TWO-LEVEL KERATOPLASTY

José I. Barraquer M.

TWO-LEVEL KERATOPLASTY is a modality of full-thickness keratoplasty which is characterized by a difference in the size of the graft at the level of the anterior and of the posterior layers of the cornea (Figure 1).

The graft consists of a peripheral laminar portion (wing), and a central portion which includes the entire thickness of the cornea.

The operation is performed by one of three modalities, each one of which has its characteristics and proper indications (Figure 2).

1. Stepping graft.
2. Mushroom graft.

The preparation of the patient, condition of the pupil, quality of donor material, use of adequate instruments, technique of sutures, etc. are common to all previously described techniques of keratoplasty and, to avoid repetition, shall be omitted. On the other hand, these techniques are difficult to perform, except for surgeons who are expert in corneal surgery.

STEPPING GRAFT

CHARACTERISTICS

The stepping graft is characterized by a slight difference between the dimensions of the graft at the level of the epithelium.
and of the endothelium (two millimeters as a maximum) (Figure 2).

HISTORY

Carrel and Eberling in 1921 (5) suggested the use of this technique, but it did not go beyond the point of an experimental curiosity. (One transparence in five cases reported) (Figure 3). A. Apollonio in 1948 (1) described his technique. José I. Barraquer in 1955 (2) described his own, which he had been using for more than five years (7, 10).

SCOPE

1. A hermetic closure of the anterior chamber to prevent biophysical complications.
2. To diminish the number of edge-to-edge stitches for the purpose of lessening the irritation they cause.
3. To diminish the endothelial surface and the volume of the graft to prevent biochemical complications.

INDICATIONS

The same as those of full-thickness keratoplasty.
Figure 2. Different kinds of two-level keratoplasty: A. Stepping graft, B. Mushroom graft, C. Posterior two-level graft.

Figure 3. Carrel's technique.
APOLLONIO'S TECHNIQUE

INSTRUMENTS

I use a specific instrument, a double concentric trephine: 5 mm. outer and 3 mm. inner trephine.

SURGICAL TECHNIQUE

Delimitation. With the concentric trephine both delimitations are simultaneously performed up to half the thickness of the cornea: on the epithelial face in the recipient and on the endothelial face in the donor cornea.

For this purpose the donor cornea has been previously resected in toto and has been fixed with the endothelial face upward, on a flat base of cork, by means of pins.

Resection. Laminar resection of the corneal ring which is confined by the two delimitations and which includes half the thickness of the cornea. This resection is performed on the epithelial face in the recipient and on the endothelial face in the graft.

Trephination. Section of the remaining corneal layers with a simple 5 mm. trephine for the graft and 3 mm. for the recipient.

Fixation. Placing the graft in its bed and fixing it by means of an inverted conjunctival flap, which is secured by retention sutures.

RESULTS

Apollonio performed the operation with this technique on 18 patients without occurrence of anterior synechiae in any of the cases.

BARRAQUER'S TECHNIQUE

INSTRUMENTS

This technique makes it necessary to use both a special trephine and a normal trephine. The special trephine (7) is provided with a noncutting concentric outer guard. The normal trephine has an inner piston of the same dimensions as those of the outer guard of the special trephine (Figures 4 and 5).

The difference of dimension between the two sections is from 0.5 mm. to 1.6 mm.
Up to the present, the operation has been performed by using the following dimensions:

<table>
<thead>
<tr>
<th>Trephine</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>External delimitation</td>
<td>8,2</td>
<td>8,1</td>
<td>7,0</td>
<td>6,5 mm.</td>
</tr>
<tr>
<td>Internal delimitation</td>
<td>6,6</td>
<td>6,5</td>
<td>5,5</td>
<td>5,0 mm.</td>
</tr>
</tbody>
</table>

Trephines Number 1 and 2 are used at the same time to correct the pre-existing defect of refraction.

<table>
<thead>
<tr>
<th>Trephine</th>
<th>Myopes</th>
<th>Hypermetropes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recipient</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Graft</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

OBTAINING THE GRAFT

*Anterior delimitation.* The surgeon holds the donor eye with his left hand. Then, with his right hand, and by using a
normal trephine of the same dimension as that of the outer guard of the special trephine that is to be used, he performs delimitation of the anterior layers of the donor eye as in an anterior lamellar keratoplasty. The inner piston of the trephine is regulated at a penetration of 0.3 mm. This regulation should not be modified, so as to use the same penetration in the recipient eye.

**Dissection of the wing.** On the donor eye, fixed by the assistant, the surgeon dissects, with the piriform spatula, a wing one millimeter in width along the entire perimeter of the delimitation, as if it were to begin an anterior lamellar keratoplasty.

To facilitate this maneuver, the right half of the delimitation is dissected first. In continuation and after the globe has been rotated 180°, the other half is dissected. In this way the surgeon will always be able to dissect the wing with his right hand. It is very important to obtain a wing of equal thickness throughout the entire perimeter, thus preventing occurrence of astigmatism.

**Curling the wing.** Once dissection of the wing is complete, a continuous suture from 12 to 6 o'clock is inserted at its free edge, so that when the suture is tied, the wing curls upward taking the form of a flower (Figure 6).

**Section of posterior layers.** To accomplish section of the posterior layers, the surgeon again holds the donor eye with his left hand and places the trephine with the guard upon the globe, exerting as little pressure as possible to maintain hypotony in the

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**FIGURE 6.** Flower made of the folded wing by means of a continuous suture.
TWO-LEVEL KERATOPLASTY

Figure 7. Application of the trephine for the obtention of a stepping graft. A. Application of the trephine with the flower inside. B. The graft with the suture and without it. C. Graft and bed.

globe. Then the trephine with the guard is placed in such a way that the curled portion of the wing (the flower) remains within the small trephine while the guard exactly fits the laminar resection, in order to have a perfect centering of the two sections (Figure 7). Once the centering guard is accurately situated the surgeon exerts a slight rotatory movement on the trephine, slightly pressing the ocular globe between his fingers at the same time for the purpose of increasing tension of the globe. In this way the edge of the inner trephine effects section of the posterior layers of the cornea. As causing injury to the iris and the crystalline lens of the donor eye is of no importance, the entire section of the posterior layers should be obtained with the trephine for greater regularity.
Graft. The graft thus secured usually remains within the trephine, whence it is taken by means of an irrigation with saline solution. It is then placed in a sterile capsule, and one proceeds to remove the preliminary suture and to examine the graft to verify regularity of its cutting and centering of the two sections (Figure 7).

OPERATION

Anterior delimitation. With the same trephine and regulation of penetration, which were used in taking the graft, one proceeds to anterior delimitation, with centering of the pupil as if it were in a lamellar keratoplasty (Figure 8).

Resection of anterior layers. Resection of the anterior layers is performed with the piriform spatula as in an anterior lamellar keratoplasty, that is, the cornea to be resected is held with the Colibri pincers and a circular movement is exerted on the piriform spatula (Figure 9). It is advisable to have the dimensions of the plane of dissection slightly surpass the limits of delimitation on the entire perimeter. This secures greater regularity in the angle of the bed and greatly facilitates placing of the edge-to-edge sutures. Care should be taken to maintain dissection in the same plane for the purpose of preventing occurrence of astigmatism. If at any point of the perimeter dissection results deeper than the incision made by the trephine, the incision
should be completed with either the elbow-bent knife or with scissors (Figure 10).

Section of posterior layers. To accomplish concentric section of the posterior layers of the recipient, the instrument is adjusted in such a way that, when it functions, the inner trephine projects 0.3 mm. from the edge of the guard, so as to allow the cutting surface to act freely upon the posterior layers. The instrument is carefully placed on the globe, verifying both its ver-
The incision should be completed with the elbow knife.

ticality and the occurrence of a perfect fit of the outer guard in the previously cut bed. When the trephine functions, the curve of the cornea and the greater exposure of the cutting edge compel the trephine to effect section of the posterior layers of the cornea (Figure 8). In this case, and because of the fact that the iris and the crystalline lens should be preserved, the section always results incomplete and should be completed either with an elbow-bent knife or with scissors, according to individual preferences (Figure 9).

Fixation. If the incisions have come out perfectly concentric, the graft fits perfectly in the bed (Figures 7 and 9).

The stitches may pass through the thickness of the wing of the graft, near the free edge of the wing, and enter the recipient through the plane of dissection that for this purpose was dissected beyond the delimitation (Figure 11). By using this technique, it is enough to place half the number of sutures which would be used in a cylindric graft of the same dimension (Figure 9). Usually eight edge-to-edge stitches are sufficient to secure coaptation as good as that which is obtained by placing 16 stitches in a cylindric graft of the same dimension. In performing this type of suture it is advisable to use 4-mm. needles, as they are
less traumatizing, and virgin silk of two cocoon threads because it is less irritant. Injection of air into the anterior chamber is optional.

Monocular bandage. The patient gets out of bed the first day after the operation, as soon as the effects of premedication have worn off.

![Figure 11. Disposition of the sutures in the stepping graft.](image)

**OPERATIVE ACCIDENTS**

The only specific operative accidents of this technique are the following:

1. Irregularity of either the thickness of the wing during cutting of the graft, or of the recipient bed during the operation.
2. Lack of concentricity between the section of the anterior and posterior layers.

If the irregularity is of the graft, another one can be cut. If it is in the recipient, the operation should be finished by using a cylindric graft of the dimension of the anterior delimitation, after
a previous resection, with scissors, of the posterior layers, to the same dimension.

For these reasons, when these techniques are to be performed, the graft should be cut first and several donor eyes should be available.

POSTOPERATIVE COURSE

The reduced dimension of the endothelial surface, the smaller mass of grafted tissue, and the smaller number of stitches used in this operation result in a simple postoperative course which is much more favorable than that which would have followed the use of a cylindric graft of the dimensions of the anterior delimitation.

This technique also permits the surgeon to authorize the patient to move freely shortly after the operation. The stitches are removed eight days earlier than they would be in the case of a cylindric graft of the same dimension due to the larger host-graft surface of contact.

RESULTS

The results of this technique (Figure 12) are summarized in Table I.

MUSHROOM GRAFT

CHARACTERISTICS

The mushroom graft consists of the association of a total anterior lamellar keratoplasty with a small penetrating central keratoplasty. The difference in size between the anterior and posterior delimitations is always great (Figure 2).

HISTORY

This technique, suggested by Franceschetti in 1950 (6), has been discussed in several reports, in which modifications both in the technique and in instruments used are advised.

Frederick W. Stocker in 1959 (11), Richard H. Keates, Miguel Martínez, Townel and Paton in 1961 (8), and Winston Roberts also in 1961 (9), described their techniques, which aimed to make the operation more simple and precise.
Figure 12. Results of the stepping graft: A. Before, B. After.
<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Diagnostic</th>
<th>Prevision</th>
<th>Anterior delimit</th>
<th>Posterior delimit</th>
<th>Post vision</th>
<th>Refraction</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M. M.</td>
<td>Scar</td>
<td>0.1</td>
<td>7.0</td>
<td>5.0</td>
<td>1.0</td>
<td>-2.50 - 1.25 x 60</td>
<td>Clear</td>
</tr>
<tr>
<td>2</td>
<td>J. C.</td>
<td>Conical cornea</td>
<td>0.3</td>
<td>8.1</td>
<td>6.5</td>
<td>1.0</td>
<td>+1.50 - 2.00 x 45</td>
<td>Clear</td>
</tr>
<tr>
<td>3</td>
<td>A. R.</td>
<td>Conical cornea</td>
<td>0.2</td>
<td>7.0</td>
<td>5.0</td>
<td>0.8</td>
<td>-3.25 - 3.00 x 95</td>
<td>Clear</td>
</tr>
<tr>
<td>4</td>
<td>A. R.</td>
<td>Conical cornea</td>
<td>0.3</td>
<td>7.0</td>
<td>5.0</td>
<td>0.7</td>
<td>-1.00 - 3.50 x 80</td>
<td>Clear</td>
</tr>
<tr>
<td>5</td>
<td>M. R.</td>
<td>Groenouw's degeneration</td>
<td>0.05</td>
<td>7.0</td>
<td>5.5</td>
<td>0.5</td>
<td>-4.00 - 1.50 x 35</td>
<td>Clear</td>
</tr>
<tr>
<td>6</td>
<td>A. R.</td>
<td>Perforated conical cornea</td>
<td>L.P.</td>
<td>8.2</td>
<td>6.6</td>
<td>0.4</td>
<td>+3.50 - 3.50 x 165</td>
<td>Hazy</td>
</tr>
<tr>
<td>7</td>
<td>H. A.</td>
<td>Conical cornea</td>
<td>0.05</td>
<td>8.1</td>
<td>6.0</td>
<td>0.67</td>
<td>Neuter</td>
<td>Emmetropse</td>
</tr>
<tr>
<td>8</td>
<td>B. P.</td>
<td>Scar</td>
<td>L.P.</td>
<td>6.5</td>
<td>5.0</td>
<td>0.3</td>
<td>-7.00 - 1.00 x 45</td>
<td>Endothelitis</td>
</tr>
<tr>
<td>9</td>
<td>S. S.</td>
<td>Scar</td>
<td>0.2</td>
<td>7.0</td>
<td>5.5</td>
<td>1.0</td>
<td>-2.00 x 75</td>
<td>Clear</td>
</tr>
<tr>
<td>10</td>
<td>T. M.</td>
<td>Scar</td>
<td>0.1</td>
<td>7.0</td>
<td>5.5</td>
<td>0.6</td>
<td>-2.50 - 1.75 x 135</td>
<td>Clear</td>
</tr>
<tr>
<td>11</td>
<td>D. M.</td>
<td>Scar</td>
<td>0.3</td>
<td>7.0</td>
<td>5.5</td>
<td>1.0</td>
<td>-4.00 - 2.00 x 50</td>
<td>Clear</td>
</tr>
<tr>
<td>12</td>
<td>L. C.</td>
<td>Tracomatous keratitis</td>
<td>L.P.</td>
<td>8.0</td>
<td>6.5</td>
<td>L.P.</td>
<td></td>
<td>Cloudy after 3 months of $V = 0.3$</td>
</tr>
<tr>
<td>13</td>
<td>E. E.</td>
<td>Conical cornea</td>
<td>0.2</td>
<td>7.0</td>
<td>5.5</td>
<td>0.67</td>
<td>-1.50 - 1.75 x 165</td>
<td>At the 3d. day acute glaucoma, paralytic mydriasis. No opening of the wound. Clear.</td>
</tr>
<tr>
<td>14</td>
<td>F. P.</td>
<td>Methaherpetic</td>
<td>L.P.</td>
<td>6.5</td>
<td>5.0</td>
<td>0.5</td>
<td>+1.25 x 90</td>
<td>Clear</td>
</tr>
<tr>
<td>15</td>
<td>K. R.</td>
<td>Scar</td>
<td>0.1</td>
<td>6.5</td>
<td>5.0</td>
<td>0.7</td>
<td>+1.00 - 2.00 x 10</td>
<td>Clear</td>
</tr>
<tr>
<td>16</td>
<td>E. A.</td>
<td>Scar</td>
<td>L.P.</td>
<td>6.5</td>
<td>5.0</td>
<td>0.6</td>
<td>-2.00 - 0.50 x 180</td>
<td>Clear</td>
</tr>
</tbody>
</table>
SCOPE

To perform in only one operation both a reconstructive anterior lamellar keratoplasty and an optic penetrating keratoplasty of small dimensions.

To improve nutrition of the penetrating graft.

INDICATIONS

1. In cases in which either a laminar or a penetrating keratoplasty are not satisfactory.
2. Severe burns.
3. When several operations previously performed have failed.
5. In unfavorable cases, with very irregular corneal surface: staphylomas and descemetocele.
6. In Fuchs's endothelial dystrophy.

DIMENSIONS OF THE MUSHROOM GRAFT

<table>
<thead>
<tr>
<th>Author</th>
<th>Lamellar</th>
<th>Penetrating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Franceschetti and Doret</td>
<td>10 mm.</td>
<td>from 3 to 5 mm.</td>
</tr>
<tr>
<td>Stocker</td>
<td>11 mm.</td>
<td>from 6 to 5.5 mm.</td>
</tr>
<tr>
<td>Keats et al.</td>
<td>10 mm.</td>
<td>from 4.5 to 6 mm.</td>
</tr>
<tr>
<td>Roberts</td>
<td>10 mm.</td>
<td>5 mm.</td>
</tr>
</tbody>
</table>

FRANCESCHETTI'S TECHNIQUE

INSTRUMENTS

This technique makes indispensable the use of a special instrument for cutting the graft. The instrument, which was invented by Franceschetti (Figure 13), consists of a movable cylinder forming the body of the apparatus. This cylinder has near its upper end two screw-nuts for blocking the ring of fixation (A) of the cornea which is to be cut (B). The instrument has an interchangeable inner cylinder, the diameter of which varies with the dimension of the trephine (E) which is to be used for posterior trephination (from 3 to 5 mm.). At the
lower end of the inner cylinder there is a bolt (D) which fixes the trephine in situ, as soon as the posterior section has been cut.

The first cylinder is mounted on a support, an arm of which carries a razor blade-holder provided with the blade (C) and moved by a spring. The spring impels the razor blade to the level of the ring of fixation toward the center of the cylinder.

**Figure 13.** Franceschetti’s device for cutting the mushroom graft.

**Surgical Technique**

*Obtaining a corneoscleral cap.* From the donor eye a cap which includes the cornea with a scleral ring is removed with a 15 mm. trephine. The remnants of the uveal tract are removed, carefully avoiding trauma to the endothelium.

*Preparation of the apparatus.* Placing of the cornea with its scleral ring at the upper end of the cylinder of the apparatus and fixing it with the ring previously prepared for this purpose.
**Posterior trephination.** The trephine is introduced through the orifice of the lower part of the apparatus and section of the posterior layers of the cornea is performed without penetrating the cornea. The apparatus is provided with a butt to stop action of the trephine immediately after posterior section. As soon as trephination is completed, the trephine is fixed *in situ* by the "ad hoc" bolt at the foot of the apparatus.

**Section of the wing.** The razor blade is placed in the apparatus and the spring of the blade is allowed to function. The cutting edge automatically contacts the periphery of the cornea. The surgeon holds the apparatus by its two supports with one hand, while he rotates the cylinder with the other. The wing is automatically cut until the razor blade strikes against the trephine which had been previously left *in situ*. The graft is then removed from the apparatus with a spatula and it immediately takes its normal curvature.

**Operation**

*Anterior delimitation.* With a 10 mm. trephine to a penetration of 0.2 mm.

*Resection.* As in a total anterior lamellar keratoplasty.

*Section of the posterior layers.* With a 3 to 5 mm. trephine centering it with the anterior section with a localizer of any type.

*Fixation.* Once the graft is placed in its bed, it is fixed by means of either four or eight edge-to-edge stitches.

**Other Techniques**

Stocker performs the operation without using any special instruments. He cuts the wing on the donor eye and he effects posterior trephination on the isolated cornea, which for this purpose has been placed on a paraffin cast. He centers the trephination by means of a caliper. He follows this procedure for fear of causing any injury to the endothelium by using Franceschetti’s apparatus.

Keats et al. have designed a clamp (Figure 14) to hold the donor cornea, which serves the double purpose of centering the anterior and posterior delimitations as well as of permitting dissection of the wing upon it (Figure 15).
Figure 14. Keates, Martínez and Paton clamp to hold the donor cornea. (Reprinted from Keates, R. H., Martínez, M., and Paton, R. T. A modified technique for mushroom corneal grafts with a new instrument. Amer. J. Ophth. 52:239, 1961.)

Figure 15. Steps of Keates, Martínez, and Paton’s Technique. A. The clamp is closed and locked, then inverted so that the endothelial side is up, and the central stem is cut. B. The clamp is turned again so that the epithelium is uppermost and the lamellar section is completed to the central stem.

Roberts has constructed a set of very complex instruments for the cutting of these grafts with precision (Figure 16).

POSTOPERATIVE COURSE

According to Franceschetti and Doret, the mushroom graft takes perfectly well, having in mind that it has been used in unfavorable cases. The eye is tranquil one week after the operation in the majority of the cases. The treatment does not have any peculiarities.
RESULTS

Roberts performed the operation on 13 patients, in 12 of whom complications did not occur. In nine, vision improved. In one, who was suffering with severe postaphakic bullous keratopathy, vision improved up to 20/40 and remained at these figures up to six months after the operation. The author regards the results as very good, particularly because the operation had been performed in desperate cases.

Figure 16. Raben's Mushroom Corneal Graft instrument set, mounted on plastic carrier (left to right). Fixing block and trephine guide; fixing cylinder and guide; “cookie cutter” 15-millimeter trephine; 10-millimeter trephine with guide for 5-millimeter. (Rear). Suction cylinder for fixation on recipient cornea. (Reprinted from Roberts, R. W. The mushroom graft. Amer. Acad. Ophth. and Otolaryn. p. 532, 1961.)

POSTERIOR TWO-LEVEL GRAFTS

CHARACTERISTICS

The P.T.L.G., as its name indicates, is characterized by a greater resection at the level of the corneal endothelium than at the level of the epithelium (Figures 2 and 3).
HISTORY

This technique was introduced by José I. Barraquer in 1947 (3) as one to be used in autofixation of penetrating grafts, with the purpose of avoiding the edge-to-edge suture in the graft. However, after several fortunate cases, the use of this technique for that purpose was discontinued because of the fact that the tenseness of the posterior wing of the graft was not sufficient to secure closure of the anterior chamber in all cases, thus resulting in elimination of the graft. This problem is solved by using the edge-to-edge suture as described in the following technique.

SCOPE

Hermetic closure of the anterior chamber. Extensive resection of posterior corneal layers with a minimal resection of tissue for rehabilitation, which may cause allergic reactions.

INDICATIONS

Fuchs's dystrophy in incipient cases. This technique makes it possible to perform an extensive resection at the level of the endothelium, which is a requirement in these cases, with a minimal resection of homoplastic tissue, thus greatly reducing the number of immunoreactions.

TECHNIQUE

Instruments. This technique needs the use of a normal trephine with inner piston of the dimension of the section at the endothelium level. This piston has in the center a concavity of the diameter of the section at the epithelium level. This concavity has the purpose of permitting concentricity of the two sections.

I have used 5 mm. in anterior resection and 8 mm. in posterior resection.

SURGICAL TECHNIQUE

Obtaining the graft. The technique for obtaining the graft is identical to that used in performing the operation and,
to avoid repetition, shall be omitted. Only in the donor eye can the section of the posterior layers be made, as a routine, exclusively with the trephine. It is advisable to have several donor eyes available and to begin the operation by cutting the graft, for greater safety.

![Figure 17](image)

**Figure 17.** Posterior two-level graft technique. *A.* Delimitations. *B.* Inter-lamellar cutting. *C.* Raised corneal flap.

**OPERATION**

*Anterior delimitation.* Anterior delimitation is performed by using a trephine regulated at 0.3 mm. of penetration, with centering of the pupil as in a lamellar keratoplasty. In continu-
tion, and by using the point of a razor blade mounted in a knife-holder, three rectilinear incisions are made, delimiting a rectangle of slightly larger dimensions than those of the trephination which is to be performed on the posterior layers. The lower border of the rectangle is not delimited (Figure 17 A).

![Figure 18](image)

**Figure 18.** Posterior two-level graft technique (Continuation). D. Trepanation of the posterior layers. E. Placing of the graft. F. Reposition of the corneal flap and graft suture.

**Dissection of the anterior flap.** With piriform spatula one proceeds to dissect the corneal flap which is delimited by the rectilinear incisions and the central trephination (Figure 17 B). This maneuver is simplified if dissection is begun with either a small piriform spatula or Paufique’s elbow-bent
knife, from the center towards the periphery about the central circular delimitation and from the periphery towards the center on the three sides of the rectangular delimitation. Once the corneal flap has been dissected, it is lifted and left folded downwards (Figure 17 C).

**FIGURE 19.** Results in a case of posterior two-level graft.

_Trephination of posterior layers._ The posterior layers are sectioned with an ordinary trephine, with an inner piston on which a concavity of the diameter of the trephine used in anterior delimitation was made. The concavity serves the purpose of centering the posterior with the anterior trephination, since the excrescence formed by this trephination enters into the cavity of the piston of the trephine used for section of the posterior layers (Figure 18 D). Section should be completed either with scissors or with the elbow-bent knife.

_Fixation._ After placing the graft in its place (Figure 18 E) the corneal flap is replaced and is fixed by means of several stitches with virgin silk; as a rule, two stitches for each side are sufficient. The incision of the anterior trephination should also be sutured with several edge-to-edge interrupted stitches. By using a 5 mm. trephine, four stitches will suffice (Figure 18 F). The results of two-level posterior keratoplasty are shown in Table II and Figure 19.
### TABLE II

RESULTS OF TWO-LEVEL POSTERIOR KERATOPLASTY

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Diagnosis</th>
<th>Vision pre.</th>
<th>Vision post.</th>
<th>Refraction</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C. P.</td>
<td>Fuchs's prim. dystrophy</td>
<td>0.3</td>
<td>0.8</td>
<td>-3.50 -4.00 x 65</td>
<td>Cure</td>
</tr>
<tr>
<td>2</td>
<td>R. N.</td>
<td>Fuchs's post aphak. dystrophy</td>
<td>L.P.</td>
<td>L.P.</td>
<td>--------</td>
<td>Opacification</td>
</tr>
<tr>
<td>3</td>
<td>E. G.</td>
<td>Fuchs's post aphak. dystrophy</td>
<td>L.P.</td>
<td>L.P.</td>
<td>--------</td>
<td>Deg. reproduction</td>
</tr>
<tr>
<td>4</td>
<td>M. M.</td>
<td>Fuchs's post aphak. dystrophy</td>
<td>0.2</td>
<td>0.5</td>
<td>+2.75 -1.50 x 135</td>
<td>Cure</td>
</tr>
</tbody>
</table>
OPERATIVE ACCIDENTS

In case of irregularity in the recipient, the best procedure is to again place the resected cornea in situ and to postpone the operation.

CONCLUSIONS

The above described techniques have been performed, up to the present, in only a few patients, and they may therefore be regarded as still in the experimental stage. The evident advantages they have from a theoretical point of view are counteracted in practice by their difficult performance. Their use will increase when simpler techniques are evaluated, and new and more perfect instruments are available.

REFERENCES