

REMOTE RESULTS OF COMPLETE HOMOTRANSPLANTATION OF THE CORNEA.

BY ALBERT H. EBELING, M.D., AND ANNE CARREL.

(From the Laboratories of The Rockefeller Institute for Medical Research.)

PLATE 34.

(Received for publication, June 6, 1921.)

Homoplastic transplantation of the cornea in its entire thickness has been attempted many times with practically constant failure. However, if this operation be performed under proper conditions, the transplanted fragments can remain transparent, and the curvatures of the cornea normal. This fact was demonstrated by Zirm, who resected part of a leucoma and substituted for it a flap of normal cornea taken from the enucleated eye of a boy.¹ About a year after the operation, the patient could see through the transplanted cornea. Although it had been implanted in scar tissue, the flap had remained transparent. Such a result is exceptional, and many other attempts have been unsuccessful. As the inadequacy of the technique was probably responsible for the failures of the operation, it would be important to improve the method of transplanting the cornea in such a way that it could be used as a routine procedure in cases of leucoma. The purpose of the experiments described in this paper was to develop a better technique for homoplastic transplantations.

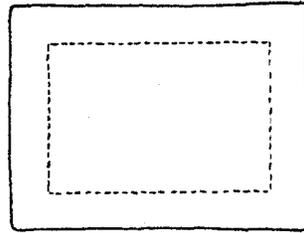
The technique consisted essentially in using a very large rectangular flap, fitted like the door of a safe into the edges of the corneal opening, and in fixing it securely in its position by stitches. This technique had been developed by Carrel in 1912, in the course of unpublished experiments on autotransplantation of the cornea. We attempted to adapt it to homoplastic transplantation, and to observe the results over a long period of time.

1. Preparation of the Eye.—The experiments were performed on cats. Cultures in bouillon were made of the secretion of the con-

¹ Zirm, E., *Arch. Opth.*, 1906, lxiv, 580; *Wien. klin. Woch.*, 1907, xx, 61.

junctiva and only animals whose conjunctiva was found to be sterile were used. The hair covering the palpebra and the skin surrounding the eye were cut with scissors. Several days previous to the operation, the eye and the surrounding skin were washed with mercury bichloride at 1:5,000. Immediately before the operation, the surrounding skin and that of the palpebra were washed with alcohol, and afterwards tincture of iodine was applied.

2. *Preparation of the Graft.*—The graft was taken from the eye of a cat under ether anesthesia. The outline of a rectangular flap 6 by 8 mm. was traced on the surface of the cornea with a sharp cataract knife. The surface was incised to a depth corresponding to about half the cornea. Then the internal edge of the flap was dissected a distance of 1 mm. The anterior chamber was opened, the incision of the posterior part of the cornea continued with the scissors, the flap removed, and put in olive oil until it was used. Its anterior surface was 6 by 8 mm., while its posterior surface was only 4 by 6 mm. (Text-fig. 1).

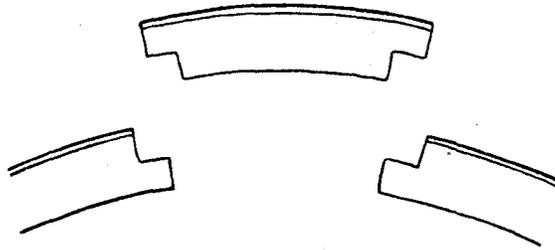


TEXT-FIG. 1. Anterior aspect of flap.

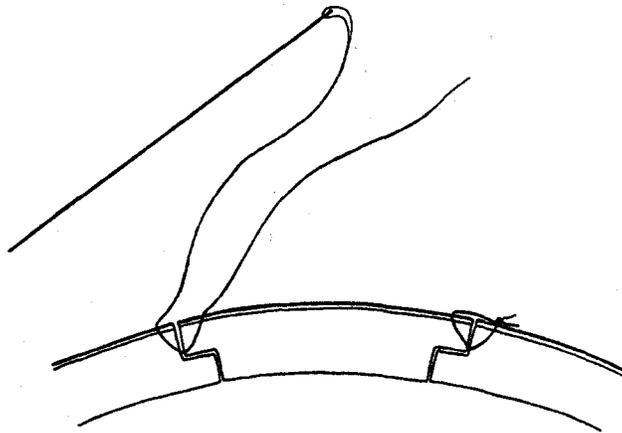
3. *Resection of the Cornea and Transplantation.*—The animal was etherized by the Meltzer-Auer method. The head was placed on a sand-bag and covered with a black silk towel, perforated in the center. The operating field was widely exposed by four small forceps fixed to the conjunctiva. The graft was placed on the surface of the cornea and the outline of the fragment to be resected was traced with the point of a cataract knife. Then the graft was replaced in olive oil. The incision of the cornea was made to a depth of about 1 mm. Then the internal edge was dissected for 1 mm., the anterior chamber was opened, and the fragment resected (Text-fig. 2). The graft was

immediately inserted in the opening, where it fitted the edges of the cornea exactly (Text-fig. 3).

4. *Fixation of the Graft.*—The suture of the graft to the cornea was made with straight needles, No. 16, and silk sterilized in vaseline. As the corneal tissue is very hard, prong-toothed dissecting forceps



TEXT-FIG. 2. Cross-section of corneal flap and opening in the cornea, showing step edges.

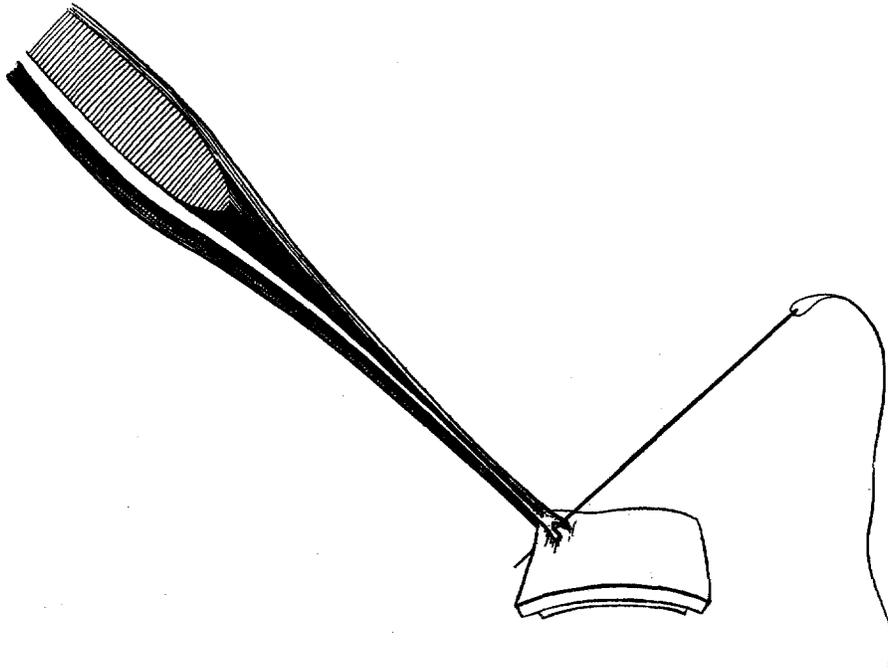


TEXT-FIG. 3. Transplanted flap in position, showing stitches passing through the superficial layers of the transplant and edge of opening in the cornea.

were used, the ends of which were bifurcated like a very small, double tined fork. The edge of the flap was seized by the forceps and the needle pushed through the tissue between the tines (Text-fig. 4). Only the superficial part of the cornea was caught by the needle. Each angle of the flap was fixed by one stitch. Another stitch was placed on the longer side of the rectangle. On account of the shape

of the edge, the incisions were closed tightly, and there was no leakage of fluid from the anterior chamber through the line of incision (Text-fig. 3).

5. *Postoperative Treatment.*—In previous experiments, it had been found that the dressing was often a cause of irritation. Therefore no dressing was applied. The animals kept the operated eye closed for several days after the transplantation. The corneal stitches fell out after a short time.



TEXT-FIG. 4. Prong-toothed dissecting forceps holding corneal flap and needle stuck through the tissue.

The experiments were made during an epidemic of distemper. Five cats were operated upon. Two died from distemper some time after the operations. Two others had a marked local infection of the eye and the cornea became completely opaque. In the fifth experiment (Cat 1, performed on May 20, 1919) the animal remained in good condition and the cornea transparent. A month later, the stitches had disappeared, the cicatrization was perfect, the cornea clear, and its curvatures did not appear to be modified. The iris was

not adherent to the cornea. There was a very small opaque spot near the inner canthus. Since that time, the animal has continued in the same condition. On May 26, 1921, the cornea was perfectly transparent, the only evidence of a previous operation being a hardly visible opaque spot on the internal part of the cornea (Fig. 1). An examination was made by Dr. W. B. Doherty, the results of which are as follows:

No line of demarcation to indicate the limitation of the corneal graft could be seen with a Zeiss loupe. Corneal epithelium perfectly even. No lack of corneal luster. Oblique illumination showed no inequalities of the corneal surface. Cornea was sensitive. Transplant perfectly transparent; no infiltration or vascularization. Ophthalmoscopic examination showed clear image of the fundus. Near the inner canthus and in the portion comprising the original cornea, there was a faint infiltration of the deeper layers with two or three small blood vessels. This opacity was of a striate appearance and gave the impression that it was produced by trauma during the operative procedure.

The result obtained in this experiment shows that the technique which was used allows a perfect reconstruction of the cornea, even when a very large fragment has been resected. The cutting of the flap is not difficult after a little training, and there is no doubt that the fixation of a flap fitted like the door of a safe to the step-edged cornea by suture increased the safety of the operation in a great measure. It is known that, in the previous attempts to transplant the entire thickness of the cornea, a disc of cornea was merely placed in an opening made with a trephine. In the operation performed by Zirm, the disc was maintained by two cross threads stitched to the conjunctiva. There is certainly a great advantage in cutting and fixing the flap in such a way that the anterior chamber is tightly closed, and that no displacement of the graft can take place.

SUMMARY.

1. A flap composed of the entire thickness of the cornea of a cat was transplanted to the cornea of another cat, and was found to be perfectly transparent 2 years after the operation.
2. The curvatures of the cornea appeared to be normal.

We wish to acknowledge our indebtedness to Dr. Doherty for the clinical examination of the eye and the report of the findings.

EXPLANATION OF PLATE 34.

FIG. 1. Cat 1. Right eye operated upon. Photograph taken May 31, 1921, 2 years and 11 days after the transplantation was made. The cornea appears normal. There is practically no difference between the cornea of the left eye and that of the right.



FIG. 1.

(Ebeling and Carrel: Complete homotransplantation of cornea.)