

METHODS

AN ACRYLIC PLASTIC CORNEA

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Transplantation of the cornea has become the operation of choice. However even in the most experienced hands the percentage of opaque corneal graft is very high, varying from 50 to 60-65% [1, 5].

The relatively large number of failures has stimulated the research into tissue compatibility, improvement of grafting technique, the development of new instruments, etc.

Recently, and particularly in plastic surgery, various plastics have found extensive application. Descriptions have been given of an attempt to use plastic as a substitute for the cornea.

Stone and Herbert [7] have described work carried out between 1947 and 1953 on the implantation of an acrylic plastic into the cornea. None of the implants survived. In a series of experiments in which the implants remained in position the trepanned openings healed over.

In experimental keratoplasty Kuwahara [6] used an acrylic implant with wings of vinyl plastic. A satisfactory result was obtained in 6 rabbits out of 16.

In 1955-1956 we carried out a series of experiments on a partial plastic corneal prosthesis for rabbits. For the implant we used polymethylmethacrylate, a polymer of the methyl ester of methacrylic acid.

The impact of polymethylmethacrylate had the shape of a small bearing (in future for convenience we will describe the plastic implant as an "alloplast" without claiming any general usage). The lower miniscus-shaped surface of the alloplast (Fig. 1) had a diameter of 4.5 mm, and the groove had a diameter of 4.1 mm. The total thickness was 1 mm. The radii of curvature of the upper and lower surfaces were 8 mm and 7 mm respectively, and both were carefully polished.

Before the operation the implant was sterilized in a solution of the following composition: carbolic acid 3.0,

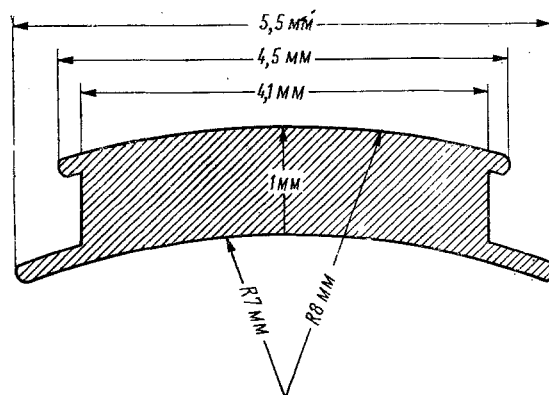


Fig. 1. Alloplast in section.



Fig. 2. Alloplast held in holder.

formalin 20.0, sodium carbonate 15.0, and distilled water 1,000.0. Sterilization with alcohol was not permissible, because it destroyed the plastic.

The operation was as follows. The rabbit was fixed to a stand, and local anesthetic was injected onto and behind the eye, after which stitches were inserted into the lids, which were then drawn apart. After the eyeball had been held in position with stitches, the cornea was trepanned. The alloplast, which was held in a special holder (Fig. 2), was brought up with one edge of the base beneath the trepanned opening. At the same time a small hook was introduced into the opening which lightly held back the edge. By a slight rotation of the disk accompanied by a pull on the hook the lower protruding part of the implant was introduced through the opening into the anterior chamber. Thus the whole corneal edge of the opening lay in the groove between the upper and lower rims of the alloplast.

After the operation 1% atropine was instilled into the conjunctival sac, and 50,000 units of penicillin were given by intramuscular injection.

Operations were carried out on 15 rabbits. In four the alloplast came away within the first week. In eight it remained in place in the cornea for a month, in two for 1½ months, and in one for seven months.

These times were longer than those achieved by other authors who had attempted a partial alloplast of full thickness. Thus Stone [7] points out that in the 15 rabbits on which he operated and which corresponded to our definition of a partial full thickness alloplast, in no case did he succeed in maintaining the implant in the cornea for more than two weeks.

It seems to us that the time for which the implant is retained depends upon the following factors.

1. The suitability of the material from which the implant is made, as determined firstly by how the tissues, in particular the corneal tissue reacts against the implant, and secondly on the ability of the tissue to grow into it.
2. The shape of the implant and particularly the shape of the rim making contact with the cornea. If special measures are not taken for fixation (stitches, tantalum grid, etc.), then the form of the implant must be such so as to secure immediate fixation in the cornea. In our opinion this latter method is to be preferred.
3. The method and technique of the operation which must as far as possible spare and be minimumly traumatic to the cornea, especially the part in contact with it.

The attainment of the final aim, of a permanent growth into the implant will depend upon the creation round the alloplast of a fibrous ring which will hold the implant permanently in place. For this purpose it seems to us best to combine a partial full thickness alloplast with the interlamellar form.

Our experiment and others which have been published show that polymethylmethacrylate is well tolerated by the cornea. In all cases when it remained in place for between one and seven months a very weak reaction of the corneal tissue to the foreign body was observed. It took the form of a moderate local edema which was most marked where the iris was pinched between the edge of the alloplast and the wound, and in the restricted ring-shaped keratitis around the implant. In many cases in the places where ingrowth had occurred the cornea contained vessels whose initial development was followed after a certain time by degeneration. Possibly the keratitis is rather a reaction of the cornea to trauma than to the acrylic implant. From the point of view of ingrowth into the implant such a keratitis is a favorable factor. The fibrous ring which forms at this place ultimately plays a fundamental part in fixation of the alloplast.

In many cases we have observed iritis with exudate into the anterior chamber. As a rule it subsided in 1-2 weeks, and the exudate was absorbed.

In almost all the operated rabbits, during the first few days a suppurative conjunctivitis developed which lasted for a few days. This could scarcely be a reaction to the introduction of the acrylic plastic, because had it been so it would have lasted much longer. It is more likely that the conjunctivitis is a reaction induced by the trauma due to fixation of the lids at the time of the operation, and it may be due to residual traces of the disinfectant solution used to treat the alloplast.

The implant remained transparent and unchanged in all the experiments in every case. Even when it had remained in the cornea for 7 months, at the end of this time the pupil could be seen through the plastic, and the reflex from the fundus was visible.

Thus in experiments with a partial full-thickness alloplast, the implant remained successfully in position in most cases from 1 to 1½ months, and in one case for 7 months. It is important to emphasize that polymethylmethacrylate is readily tolerated by the tissues of the eye. In particular, the cornea reacts so mildly as to give the impression that the reaction is elicited more by the trauma than by the material from which the implant is made.

Further experiments are required with regard to fixation of the implant, methods of operation, and the reaction of the eye to the implantation of various plastic materials, in order to work up to a clinical application.

SUMMARY

A series of experiments was carried out on 15 rabbits in which a polymethylmethacrylate implant (alloplast) was made into the cornea. We described this operation as a partial perforating alloplast of the cornea. The implant was a meniscus having the following diameters: lower surface of meniscus 5.5 mm, upper surface 4.5 mm, and the groove in the edge 4.1 mm. The thickness was 1.0 mm. In four rabbits it fell out, in eight, it remained in the cornea for one month, in two it held for 1.5 months, and in one for seven months.

The reaction of the cornea was but slight, and the implant remained transparent in all cases. We consider the results of these experiments to be quite promising.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. Some or all of this periodical literature may well be available in English translation. A complete list of the cover-to-cover English translations appears at the back of this issue.
