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SELECTION OF PATIENTS FOR KERATOPLASTY

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GRAFTS FOR THE IMPROVEMENT OF VISION

Keratoplasty is most frequently performed to restore vision which disease or deformity have rendered insufficient for the patient's needs. Vision 20/200, classified as industrial blindness, is generally considered poor enough to indicate the operation; but under some circumstances a corneal graft may be advisable even when the patient sees a good deal better than this.

Technics of keratoplasty vàry according to the shape of the graft, its size, its thickness—partial or full, or the mode of fixation. Technics improve continuously as new instruments, better suturing materials, and other technical advancements become available.

TYPES OF KERATOPLASTY

The main types of keratoplasty are:

(1) Circumscribed, or partial, lamellar keratoplasty: A circumscribed area of the external lamellae comprising approximately one-half to two-thirds of its thickness is replaced by transparent cornea of the same size and thickness taken from a donor eye. In favorable cases, this type of keratoplasty gives a high percentage (90 per cent) of good results.

(2) Total lamellar keratoplasty: The external layers of the whole cornea, comprising approximately from one-half to two-thirds of its thickness, are replaced with a graft of similar size and thickness from a transparent cornea. This operation is used in cases of superficial opacity extending over the entire area of the cornea. Although it is not as likely as a smaller graft to be successful, it gives a fairly high percentage (50 per cent) of successful results in selected cases.

(3) Circumscribed, or partial, penetrating keratoplasty: A variable area of the full thickness of the opaque or deformed cornea is replaced by a corresponding piece of normal cornea. This is the type of operation most frequently used at present, and is suitable to the greatest number of eyes affected with corneal opacities or deformities. In favorable cases it gives a high percentage (90 per cent) of successful results.

(4) Total penetrating keratoplasty: The entire cornea is transplanted to replace a badly scarred cornea which is diseased or deformed over the entire, or

nearly the entire, surface. Until a few years ago this type of keratoplasty was not reported as completely successful. During the past seven years the author has reported cases of successful total penetrating keratoplasty, some already under observation over seven years. Total penetrating keratoplasty is performed only in extreme cases when other types of operation cannot be carried out successfully. It is undertaken only in eyes still preserving good perception and projection of light, and in which tension is within normal limits. Total penetrating keratoplasty results in about 25 per cent of either transparent or fairly transparent grafts, with some, or considerable, improvement of vision.

THE USE OF DIFFERENT TYPES OF GRAFTS

Lamellar grafts do not ordinarily achieve as brilliant results as penetrating grafts. Vision of 20/20 or better, which not infrequently follows penetrating grafts, is exceptional after lamellar grafting. Unquestionably, however, lamellar grafts are safer, because they eliminate such complications as iris incarceration or prolapse, injury to the lens, secondary glaucoma, or endophthalmitis. In spite of the less satisfactory results, therefore, lamellar grafts are chosen when the factor of safety is exceptionally important; for example, in one-eyed persons and for aphakic eyes. For the same reason, they are selected for children or other patients who are likely to jeopardize the success of the operation by unruly behavior during the postoperative period. Lamellar keratoplasty is also preferred when the opacity is superficial, especially if the opacity is restricted to the pupillary area and the rest of the cornea is in good condition. Lamellar grafts are sometimes used when the operation is performed chiefly for cosmetic reasons. They are practical for removing superficial opacities which appear after penetrating keratoplasty. Although vision may be better if a penetrating graft is used, a lamellar graft benefits corneal dystrophies of the Fleischer, Groenow or Haab-Dimmer types, and also other dystrophies which do not involve the deeper layers of the cornea.

Unless lamellar grafts are clearly indicated by some of these considerations, penetrating grafts are preferred and are indicated in the largest proportion of cases.

INDICATIONS FOR KERATOPLASTY

With the knowledge available today, the surgeon can predict fairly accurately the chances of a successful operation on a particular eye. If, for example, the deformity or opacity is central and is surrounded by healthy tissue, the chances of success are high; at the other extreme, if dense scarring covers most of the cornea, especially if vascularization has become established, the chances of a successful outcome are limited. Eyes may be classified as (1) favorable, (2) moderately favorable, and (3) unfavorable.

Group I. Favorable

In this group about 90 per cent of clear grafts may be expected, with final vision usually over 20/50, and not infrequently achieving 20/20 or better. Favorable eyes include those with the following conditions:

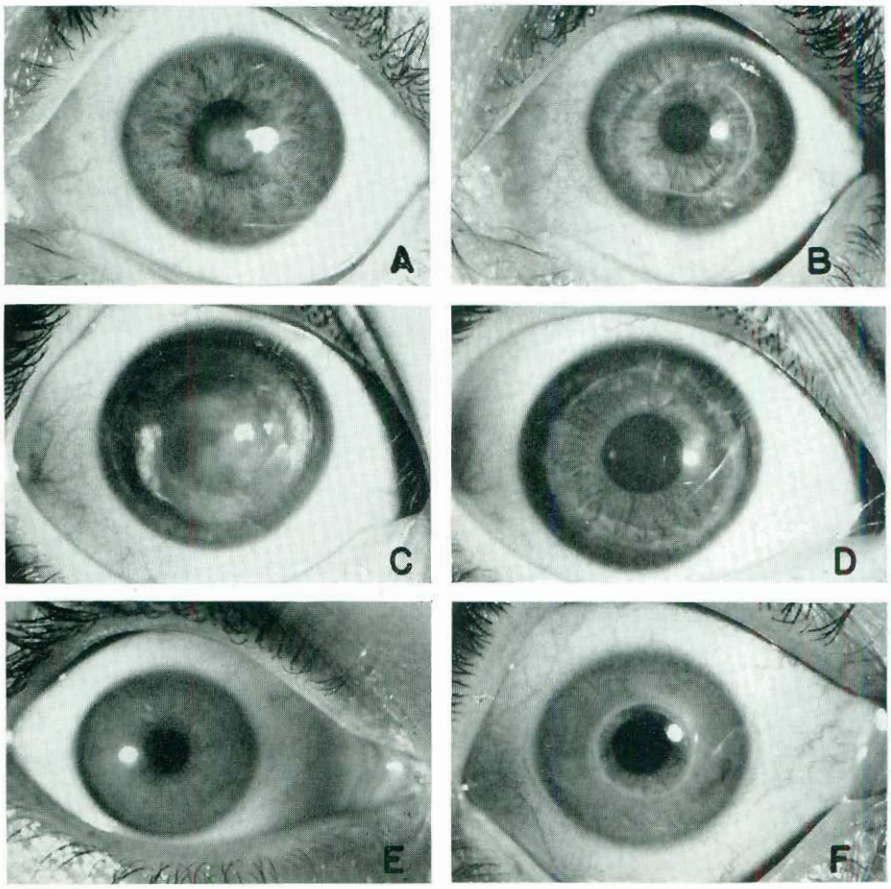

FIG. 1. Keratoplasties in favorable cases. *A*, central superficial corneal opacity following ulcer; *B*, after partial lamellar keratoplasty; *C*, superficial corneal opacity, sequela of recurrent keratitis; *D*, after partial lamellar keratoplasty; *E*, Groenouw's dystrophy; *F*, after partial penetrating keratoplasty.

(1) Central corneal opacities surrounded by healthy corneal tissue (Fig. 1 *A*, *B*, *C* and *D*).

(2) Keratoconus, if vision cannot be improved by regular or contact lenses, or if contact lenses are not tolerated. If the transplant is not large enough to replace the entire conus, the graft may heal unevenly with protrusion; in such instances a high degree of astigmatism or myopia may cause such poor vision as to defeat the purpose of keratoplasty (Figs. 2 and 9).

(3) Interstitial keratitis, if the opacity is not too dense and extensive so that the graft will be in contact with fairly healthy corneal tissue.

(4) Corneal dystrophies of the Fleischer, Haab-Dimmer and Groenow types (Fig. 1 *E* and *F*).

Group II. Moderately Favorable

Keratoplasty can be expected to give clear grafts, or at least considerable improvement of vision, in about half of all eyes with the condition mentioned

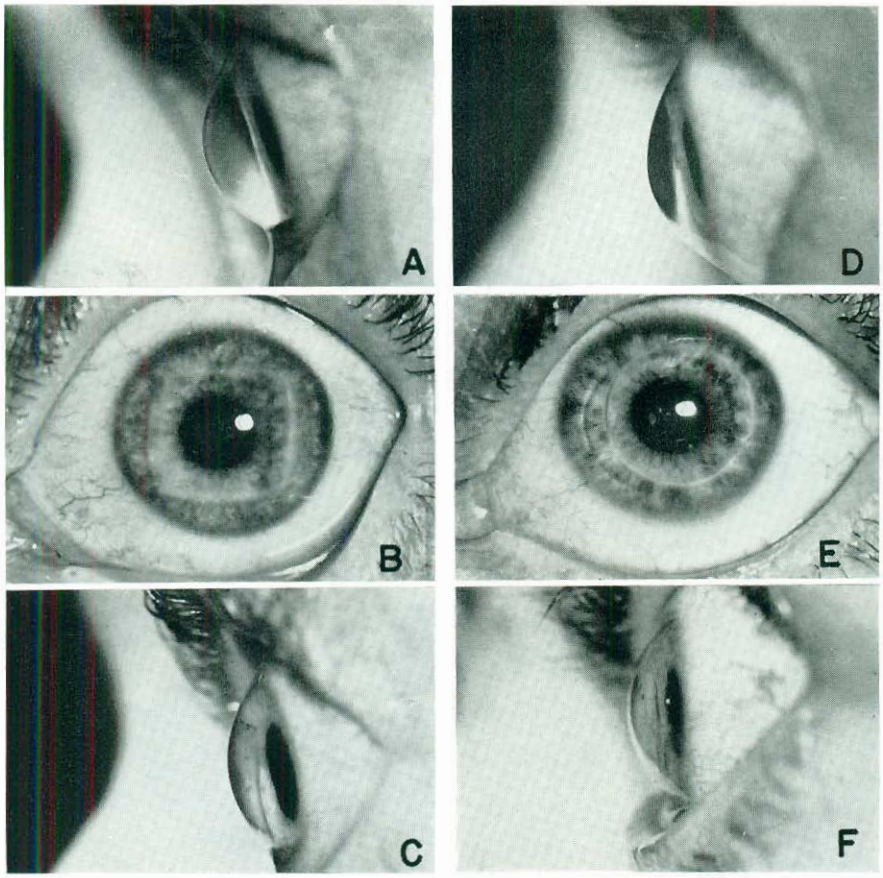

FIG. 2. Keratoplasty in favorable cases. *A*, advanced keratoconus; *B* and *C*, after partial penetrating square keratoplasty; *D*, advanced keratoconus; *E* and *F*, after partial penetrating circular keratoplasty.

below. (1) Superficial opacities extending over the entire surface of the cornea; if the epithelium appears healthy, the cornea is not superficially vascularized and it can be determined that most of the layers of the stroma under the opacity are healthy (Fig. 3 *A* and *B*).

(2) Tear-gas burns, if there is no pannus-like superficial vascularization and only a limited area of the superficial cornea is destroyed, leaving enough healthy tissue to nourish the graft.

(3) Adherent leukomas, provided the iris is freed from the corneal scar by preliminary operation before the keratoplasty is undertaken.

(4) Interstitial keratitis greater in extent and more densely opaque than in Group I, but with enough permeability remaining in the stroma to indicate that a graft should remain more transparent than the original diseased cornea (Fig. 3 *C* and *D*).

(5) Salsmann's corneal dystrophy.

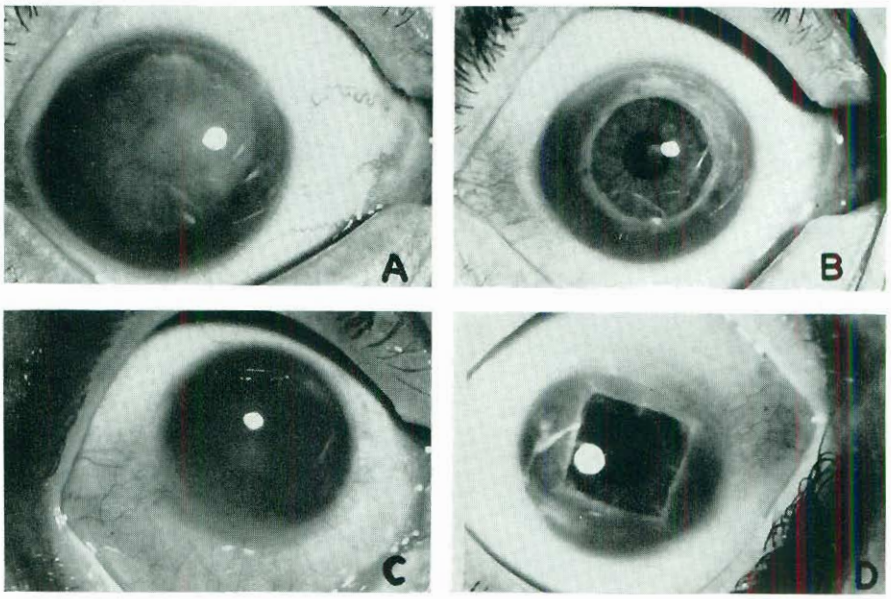

FIG. 3. Keratoplasties in moderately favorable cases. *A*, extensive superficial corneal opacity sequela of keratitis; *B*, after partial penetrating circular keratoplasty. *C*, interstitial keratitis, sequela of syphilis; *D*, after partial penetrating square keratoplasty.

(6) Fuch's epithelial and endothelial dystrophy, in the early stages and when only the center of the cornea is affected and the entire diseased portion can be excised (Fig. 4).

Group III. Unfavorable

Keratoplasty carried out on eyes with the conditions listed in this group is unlikely to be successful. However, in some instances preliminary operations to be described later may improve the chances of success enough to warrant grafting.

(1) Corneal scars which include the pupillary area and extend to the limbus. In these cases the graft is likely to become vascularized and the cornea opaque.

(2) Leukomas extensive enough so that over half of the graft would be adjacent to dense scar tissue in the host.

(3) Band-shaped, or other types of opacity, in eyes affected by active uveitis.

(4) Dystrophia adiposa: The implant is invariably invaded by the dystrophy and consequently becomes opaque.

(5) Deep, extensive tear-gas burns, especially if the eye is irritable and photophobic, and blepharospasm and lacrimation are present.

(6) Deep, extensive tattoo-like opacities caused by explosions.

(7) Opacities in aphakic eyes in which opacities are too deep for lamellar grafting, especially if intracapsular extraction has been performed. A full-thickness graft in such an eye is frequently complicated by incarceration of the iris, lens capsule, or vitreous, with subsequent development of cloudiness or opacity. If incarcerations do not develop some of these grafts may preserve transparency.

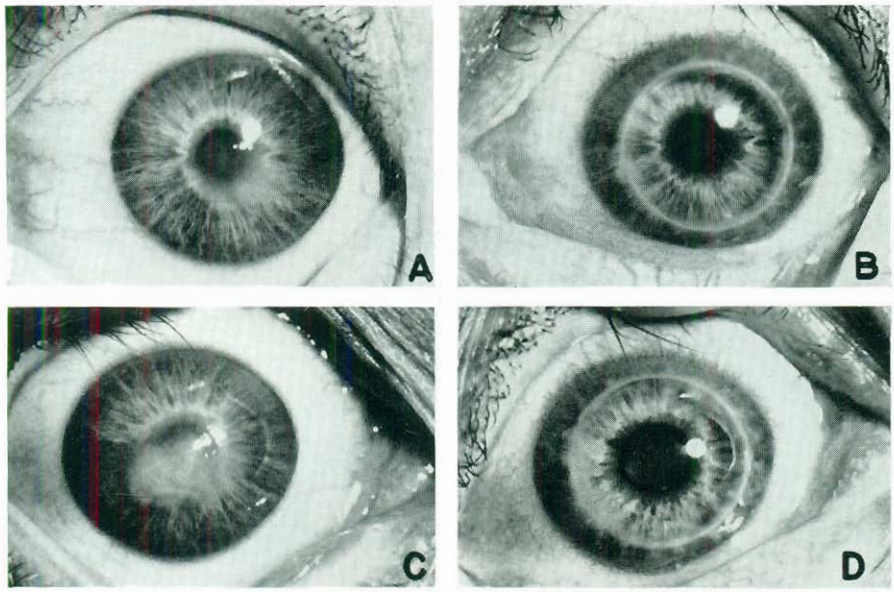

FIG. 4. Keratoplasties in moderately favorable cases. *A*, Fuch's epithelial and endothelial dystrophy affecting only the central portions of the cornea; *B*, after large partial penetrating circular keratoplasty; *C*, the fellow eye of the same patient also affected with Fuch's epithelial and endothelial dystrophy; *D*, after partial penetrating circular keratopalsty.

(8) Extensive opacities with superficial pannus-like vascularization, usually caused by chemical, flame, or molten-metal burns and accompanied by variable degrees of symblepharon and often intensive photophobia. Transplants in these eyes become opaque.

(9) Advanced Fuch's epithelial dystrophy, extensive opacities with calcareous degeneration, and opacity due to pemphigus.

(10) Opacity accompanied by anterior synechias if they are combined with increased intraocular pressure; if tensions can be normalized by preliminary operation, such eyes offer improved prognosis.

(11) Opacity of many years' duration, especially if it has been present since shortly after birth. These eyes usually have pronounced nystagmus so that, even though transplants may remain clear, a high degree of amblyopia prevents visual improvement.

PRELIMINARY TREATMENT OF UNFAVORABLE EYES

When the condition of an eye is very unfavorable to keratoplasty and the graft would otherwise almost certainly remain cloudy, a preliminary operation may improve the cornea structurally and make it more favorable for keratoplasty for visual improvement. If a cornea is superficially opaque and vascularized, the outer layers including the greater part of the abnormality can be excised, using a partial or total keratectomy. The open blood vessels at the periphery of the

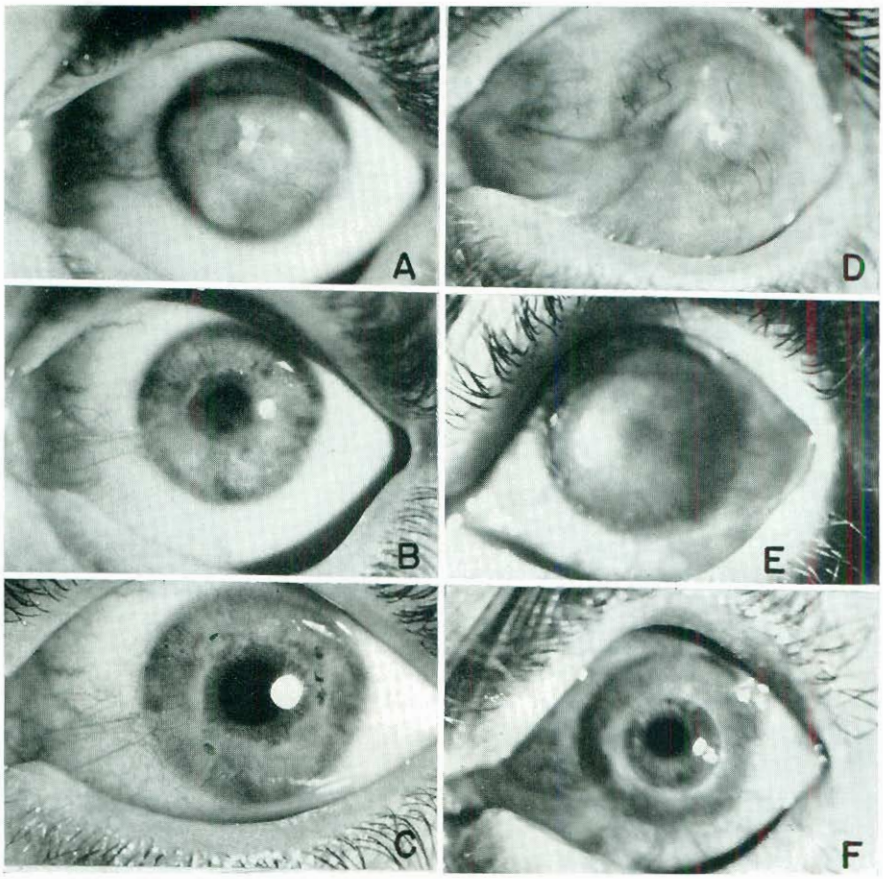

FIG. 5. Cases unfavorable for keratoplasty rendered more favorable by preliminary surgery. *A*, extensive vascularized corneal opacity; *B*, after partial lamellar keratectomy; *C*, after partial penetrating square keratoplasty; *D*, dense vascularized corneal opacity and symblepharon; *E*, after total lamellar keratectomy, plastic repair of conjunctiva and β irradiation; *F*, after partial penetrating circular keratoplasty.

keratectomy are then treated by β-irradiation to prevent revascularization. These procedures may improve the condition of the cornea sufficiently so that when the eye has become quiet a keratoplasty can be carried out with a fair promise of success (Fig. 5).

If an eye is severely scarred by burns and is affected, not only by dense vascularized leukoma, but also by symblepharon, the latter should be treated first by plastic repair, with or without mucous membrane transplants. The vascularized opacity should then be treated by lamellar keratectomy. β-Irradiation should be applied after operation to prevent the recurrence of vascularity. Finally, the cornea, thus greatly improved, is in a more favorable condition for an optical keratoplasty (Fig. 6).

If the symblepharons are not large, the bulbar conjunctiva, tarsus and fornix

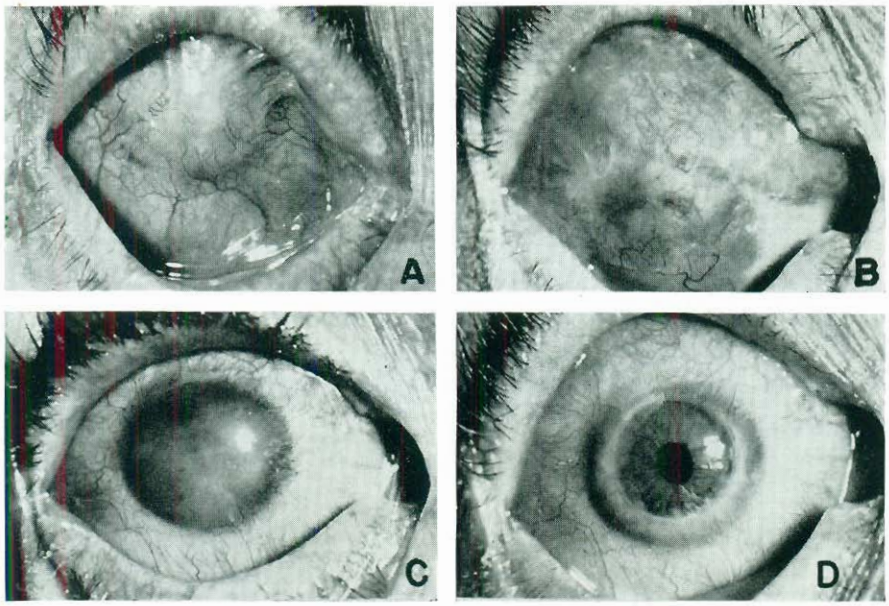

FIG. 6. Very unfavorable case for keratoplasty made more favorable by preliminary surgery. *A*, very dense vascularized corneal opacity with extensive symblepharon; *B*, after plastic repair of conjunctiva with mucous membrane graft; *C*, after total lamellar keratectomy and β irradiation; *D*, after partial penetrating circular keratoplasty.

can be repaired by sliding conjunctival flaps from the adjacent area. However, conjunctival material may not be sufficient for repairing both bulbar and tarsal regions if the symblepharon is very large. In such cases, the shortage is made up by free mucosal grafts taken from the same individual's buccal mucosa; material from the lower lip or lateral mouth surface is the best substitute for conjunctiva. The buccal graft should be cut slightly larger than the defects to be covered, and should be very thin; if either of these conditions is not met, structural correction and cosmetic effect will not be optimal. After it has been cut from the mouth, the graft can be placed on the finger with the epithelium next to the finger. The graft is then thinned as much as possible with fine scissors until little remains but minimal supportive tissue and the epithelium itself. A graft thinned in this manner is easily handled. It is placed in the eye, trimmed if necessary to fit the defect, and sutured into place. In suturing it is important to anchor each stitch to the sclera to insure smooth cicatrization and to prevent contraction of the graft. After a few months, the graft resembles normal conjunctiva, or, at worst, slightly congested conjunctiva. If, however, it has not been sufficiently thinned, it tends to contract and remains red, thick and unsightly.

Some eyes in the unfavorable group cannot be improved with a view to keratoplasty because of complicating conditions due to intraocular disease which cannot be corrected. Densely opaque corneas with extensive or total anterior synechias are of this type. However, if such eyes are not affected by secondary glaucoma and if light perception and projection remain good, a total penetrating

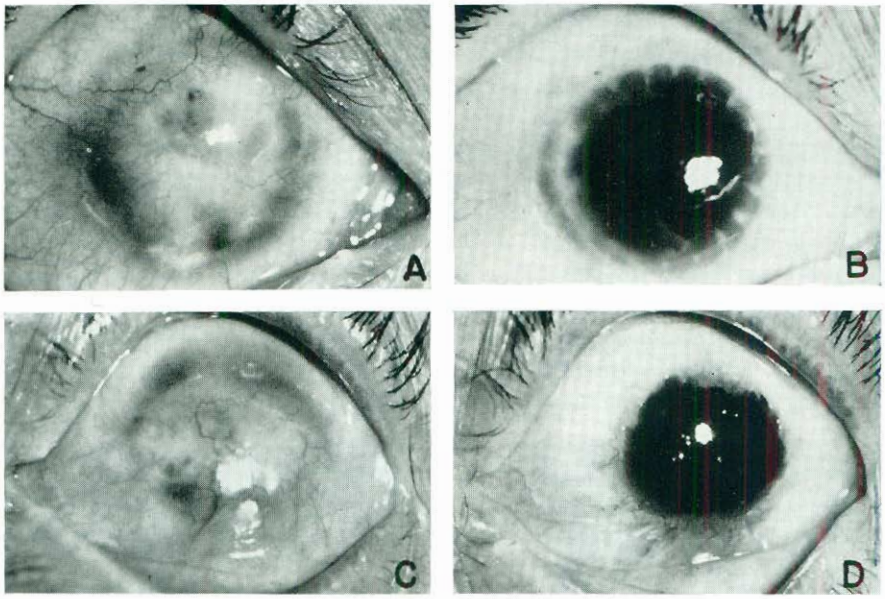

FIG. 7. Cases very unfavorable for keratoplasty with extensive vascularized corneal opacities and extensive anterior synechiae. *A* and *C*, before and *B*, and *D*, after total penetrating keratoplasty.

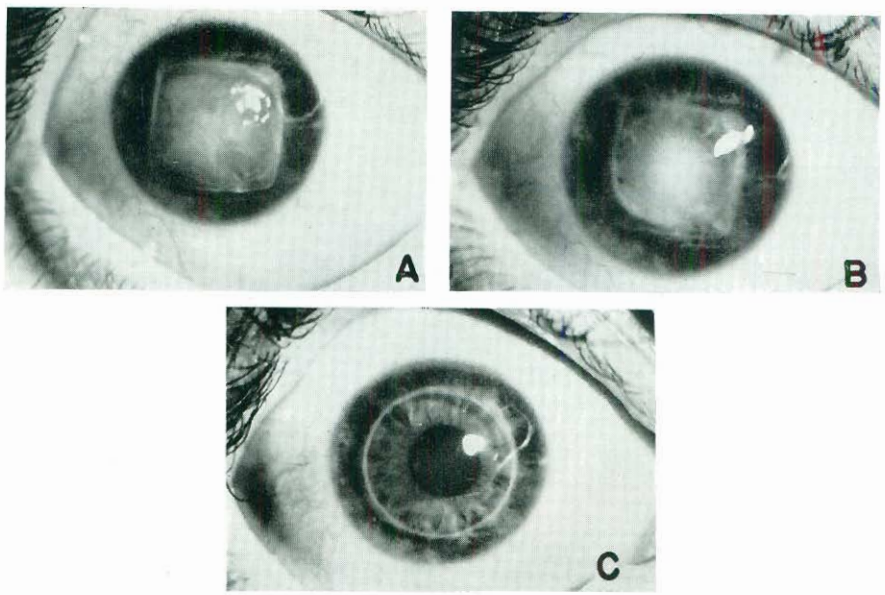

FIG. 8. *A*, opaque partial penetrating square keratoplasty; *B*, opaque partial penetrating circular keratoplasty within previous graft and *C*, third successful partial penetrating circular keratoplasty.

keratoplasty offers some chance of restoring vision, and is the only procedure which does offer any promise (Fig. 7).

RETRANSPLANTS

The graft may become cloudy because of protrusion, poor nutrition during recuperation, anterior synechias or postoperative uveitis. If complications such as opacity or vascularization which might interfere with permanent transparency of a new graft have not appeared in the surrounding cornea, these eyes may be improved by a second or sometimes by more retransplants (Fig. 8). A second transplant should not be considered, however, until the eye has become quiet after the first operation. At least six months, preferably a year, should be allowed.

If the first operation failed because the technic was erroneously selected, the failure may be corrected by using a more suitable technic for the second operation.

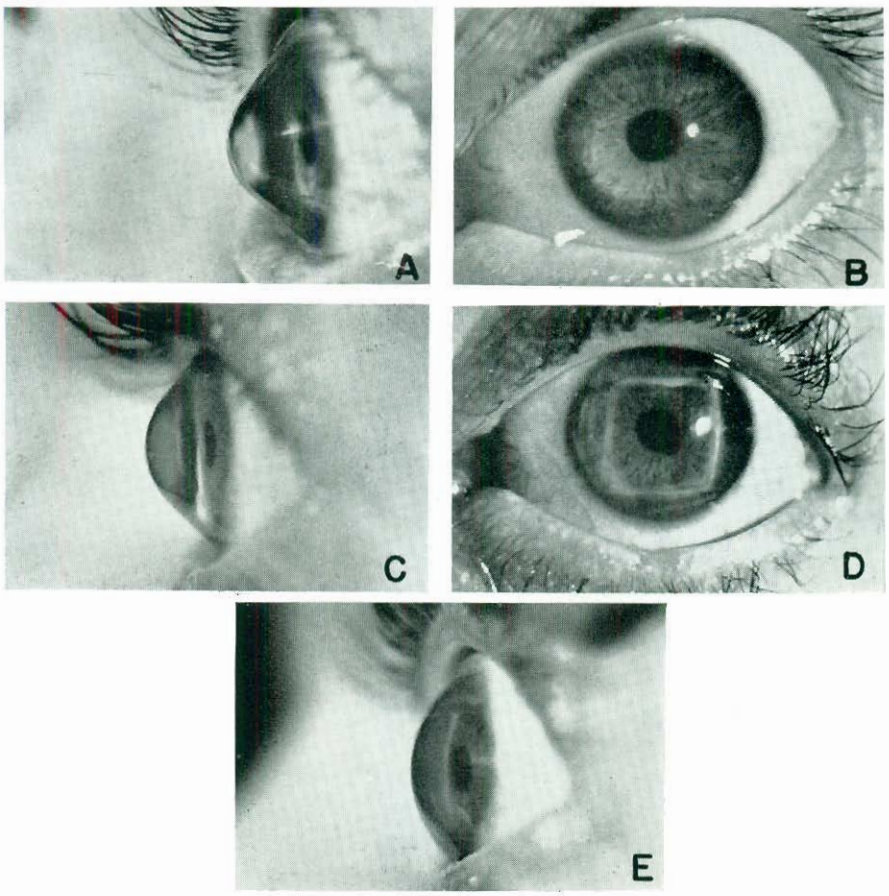

FIG. 9. *A*, case of advanced keratoconus; *B* and *C*, after partial penetrating square keratoplasty. The graft was too small to remove the whole conus resulting in poor vision. *D* and *E*, after a larger partial penetrating square retransplant which restored normal corneal curvature.

For example, if the first graft performed to correct keratoconus was not large enough to remove all, or almost all, of the conus, the graft may have remained transparent; but, because it was set in a protruding area, may have resulted in myopia or astigmatism severe enough to counteract any visual improvement due to the clarity of the graft. A second transplant larger than the first should improve the cornea structurally and restore the curvature to normal or near normal and therefore insure better vision (Fig. 9).

KERATOPLASTY FOR PURPOSES OTHER THAN VISUAL IMPROVEMENT

THERAPEUTIC KERATOPLASTY

If an irritable, inflammatory, or degenerative corneal disease does not respond well to conservative treatment, keratoplasty may stop or shorten the evolution of an acute torpid state or a recurrent lesion. Among the conditions which may benefit from therapeutic keratoplasty are corneal abscess, herpetic and disciform keratitis, acute interstitial keratitis, and traumatic lesions. If traumatic lesions are perforated or if Descemetocele or perforation are imminent in cases of progressive ulceration, emergency transplantations are indicated (Fig. 10).

RECONSTRUCTIVE KERATOPLASTY

A reconstructive graft is indicated when the eye is very unfavorable to keratoplasty because the cornea is in poor condition. The reconstructive graft is used to improve the cornea structurally and is followed by a final optical keratoplasty. Severe burns are the best indication for this type of graft. Superficial layers of opaque vascularized cornea are excised, using partial or total lamellar keratectomy, and replaced by a lamellar graft of the same dimensions as the excised corneal tissue. If the lamellar graft does not improve vision enough for practical purposes, the structural improvement of the cornea renders the eye more favorable for a final partial lamellar or penetrating keratoplasty performed to improve vision.

KERATOPLASTY FOR COSMETIC IMPROVEMENT

Occasionally eyes with corneal opacity dating from early infancy, and therefore very amblyopic, may require a partial corneal transplantation only to im-

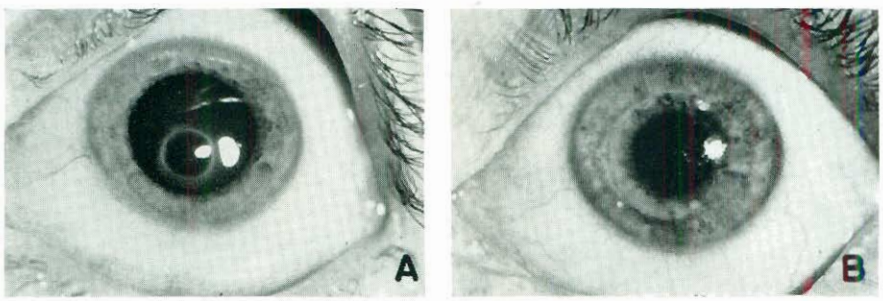

FIG. 10. Case of Descemetocele. *A*, before and *B*, after partial penetrating circular keratoplasty.

prove the eye cosmetically. A total penetrating keratoplasty may be performed in some blind eyes with extensive staphyloma in a final attempt to improve appearances before resorting to enucleation.

TROPHIC KERATOPLASTY

Corneal transplantation may have a beneficial effect on the host tissues, and in some instances may clear areas of opacity adjacent to the graft. For this reason, some surgeons have implanted corneal tissue next to grafts which have become cloudy in order to clarify them, or in the hope of speeding the clearing process which would naturally occur in time if no irreversible changes, such as fibrosis, have developed.

CONCLUSION

Clinical keratoplasty in man is no longer in an experimental stage. Thousands of cases reported have proved that corneal grafts can be successful in a very high percentage of favorable cases when suitable technics are used. The indications for keratoplasty are becoming more numerous almost daily. Many unfavorable cases which only a few years ago were dismissed as unsuitable for successful grafting can at present be rehabilitated by combined procedures of plastic and conjunctival repair, keratectomy and keratoplasty.