

**SOME TECHNIQUES IN CORNEAL GRAFTING**

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**SUMMARY**

*Some of the special procedures adopted in both lamellar and full-thickness keratoplasty are described, and several cases presenting unusual features and requiring an unusual approach are discussed.*

The title of this paper indicates its scope. The intention is to mention a few details we have found worth noting, and emphasize a few of the lesser-known uses of corneal grafts. At times one has had to improvise or temporize.

**CUTTING THE DONOR GRAFT**

In the full-thickness graft the circular trephine is opened up to at least 3 mm and a few bold sweeping rotatory movements will ensure a clean cut at the endothelial surface as possible. It should never be necessary to complete the section by scissors or other means. The endothelium must not be torn or shifted from the under-surface by a blunt edge or shaky hand.

In a donor eye the corneal surface flattens before the trephine and results in a trephine hole with sides sloping inwards, and hence a donor disc with an inside diameter slightly less than outside (Fig. 1).<sup>1</sup>

IOP (H <sub>2</sub> O per inch)		Equivalent (mm Hg)
5		7
10-15		18-27
15-20		27-37
20-25		37-46
25-35	No constant shape	46-64
35-40		64-74
45-50		83-92

Fig. 1. To show how the cut edge of donor disc varies with the intra-ocular pressure.

The eye holder or stand is well known, but we use here a cover (designed by Dr R. L. H. Townsend) to fit over and clamp the eye, with the cornea exposed in a circular aperture. This enables one, with pressure, to

cause the cornea to become taut, and in practice one can simulate as nearly as possible the intra-ocular tension of the recipient.

In this manner the apposition of the graft to the host cornea is as satisfactory as possible. It is in fact much more important for the deep edges to meet flush than the superficial edges. A gap in the internal junction will lead to hydration of the stroma and oedema of the epithelium (one form of Fuch's dystrophy). This question assumes

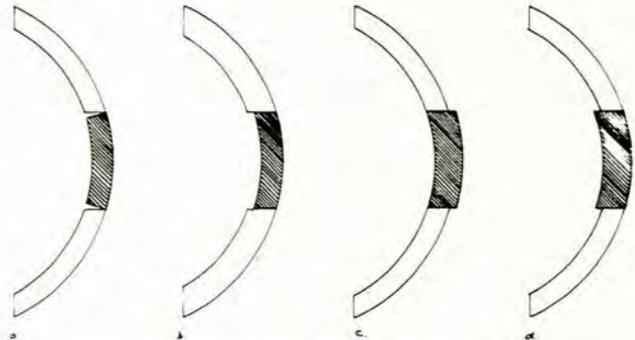


Fig. 2. Variations in donor disc thickness and apposition to host (diagrammatic).

importance, especially in thin fibrous or ectatic corneae, such as keratoconus, keratoglobus and bulging fibrotic corneae. The position shown in Fig. 2(d) is much less likely to end up satisfactorily than the one shown in Fig. 2(c).

I have seen a thick cornea, protruding from the surface of the trephine hole, flatten eventually and remain clear.

In moderate cases of this nature it may be possible to place a 7- or 8-mm graft in thick corneal stroma, but in extreme cases it may be advisable first to place a tectonic lamellar graft in order to obtain a more uniform thickness, preliminary to a full-thickness graft later, if necessary, because often such a lamellar graft may give an excellent optical quality.

In every case the thickness of the cornea must be measured before proceeding with a graft.

In a fibrous cornea a fact easily overlooked is its non-rigid nature. One has faced the situation where the graft is ready and the recipient trephined with the same trephine, only to encounter a gaping hole with collapsing edges, obviously too large for the graft. In these cases it is much better to cut the graft with a slightly larger trephine to ensure a snug fit. For this reason I think it is better to have the trephine diameters stepped up in 0.5-mm stages.

It is never possible to make a clean complete section of the recipient cornea—certainly not by hand trephine. I found a razor-knife very useful for completing this section, and less cumbersome than scissors. For this purpose a central 6/0 silk suture through the superficial layers of the cornea to be removed, tied with one knot and cut about 2 mm short, enables one to lift the disc and see the remaining adherent endothelial section.

In lamellar grafting the donor disc presents much less difficulty than the recipient bed. Even so, I have always thought a clean-cut undersurface of a graft important in securing a good optical union.

A device which I call the lamellotome<sup>2</sup> has enabled me to cut many a clean-looking graft of whatever thickness required in as short a space of time as one may reasonably wish for. The graft is of uniform thickness, the undersurface is clean-cut and the edges are undamaged by forceps grip.

When it comes to the recipient, one has to use hand cutting methods. Here it may be possible to obtain an even bed by tearing out the disc, bearing in mind that a scarred cornea may not be of even thickness, nor will it separate along a plane so simply.

The operating microscope is indispensable. In deep dissections it will enable one to detect a weak spot, or even an incipient leak, early.

In such cases, where the thickness of a cornea has been guessed rather than measured, and the section reaches the Descemet's layer or threatens to perforate, one may take a precautionary step and suture the graft into its place for about one-third its circumference, and then dissect the host disc from the opposite end so as to leave the very thin spot for the last. If it should develop a leak at separation of the disc, the donor disc can be put firmly into position and sutured with a minimum of delay.

Such a leak does not necessarily mean a damaged graft. It may heal by growth of the host endothelium and we have a few such cases that have turned out well.

Not the least essential component of a successful graft operation is the suturing. We use here almost exclusively 8/0 virgin silk on a special needle, and I find this quite thin enough. There are thinner materials up to 10/0 gauge, but I have not used these. It seems to me the danger of cutting out with tension on the sutures is greater.

Edge-to-edge suturing has now replaced overlying sutures or the graft splint. The former can leave permanent suture tracks over an otherwise clear graft. The latter does not ensure snug apposition and may similarly leave a permanent haze on a graft if left too long. The minimum time lapse for removing sutures is 25 days, but with the use of virgin silk a patient may even be sent home with his sutures *in situ* to return later for removal.

A useful hint is to try to place the knot outside the junction line and away from the graft. The continuous suture has no advantages over the interrupted one. A loosening or tear-out at one point will slacken the whole suture and jeopardize the union. It looks prettier and has the doubtful advantage of no loose tags and less irritation.

#### TYPES OF GRAFTS IN SPECIAL CASES

##### 1. Recurrent Pterygium

The use here is well known and needs no elaboration. The graft may be shaped, but I have always found the circular graft quite suitable even if a fair portion lies on the sclera.

A point to remember is that in some cases the underlying cornea is very thin, and, being fibrous and opaque, its thickness cannot be gauged accurately. The host cornea

therefore needs only be scraped within the circular demarcated circle to receive a thin (0.1 or 0.2 mm) lamella.

*Case 1.* A White female aged 55 years had had three previous operations for a pterygium of her right eye. In trephining the denuded area of cornea to place a 7-mm lamellar graft, I perforated the thin cornea at the pupillary sector, and aqueous flowed. I sutured the wound and merely laid the graft over the whole area and sutured it down. Healing was uneventful. Visual acuity was corrected to 6/9 in spite of distortion and encroachment of the fibrotic process on the pupillary area.

There has been no recurrence and inspection shows an attempt at vascular invasion 'foiled' by the graft—a large vessel was seen to turn back on its course.

##### 2. The Shaped Graft

By a 'shaped' graft I mean a tailor-made graft, fashioned to cover a special area of the cornea. This has been attempted in Mooren's ulcer and in a case of heat trauma. This procedure applies particularly in lesions where the central cornea is spared.

*Case 2.* A Coloured male, aged 25 years, when first seen had a marginal area of cornea eroded deeply by a Mooren-type ulcer that was threatening to perforate.

After two failed consecutive flap operations a lamellar graft was fashioned by hand and was placed over the eroded area after it had been scraped. The graft took well. Two months later a new erosion developed at the junction with host cornea and extended round the limbal area.

A further shaped lamellar graft was placed after scraping and carbolicizing the ulcer. This settled down well and he went home to the country. We have lost trace of him.

This is not claimed as a success, but it does show that the graft can heal and re-inforce the eroded area, and I believe a more extensive procedure at the first attempt, such as a total ring lamellar, leaving the pupil clear, would have controlled it permanently.

*Case 3.* A Bantu male aged 48 years sustained a heat burn of the whole medial conjunctiva and portion of the cornea of his right eye. The result was a large pseudo-ptyerygium extending from about 1 to 5 o'clock on the limbus, with the point very near the centre of the cornea. It was vascular and irritating.

The cornea was stripped of conjunctiva to the limbus and exactly half of a 10.0 × 0.2 mm lamellar graft, with a 3-mm cut-out for the pupil, was placed over a similarly prepared area of the damaged cornea, resected very shallowly.

The graft settled well. The eye remains quiet and the vision is unchanged at 6/12.

##### 3. The Conjunctival Flap (after Gundersen)

This is a type of conjunctival flap, described by Gundersen of Boston, and devised by him as a means of treating such chronic ailments of the cornea as bullous keratopathy, herpetic keratitis, filamentary keratitis and recurrent erosions.

It is essentially a thin, carefully dissected strip of bulbar conjunctiva brought down from the upper portion of the eyeball and laid horizontally across a cornea cleared of epithelium and of superficial diseased tissue. It is sutured

in place and is intended to be permanent and to supply the cornea with a 'healthy' epithelium (Fig. 3).<sup>3</sup>

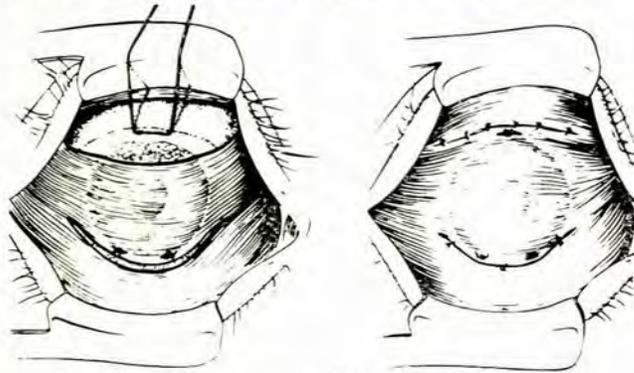


Fig. 3. The conjunctival flap of Gundersen.

He claims it has a strong healing action and relieves pain in bullous keratopathy. In the course of time it wears very thin and becomes entirely transparent.

The object in mentioning it here is to show the use to which we put it in a case of persistent herpetic keratitis where the herpes recurred in a virulent form after a lamellar graft.

*Case 4.* A White male aged 51 years was subject to recurrent herpes corneae. The visual acuity was less than 6/60. The left eye had had a central nebula since childhood and was deemed amblyopic.

Six weeks after a  $7 \times 0.3$  mm lamellar graft in the right eye was placed, ulceration occurred in the graft junction. A total thin conjunctival flap was sutured over the cornea after the infected graft had been removed. Four months later the flap was thin to the point of transparency. It was then dissected off leaving a rather uneven corneal surface.

Five months later a  $8.1 \times 0.35$  mm lamellar graft was placed. After a fitful start the graft cleared and remained healthy.

Four years later I found him wearing a contact lens on this cornea, and the vision was 6/9. There were signs of erosion of the graft epithelium of which, of course, he was unaware, but he failed to report for treatment.

Fortunately for his graft, he lost his contact lens and was reduced to vision of 6/36, which could however be corrected to 6/9 by lenses. There was no corneal sensation.

#### 4. The Temporary Therapeutic Graft

Some corneal degenerative states are not suitable for a full-thickness graft owing to the poor quality of the corneal substance. A preliminary lamellar graft will exercise a therapeutic as well as a tectonic function.

*Case 5.* A White female aged 54 years had had a corneal degeneration since early youth, labelled by us as a lipid dystrophy, from microscopic sections. The patient was a registered blind person. Visual acuity was counting fingers only in both eyes.

In the eye appearing the worst a 5-mm full-thickness graft was placed which remained clear, but never united. On removal of the splint used, it lifted, and was resutured on two occasions, and still failed to unite. In the end rising tension and pain caused the removal of the eye.

The other eye still had hand-movement vision, but showed increasing vascular invasion.

A total  $11 \times 0.2$  mm lamellar graft was applied after clearing the superficial layer of the cornea and the surrounding limbal overgrowth.

The graft remained clear for nearly a year, when evidence of recurring vascularity and increasing discomfort led to a decision to 'do something', at the patient's request.

A 7-mm full-thickness graft was done. The graft has remained clear, and more than a year later she is still very comfortable and the corrected visual acuity is 6/60. This, however, is not a true indication of the much improved visual capacity and comfort. The intention here was to demonstrate the value of the tectonic lamellar graft preceding a subsequent full-thickness graft.

#### 5. The Stop-Gap Graft

In repairing a weak spot in the cornea it is of prime importance to preserve the visual acuity which may be very good in spite of a peripheral and potentially dangerous weak spot, such as a descemetocele.

A small full-thickness or deep lamellar graft will plug the site.

*Case 6.* A young White woman aged 20 years had a deeply embedded foreign body removed from her cornea leaving a crater quite unusually deep, with vertical edges, and showing little more than Descemet's membrane in the floor. It was about 2 mm in diameter and situated just medial to the pupillary area in the right eye. The visual acuity was 6/9 unaided.

I was asked to do something—and decided to leave well alone. Sometime later she presented with a huge descemetocele caused by a blow from her baby's fist. The herniated iris was clearly seen and the eye was sensitive. The situation called for some action.

A  $5 \times 0.3$  mm lamellar graft was laid over the descemetocele after dissecting away the immediately surrounding cornea in order to take the edge of the graft.

At the operation only the iris was seen to line the gap. The graft took well and more than a year later the cornea showed a flat surface and although the graft was not clear and the adherent iris still caused a disfiguring mark, the unaided vision was still 6/9.

#### 6. The Reinforcing Graft

Here I wish to mention particularly keratoconus and keratoglobus. I am aware that the ideal graft in these cases is a full-thickness graft large enough to abut on a portion of the peripheral cornea that is of normal thickness. However, several workers have shown the value of a lamellar graft placed first to strengthen the thin cornea, and in a proportion of cases this may turn out to be optically very good.

In extreme cases, where thinning of the cornea extends almost to the limbus, for technical and physiological reasons the graft is bound to fail owing to poor apposition.

Here one may attempt to fashion a thicker cornea as a whole by a large lamellar graft. The technical difficulties became strikingly clear to me in the following case:

*Case 7.* A White female aged 35 years presented with advanced bilateral keratoglobus. It had already been apparent in 1948, when she travelled to New York to see

Castroviejo. He advised contact lenses of the haptic variety, in order to span the bulge of the cornea.

These functioned very well for many years until the increasing bulge of the cornea caused corneal friction and discomfort. At the time we saw her the right lens could no longer be tolerated and the left lens could be worn only for periods, giving, with addition of spectacle lenses, a visual acuity of 6/36.

The corneal thickness was measured and found to be 0.35 mm in the centre (it appeared even thinner) and 0.7 mm at the limbus. It was decided to attempt a total lamellar graft in order to produce a thicker cornea, with a view, perhaps, to a full-thickness graft later.

An 11 × 0.3 mm lamellar graft was laid over the cornea which was very delicately stripped of its superficial layers. The bulge of the cornea was reduced by paracentesis and the graft sutured in position by 20 8/0 virgin silk sutures.

The immediate postoperative appearance was a much flattened curvature. The corneal thickness was now shown to be 0.65 mm in the centre. Three weeks later this flattening was not sustained, and the bulge appeared almost as before.

There is a distinct ridge at the edge of the graft, but it has taken well and sits firmly. The patient assures me that the excursion of the upper lid over the cornea is now more comfortable than before. A fair view of the fundus is possible and the corrected visual acuity is 6/60.

Obviously the operation has failed to fulfil our original hopes. The natural intra-ocular tension has resulted in an extension of the curve, even though this tension has never been high.

It may be possible in future to consider a full-thickness graft, but a lapse of time is necessary to ensure that the whole structure is not thinned as before. In theory, a large (11.0 mm) full-thickness graft may be preferred to a smaller one. The central area of the cornea is still streaked with folds of Descemet's membrane.

In another case, a keratoconus which had been subject to an episode of acute hydrops received an 8-mm lamellar graft which turned out to be optically so clear as to obviate the need for any further action.

#### 7. The Therapeutic Optical Graft

I have mentioned above the tectonic graft which turns out to be a good optical graft. There is a type which may be applied for its therapeutic effect and turns out to be a good optical procedure.

The principle here again is to resect all affected corneal material as deeply as possible and clear the surrounding limbus, if necessary, before applying a lamellar graft.

*Case 8.* A 6-year-old Coloured female showed gross bilateral overgrowth of epithelium and vascularization, raised at the limbal area, so as to justify the tentative diagnosis of hypertrophic 'spring catarrh' of the bulbar type. Visual acuity was certainly less than 6/60 and probably only hand movements.

Both eyes received a large lamellar graft (9 mm and 10 mm respectively) after stripping the whole of the superficial portion of the cornea and surrounding limbal overgrowth. The bed prepared for the graft revealed a thin layer of cornea which was almost entirely Descemet's membrane. At this stage the iris and anterior chamber

were clearly visible.

The result in both eyes has been very satisfactory. One cornea has retained a patch of cloudiness, but this turned out to be a squinting amblyopic eye.

The transparency of the cornea has now markedly improved and we were able to provide lenses by retinoscopy.

#### FULL-THICKNESS GRAFTS

These are commonplace and there is no need here for detailed descriptions of technique. Some of the basic principles have already been mentioned.

An interesting and very useful type of full-thickness graft is the rotating autograft. Admittedly, the occasion does not often arise. It requires a sector of the affected cornea that is clear and extends from just short of the central area to the limbus. In this way an eccentrically

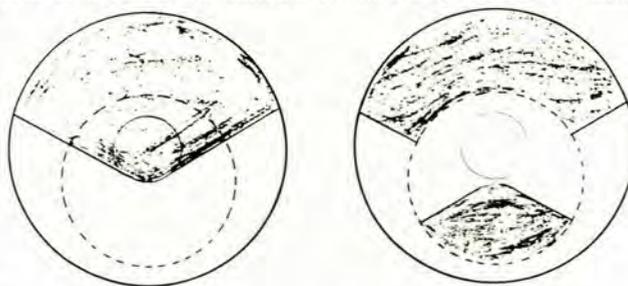


Fig. 4. Rotating autograft (diagrammatic).

placed disc of host cornea can be rotated so as to bring the transparent portion in front of the pupil. Here one must be careful to place sutures in such a way as not to diminish the value of such a procedure (Fig. 4).

*Case 9.* A Coloured female aged 38 years sustained extensive burns on the face when her bedclothes caught alight after she had been smoking in bed and fallen asleep.

After a great deal of reparative surgery by the plastic surgeons, she ended up with corneal scarring from exposure keratitis as well as burns.

A rotating autograft was performed in the left eye and vision was considerably improved. She was a derelict of society and her progress was difficult to control or even follow. She subsequently developed cataract in both eyes, but we have lost sight of her.

The total or subtotal full-thickness graft in desperate cases may require a special approach. Occasionally one comes across a case where both corneae have been extensively damaged by disease or degeneration or trauma, or a combination of these, and there is evidence of adequate function behind the lens-iris diaphragm. In such cases the patient's vision is reduced to shadows only, and he has nothing to lose by a large full-thickness graft fixed to relatively healthy corneae near the limbus.

In aphakic cases the vitreous must be handled properly as it lies exposed behind the cornea, and in phakic cases there may be an adherent leucoma with secondary cataract, which must be removed at the same time.

In these conditions good hypotension is essential. I have not used the Flieringa ring, mainly because of the added time factor and the trauma to the eyeball, as well as more traction-suture impediment than I like. I prefer to fix the eyeball at the four rectus muscle insertions. This gives

adequate immobility. We use intravenous Diamox, or urovert if necessary.

The disc cannot be cleanly trephined out in such a soft eye and a good deal of use is made of the scissors or razor-knife. Adherent iris must be abscised freely, and if there is a cataractous lens, it is removed by cryophake.

Both here and in aphakic cases vitreous anterior to the iris must be swept away or lifted on a sponge so as to clear the angle as far as possible. Four large peripheral iridectomies are performed when the iris is intact.

Here it is useful to remember that the hole gapes and a graft somewhat larger than the hole may be an advantage, as I have already mentioned. As many sutures as possible must be inserted—ideally 24 in such a large graft.

It is my custom always to introduce air behind the cornea in a full-thickness graft, unless I can see the anterior chamber forming. This is done by a preplaced oblique puncture just in front of the limbus using a Rycroft needle. This will separate the iris and vitreous from the posterior corneal surface and open the angle.

In very large grafts this may not be possible and here it is better to introduce the air by a cyclodialysis route, entering some 4 mm behind the limbus and, of course, entering the anterior chamber at the angle.

*Case 10.* A White male aged 65 years was sent to us from a distant part with gross bilateral corneal degeneration and bullous keratopathy which developed, as he stated, after operations for cataract followed by needling. Both corneae were white and irregular for most of their extent, except for a narrow paralimbal strip.

The right vision was hand movements only, the left had no perception of light. In the right eye an 8.1-mm full-thickness graft was placed in an 8-mm trephine cavity. Intravenous urovert was used. Vitreous protruded through a large gap in the posterior capsule, of which some remained. This was abscised, leaving a clear vitreous-iris diaphragm.

Four weeks later the graft was clear and corrected vision 6/36. Slit-lamp examination showed some vitreous in front of the iris, but it had some sort of 'face' and there was aqueous between it and the cornea. Our latest

information is that the cornea remains clear.

Overlying sutures are no longer used, and if they are, then only during the operation in larger grafts in order to hold the graft in position to prevent excessive bulging of the iris diaphragm. After all the edge-to-edge sutures have been tied, the overlying sutures are removed.

The autograft, of course, is the most gratifying of all grafts. Wherever possible, the blind eye should receive the disc from the other eye unless it is very degenerate or calcified or too thin, because it will take much more readily than a homograft and the patient is no worse off cosmetically. The only disadvantage is a puzzling appearance after the operation, owing to an apparent transposition of the eyes!<sup>4</sup>

*Case 11.* A Coloured man aged 50 years was sent to us from the platteland, with a blind right eye with a clear cornea and a left eye with very poor vision and a scarred cornea from long-standing ulceration.

A cross-over autograft was performed and the result has been highly satisfactory. He can now see to get around and help himself. The poor cornea has been placed on his blind eye, which is no worse off than before.

#### CONCLUSION

The conditions discussed and the cases presented serve to illustrate the wide variety of types of corneal disease one encounters in a large general hospital which serves a large area of the country. In each case an assessment has to be made of the peculiar needs of the patient and a decision reached as to the best procedure for re-establishing useful vision, whether by a preliminary graft or a final functional optical graft.

I am sure that many other hospitals in the country present equally challenging opportunities for those who wish to promote the restoration of visual function by providing a healthy transparent cornea.

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