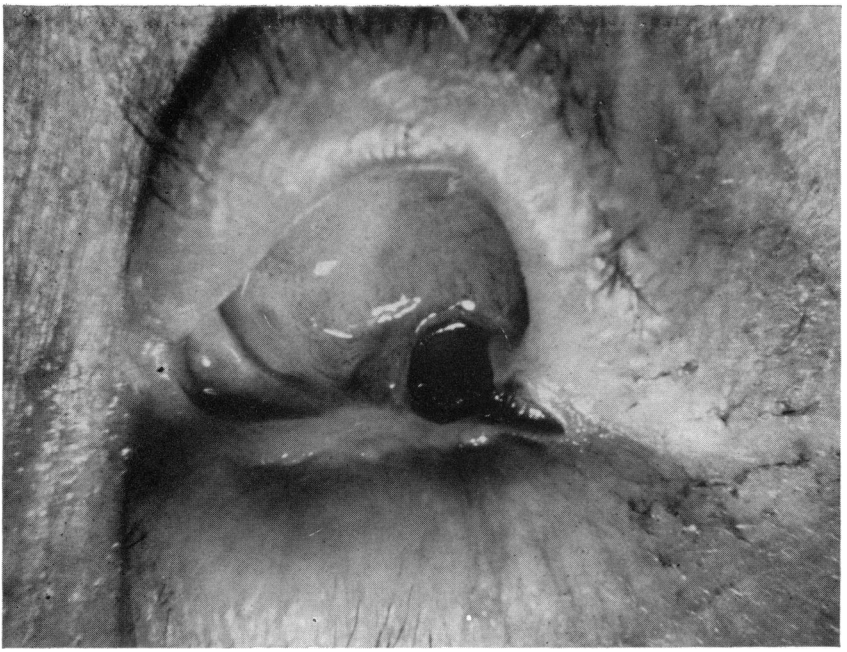

FIGURE 16B
Case v. One month later.

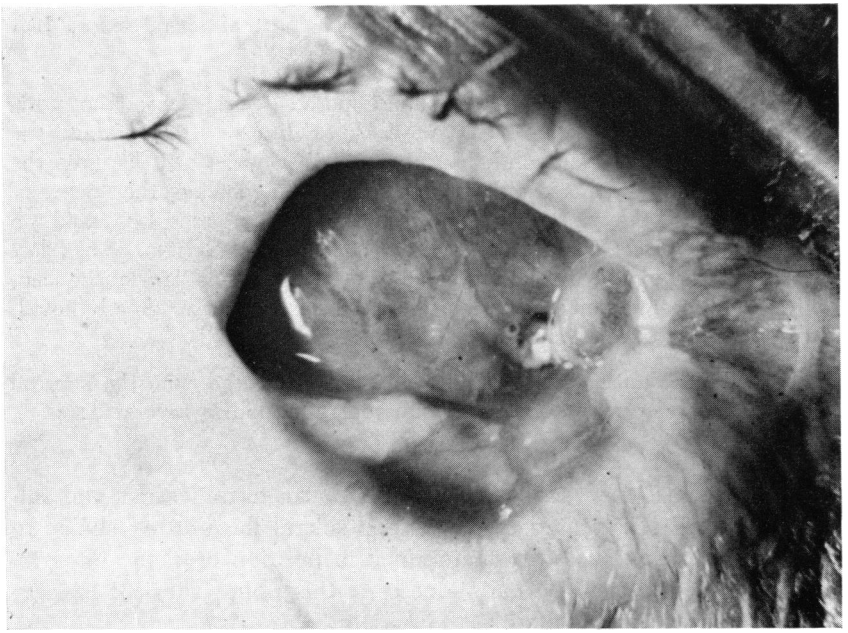

FIGURE 16C
Case v. January 1967. Since then multiple procedures have been performed. There is essentially no cul-de-sac at this time, 20 May 1970.

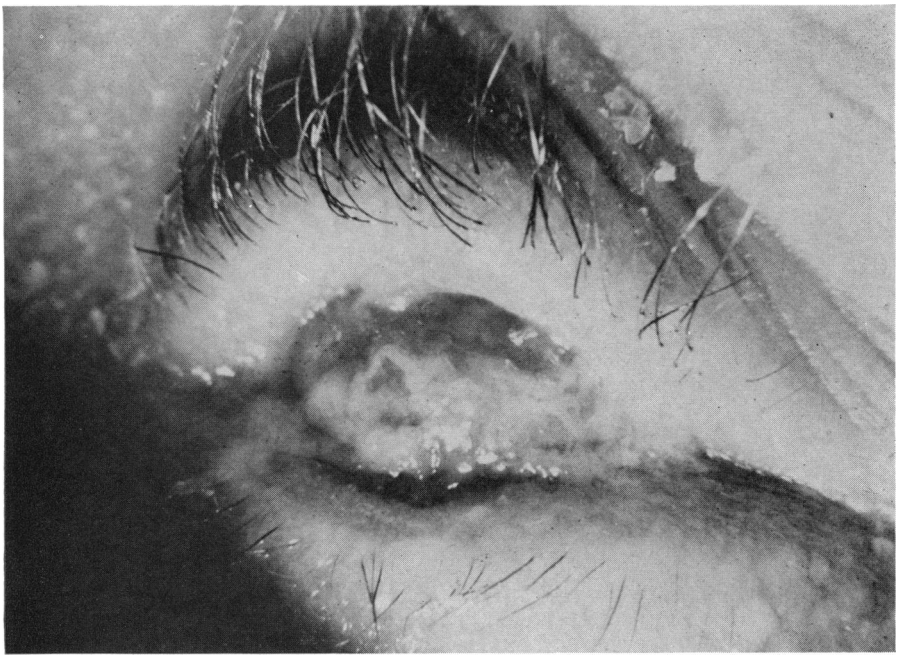

FIGURE 17A

Ocular Pemphigus: six months postoperative placement of scleral lenses. Left eye, light perception only. Case VI.

prosthesis was performed with a superimposed scleral lens. The postoperative course was uneventful until 26 February 1969, when the patient appeared with endophthalmitis of the right eye. Until this time the patient had noted colors and moving objects. Following the onset of endophthalmitis the vision was reduced to no light perception, and no further attempt was made to restore the cul-de-sacs or vision. When last seen on 8 January 1970, the condition was essentially as previously seen, with no light perception in the right eye and the left eye as already noted. No further surgical intervention is contemplated.

Case VII. This patient removed her lenses on discharge from the hospital and refused replacement. The symblepharon re-formed in several days.

Corneal Burns

A number of patients receiving (alkaline) burns to the cornea and cul-de-sacs have been treated using molded scleral flush-fitting shells. In general terms the lenses are maintained in position until the integrity of the cul-de-sacs can be maintained. At this point, surgical therapy by keratoplasty is attempted.

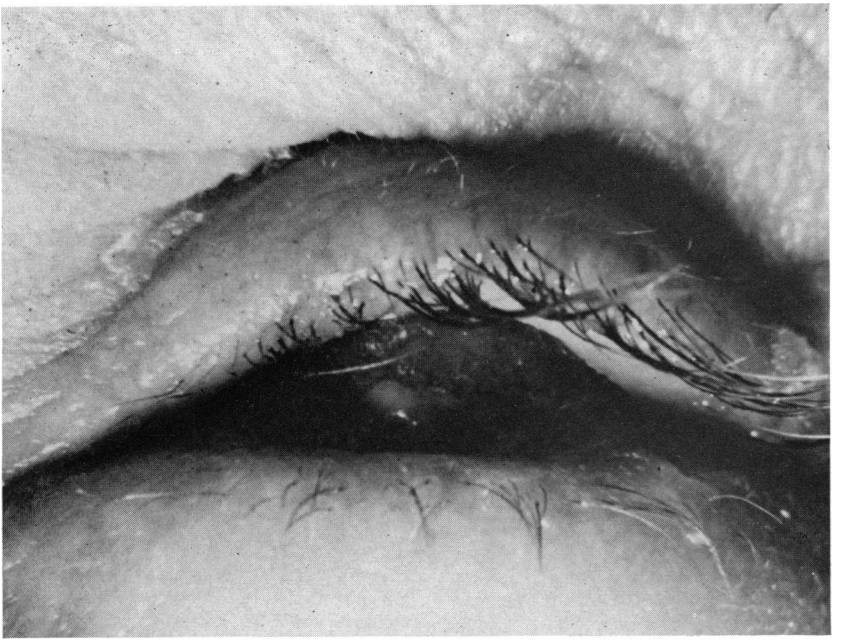

FIGURE 17B
Case VI. Right eye, light perception and projection.

Case VIII. A 43-year-old Negro female was originally seen at Detroit General Hospital in 1964 following severe lye burns (Figure 18A). The patient was treated with scleral lenses to maintain the cul-de-sacs. A keratoplasty was performed on the right eye in 1965, without improvement in vision. A keratoprosthesis was performed in 1966 with visual improvement to 20/200. There have been multiple procedures and the cul-de-sacs have been maintained (Figure 18B); however, the visual acuity has not been improved to the original level.

Case IX. A 48-year-old white male was first seen on 17 January 1966, following an ammonia burn of both eyes. Vision was reduced to 20/200 in the right eye and to counting fingers in the left eye. Scleral lenses were placed at that time. When the patient was next seen on 22 March 1966, there was no symblepharon. Vision remained 20/200 in the right eye and counting fingers in the left eye. External examination revealed marked corneal clouding with evidence of inflammation of the anterior segment. Pupils were dilated and fixed. Mature cataracts were noted in both eyes. Intraocular pressure was off the scale in the right eye with the 10-g weight of a Schiøtz tonometer; pressure in the left eye was 42 mm Hg. Ophthalmoscopic examination was impossible. Multiple corneal procedures have been

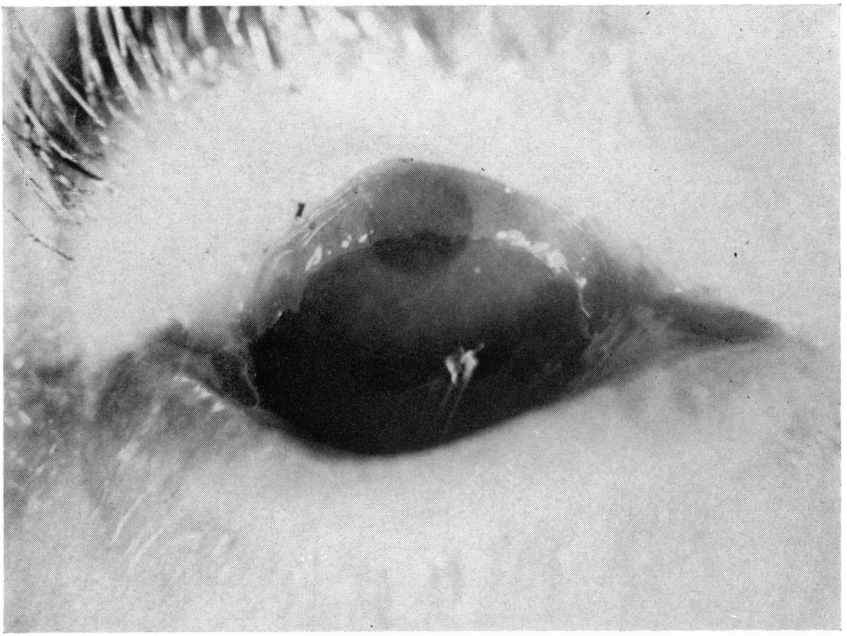

FIGURE 17C

Case VI. Right eye, October 1968, three months after placement of keratoprosthesis and superimposed scleral lens. Patient could see the food on his plate until February 1969, when he returned with panophthalmitis in the right eye.

attempted on both eyes, including a keratoprosthesis in the left eye, originally placed on 6 December 1968. When last checked on 28 April 1970, vision was light perception and projection in the right eye, and 20/40 with pinhole in the left eye. Adequate cul-de-sacs have remained to date.

Neuroparalytic Keratitis

Four patients with damage to the fifth and seventh nerves secondary to removal of a brain tumor have been treated with scleral lenses. All have shown adequate control of corneal changes as long as close observation of the cornea has been maintained.

Three patients with damage to the fifth nerve secondary to tic douloureux procedures have also been treated with scleral lenses. Severe intraocular inflammation developed in one patient without adequate control of the corneal disease. Adequate control of the corneal changes was obtained in the other two patients with eventual reduction in lens wearing time.

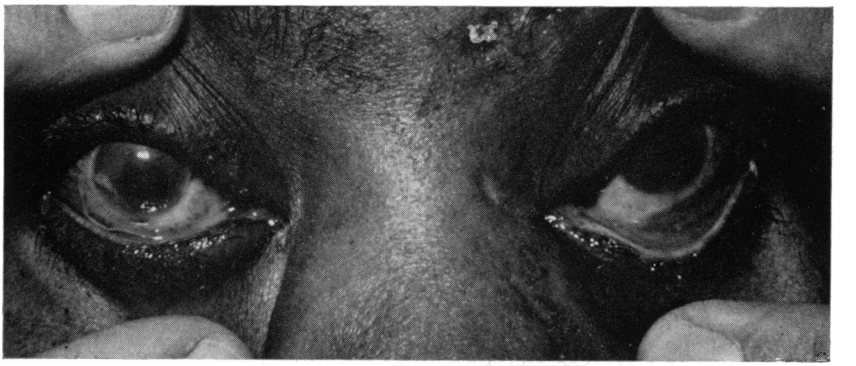

FIGURE 18A

Lye Burn: November 1964, cul-de-sacs re-formed by scleral lenses. Case VIII.

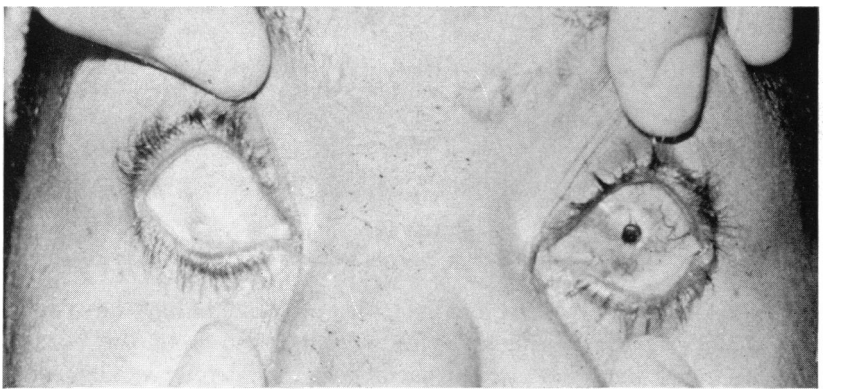

FIGURE 18B

Case VIII. July 1968, note cul-de-sacs after multiple corneal procedures.

Corneal Abscess and Perforation

Case X. The first case treated was a 42-year-old white male with far advanced scleroderma. The patient was first seen on 25 October 1963. External examination revealed total ectropion of both upper and lower lids. The cornea of the right eye had developed a central necrosis with perforation. The cornea of the left eye was involved to a lesser degree. On 29 October 1963, scleral lenses were molded to both eyes under local anesthesia. Within a period of two weeks the corneal surface had completely healed over. The patient retained light perception and projection with normal intraocular pressure and until his death he was determined that he would subject himself to keratoplasty. The patient's features were so shocking that photographs were never attempted.

Since that time a number of patients with corneal necrosis, abscess,

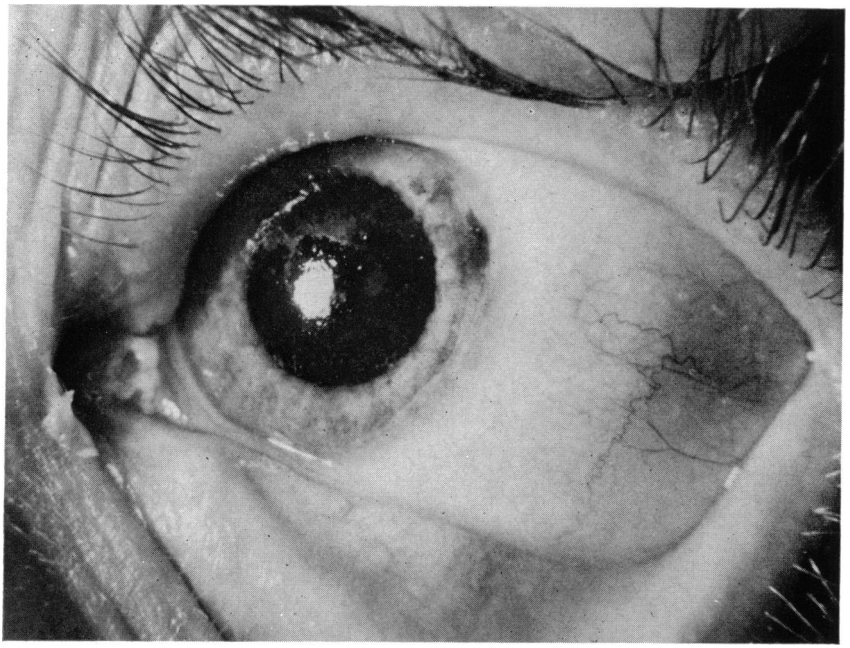

FIGURE 19A
Filamentous Keratopathy with Sjögren's Disease: left eye. Case XI.

and even perforation (occasionally with endophthalmitis) have been treated with neutral- or flush-fitting scleral lenses until the corneal integrity could be maintained. Controlled surgical intervention could then be attempted.

Case XI. A 32-year-old white female was first seen on 29 October 1962, with a history extending for more than two years. She first noted almost total loss of saliva and tearing. This had occurred secondary to a heart attack suffered by her husband. She had first noted swelling over both parotid glands and intermitten painful swelling over both lacrimal gland areas. Intractable filamentous keratitis developed in both corneas, more notably the right one (Figures 19A and 19B). Her teeth crumbled and were gradually extracted. Hypopituitarism and chronic rheumatoid arthritis necessitated steroid and supportive therapy.

Vision on the first visit was 20/100 in both eyes. External examination revealed filamentous keratitis and pseudoptosis in both eyes. In both eyes, tactile tension was normal, ophthalmoscopic examination was normal and the Schirmer test measured 2 mm.

On 6 November 1963, a Ridley lens was fitted to the right eye. By 30 November 1963, a severe central descemetocele developed in the right

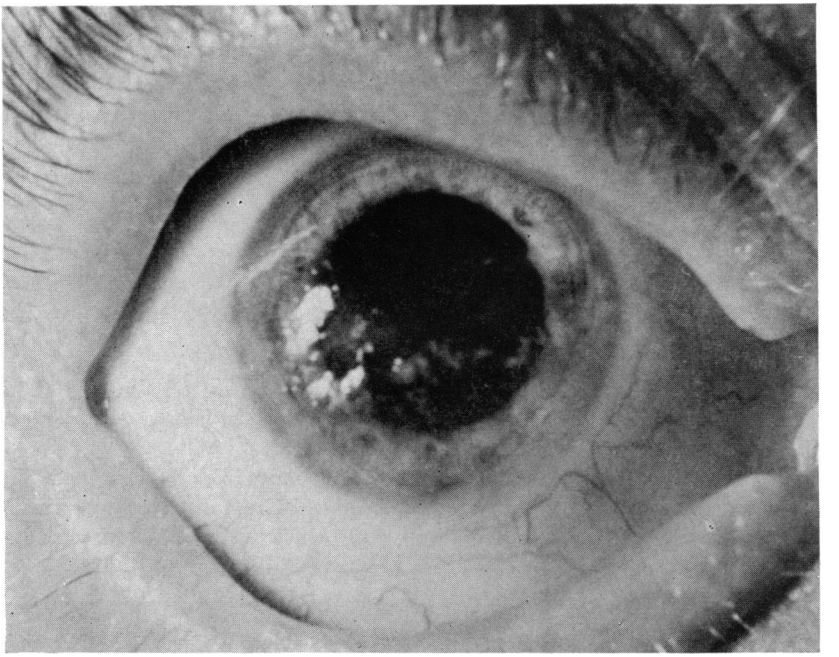

FIGURE 19B

Case XI. The right eye was fitted with a scleral lens. Within three weeks time a descemetocele had developed and a penetrating kertoplasty was performed.

cornea. A penetrating keratoplasty was performed on 17 December 1963. The postoperative course was uneventful, but the graft did not clear.

In June 1967 local prostigmin therapy was instituted, and eventually the condition was controlled with a 2.5 per cent solution applied three times daily to both eyes. Both eyes remained quiescent; in fact, the patient had a notable increase in tearing. The patient remained comfortable with systematic therapy, local prostigmin and artificial tears as needed until 31 March 1970, when a regraft (8-mm penetrating keratoplasty) was performed on the right eye. Preoperative medications were continued and the graft was clear on 13 May 1970. Vision in the left eye has remained 20/30.

The reason for placing this patient in this series is to point out the apparent need for adequate tear formation and function. In our experience, a dry eye is extremely difficult to fit with a scleral lens. The patients are often extremely uncomfortable and, in fact, wearing time is usually not satisfactory. Therefore, maintenance of the lens requires frequent observation. The patient with a "dry eye" has a guarded prognosis in terms of success with a scleral lens.

Post Keratoplasty

Occasionally the neutral-fitting scleral lens can be used as a stent following keratoplasty. This has been attempted only when the patient's acuity in the other eye is nil or inadequate for him to get around in a hospital or in a postoperative situation.

COSMETIC COVER SHELLS

Iridodialysis

A flush-fitting scleral lens with the iris painted on the back portion of the lens (with or without correction) can be used to correct the visual deficiency which occurs with iridodialysis.

Case XII. A 37-year-old white male was first seen on 22 October 1956. The patient had been struck in the left eye five weeks before with a piece of chalk.

Eye examination was negative except for a large iridodialysis involving the nasal half of the left iris and minimal cataractous changes nasally (Figure 20A). The patient was fitted with a scleral lens, tinted over the entire iris portion, on 7 January 1957 (Figures 20B, 20C, and 20D).

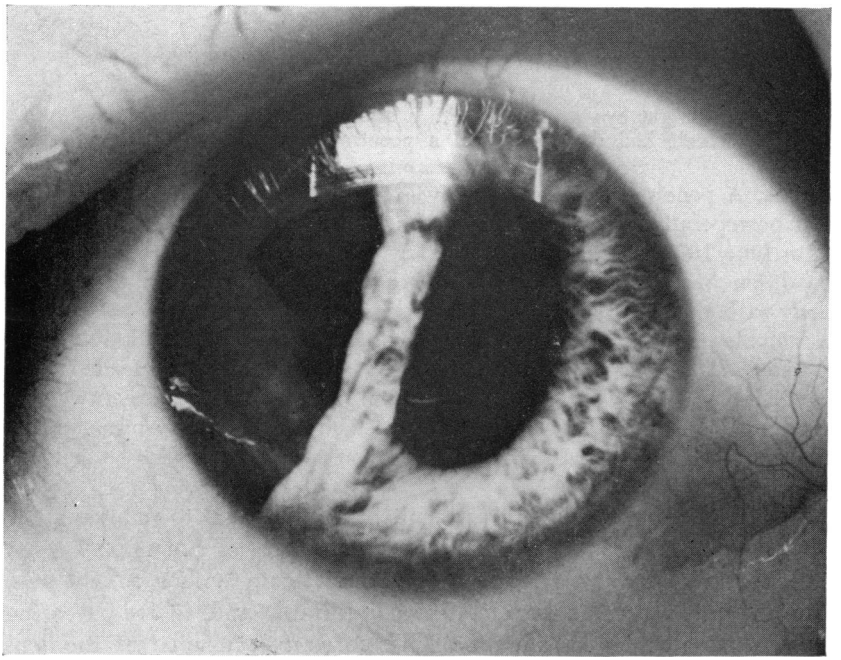

FIGURE 20A
Iridodialysis: left eye. Case XII.

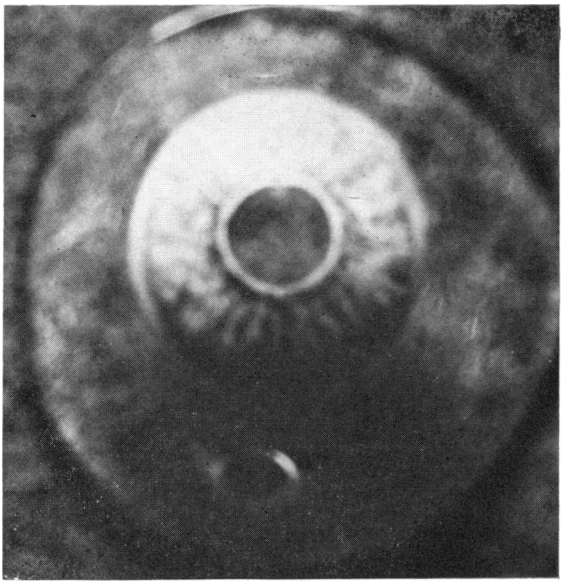

FIGURE 20B
Case XII. Painted cover shell.

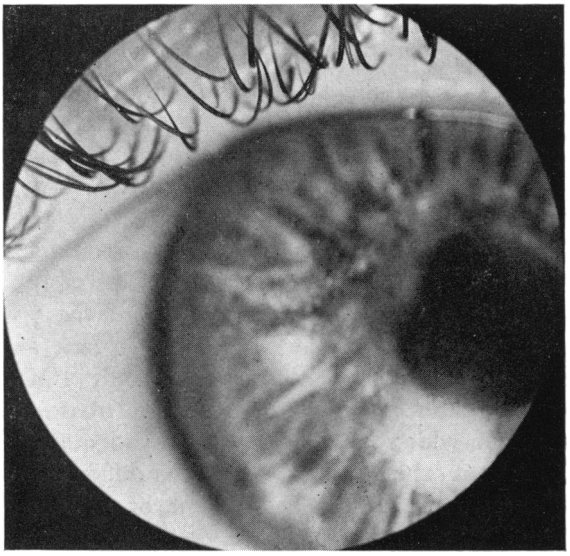

FIGURE 20C
CASE XII. Cover shell in place, 20/20 vision.

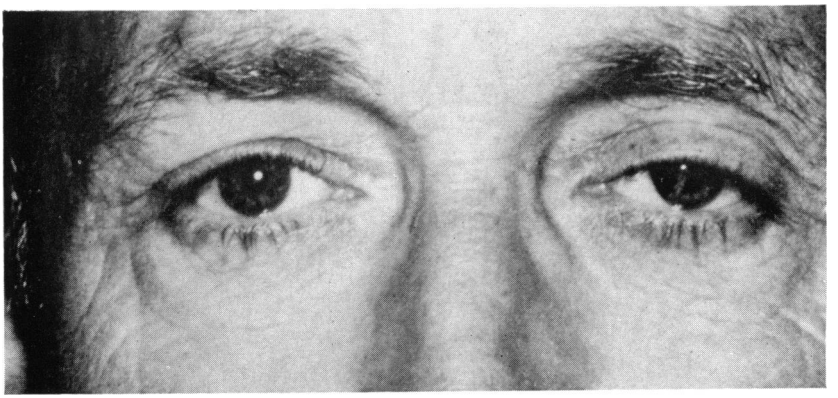

FIGURE 20D
Case XII. Patient with cover shell in place nine years later. Vision 20/20.

When last seen on 26 February 1968, the eye was quiet except for the noted iridodialysis and slight cataractous changes nasally. The pupillary zone of the lens was clear. Vision was 20/15 in the right eye and 20/30+ in the left eye. Schiøtz tonometer readings were 22 mm Hg with a 7.5-g weight; pupils dilated with 1 per cent Mydriacyl.

Cover Shell

An eye that is microphthalmic, phthisical, or useless for any reason may be covered with a flush-fitting shell that is painted to match the other eye. As long the globe remains quiescent, the cover shell can be utilized with great cosmetic satisfaction to the patient. These shells are particularly useful in microphthalmic eyes or disfigured eyes of infants. If the eye is not potentially useful for vision a shell may be molded over the anterior surface (Figures 21A, 21B, and 21C). The infant with a microphthalmic or useless eye is particularly helped by a cosmetic shell molded over the anterior surface of the globe. This results in an improved cosmetic appearance of the youngster and obviates the necessity to enucleate the globe. In fact, an enucleation in an infant with such a disability may actually lead to a severe cosmetic defect in later years. There are several reasons for this, the most important of which is the difficulty in adequately placing an implant in the infant orbit. In many cases it is difficult to maintain the implant in Tenon's capsule. Displacement of the implant occurs, and a cosmetic shell cannot be made. A cover shell allows the useless eye to be covered. The result is comfort and satisfaction of both patient and parent.

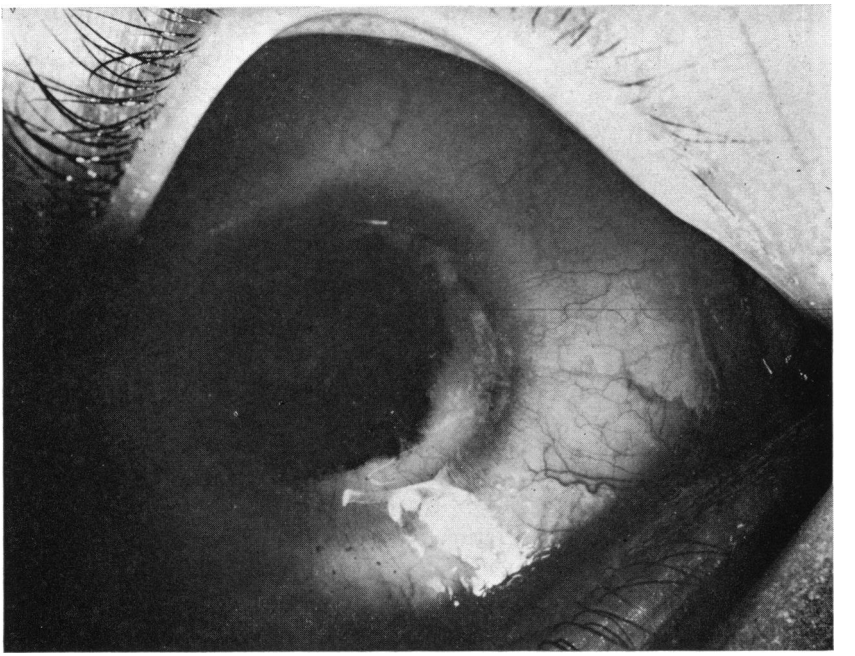

FIGURE 21A
Cosmetic Cover Shell: left eye after corneal tattoo.

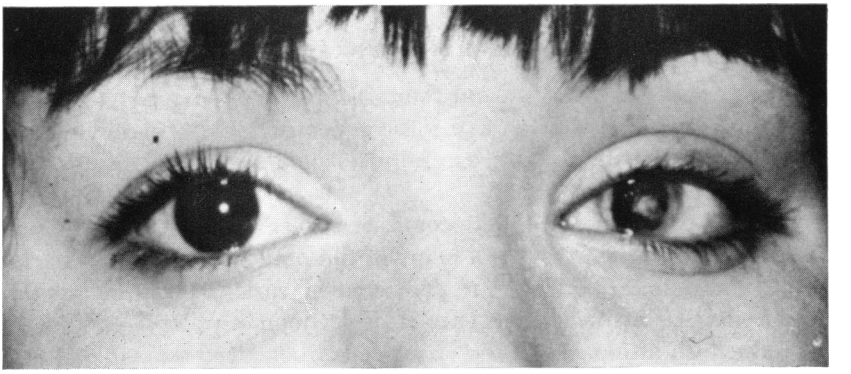

FIGURE 21B
Without a cover shell.

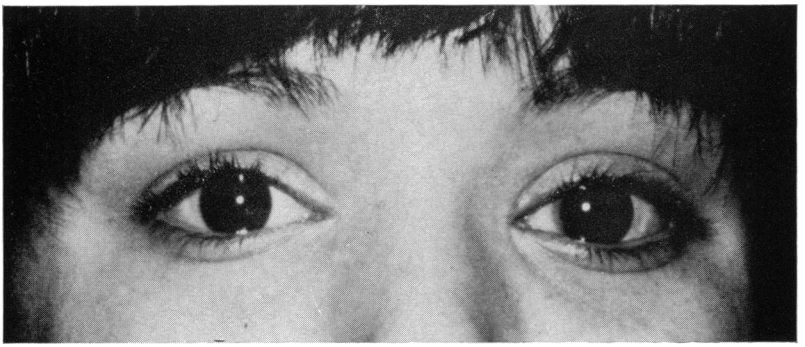

FIGURE 21C
With cover shell in place.

Evisceration Shell

Hundreds of cases have been treated utilizing a thin flush-fitting cover shell over an evisceration, with cornea retained. In a blind painful eye without evidence of tumor or sympathetic ophthalmia a modified Burch evisceration with cornea retained has been utilized for some years. A properly fitting flush shell is essential to the continued function of the evisceration. Orbital volume is maintained. Superior ocular movement is notable, the finished shell must not contact the corneal surface in any area and it must not rotate. Most patients wear the cosmetic cover shells continuously, removing them only occasionally for cleaning and polishing. The occasionally noted increased or abnormal secretion can be handled by properly maintained hygiene. On occasion, emolient eye drops may be necessary.

SUMMARY AND CONCLUSIONS

Over the past ten years several thousand patients have been treated, utilizing one or another of five basic types of molded methylmethacrylate scleral shells. In this carefully selected series the results have been generally successful.

In those cases, such as keratoconus or corneal disease, where visual function is essential to the well being of the patient, the molded scleral lens has a definite benefit. The treatment of various types of anterior ocular disease involving the cornea and conjunctiva and cul-de-sacs with the flush-fitting scleral shell has been of benefit to the patient.

In those cases where vision has been lost for any number of reasons (or adequate visual efficiency cannot be obtained) a cosmetic cover shell can be utilized over the globe. The evisceration shell is bene-

ficial when tumor or sympathetic ophthalmia are not present. A superior cosmetic effect is obtained, the patient has excellent mobility, retention of orbital volume, and minimal abnormal secretions because the normal cul-de-sac is retained.

The reason for the therapeutic success of the molded scleral lens is still in question. There is no doubt that the smooth non-irritating plastic surface of the lens is a factor. The easy passage of tears beneath the lens (should tears be present) is also a factor. In our opinion, the "splinting" effect of the lens, as well as the prevention of lid action, is the best reason for the success of the scleral lens. It must be stressed that both intra- and extraocular conditions must be stabilized for the lens to function.

In our experience ocular pemphigus cannot be treated adequately with flush-fitting scleral lenses. The patient with a "dry eye" is also extremely difficult to fit with a lens and has trouble maintaining one.

In every case in this series, success was obtained only when adequate supervision and proper hygienic conditions were maintained. Superior technical skill is essential to the molding, completion, and fitting of a proper scleral contact lens. A satisfactory retention of function can only be retained if all conditions are met.

We have found the scleral contact lens in its various forms to have a definite place in our therapeutic armamentarium.

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DISCUSSION

Dr Byron Smith. In this photograph a case of cul-de-sac restriction subsequent to development of juvenile granuloma complicating muscle surgery is shown. The cul-de-sacs were dissected free; a conjunctival mucous mem-

brane graft was inserted and held in place with a donut-type of scleral shell. Over the past few years we have felt that these shells are beneficial in maintaining the position of the graft as well as retaining the cul-de-sacs. Some of these shells have been left in place from one week up to several months.

[Slide] A 0.3-mm mucous membrane graft taken from the mouth is shown in position beneath the donut-type scleral lens. The graft was taken with the Castroviejo mucotome. This instrument is the best means of taking such a graft, so far as I am aware.

[Slide] This photograph depicts re-configuration of a donut shell. Some of these shells are made in colored plastic so that they are obvious during the postoperative course. Under certain circumstances it is desirable to have these shells colorless and transparent.

[Slide] This photograph shows a donut shell in place without any evidence of corneal irritation over an extended period of time.

[Slide] This photograph depicts the use of a scleral type of donut shell as a means of treatment for ptosis. A ledge on the surface of the shell supports the upper lid at its proper configuration. This type of a device has been used in many places, by various surgeons.

[Slide] Another use for the contact shell is protection of the cornea against trichiasis in either or both of the eyelids. In some cases the use of the shell is a means of avoiding radical surgery for the correction of trichiasis. It is also useful in cases where trichiasis is repeatedly recurrent.

[Slide] Another condition in which we have found the scleral shells of benefit is in the treatment of congenital and traumatic coloboma of one or both lids.

DR RUEDEMANN. I think the most important thing we must remember with scleral lenses is that they are a functional entity, but they are only functional when you have very great discipline on the part of the patient and the observer. These people must be watched, particularly in the dry eye situation, or in a situation where other conditions are existent.

We never could have made the study if we had not had a man like Fritz Jardon, because the techniques and the workmanship required must be good. I should add that we feel the physician should learn how to take a mold. We should know how to do this, and we will see further use of this type of material.

The question was asked about how early one can fit scleral lenses. We haven't fitted any newborns, but we have a number of children wearing these lenses. I am talking about infants. It is remarkable how these young people can handle these lenses themselves. This is another area of consideration. I would think you could fit the lenses on a newborn. You could fit the lenses on anyone if you watch him. These people can't go away without attention.