

TRANSPLANTATION OF THE CORNEA FROM PRESERVED CADAVERS' EYES

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TILL recently the chief source of material for the transplantation of the cornea in man consisted of eyes enucleated from living people owing to some disease of the eye or of the orbit. The possibility of obtaining a permanent, transparent union of the corneal graft from the living eye has been proved beyond any doubt; many cases have been recorded where the transparency of the cornea has been observed for nine months or more—notably 31 cases from Elschmig's clinic (Ascher 1919, 1922, Liebsch 1930, Stanka 1927), 16 from my own observation (Filatov 1935b), and the cases of Zirm (1907), Plange (1912), Löhlein (1912), Tudor Thomas (1933, 1934), Castroviejo (1933, 1934, 1935), Vasiutinsky (1935), Belajev (1924), and other authors. About 70 cases are on record of successful transplantation of the cornea from living eyes. Almost all of these successes have been obtained with the method of partial penetrating transplantation; in a few of the cases the lamellar partial transplantation was made; while one only fairly successful case has been recorded (Schimanovsky 1913) of complete transplantation.

All my cases were under observation for not less than a year, the only exception being a patient who died seven and a half months after the operation. As regards more remote results of transplantation from the living eye a number of cases have been recorded by Elschmig, as well as by myself, which have been under observation for several years. Fig. 1 shows eyes whose transplants were found to be transparent after varying periods.

GRAFTS FROM THE LIVING

CASE A.—Complete leukoma, developed after recurring scrofulous keratitis. In the leukoma were some remnants of the semi-transparent corneal tissue. Vision before operation (Oct. 18th, 1923) was equivalent to perception of light; vision after operation was 3/60 on aphakic correction. This vision remained unchanged till the patient died 6 years later (Filatov 1925).

CASE B.—Dense opacity after parenchymatous keratitis. Vision before operation (Dec. 23rd, 1930) 0.025. The transplant retained a fine transparency during the time of observation (5½ years). Vision after the operation was 0.7 till May, 1934, when it became and remained 0.4. Fundus oculi clearly visible (Filatov and Velter 1932) (Fig. 1).

CASE C.—Dense opacity of the central part of the cornea of the right eye and less dense opacity on its periphery; both developed after parenchymatous keratitis. Vision before the operation (Feb. 2nd, 1932) was 3/60. The transplant is now, 4 years and 7 months after the operation, still fully transparent. Vision was 0.5 (Filatov and Velter 1934) (Fig. 1).

CASE D.—Opacity developed in the left eye after parenchymatous keratitis. Vision before the operation (March 10th, 1932) was 5/60. The transplant is now, 4½ years after the operation, fully transparent. Vision=0.3 (Filatov and Velter 1934).

CASE E.—Leukoma developed after a traumatic ulcer. In the upper third of the cornea a strip of the tissue is transparent. Vision before the operation 1/60; after the operation, performed in December, 1931, by Prof. Zykulenko, vision rose to 0.4. Binocular vision was restored. Length of observation time 4 years 9 months (Zykulenko and Velter 1933) (Fig. 1).

These results illustrate the bright prospects of corneal grafting, and there is now reason to think that the operation may prove to be a practical means of overcoming the blindness and disablement due to leukoma.

NEED FOR NEW SOURCES

The question now arose whether the number of suitable eyes removed from living people would be enough for all the cases in which the transplantation was indicated. For it must be kept in mind that there are six million blind in the world and fifteen millions suffering from diseases of the eye (Samoilov and Braunstein 1935). According to the official census in 1926 there were 234,800 blind people in the Soviet Union (Savvaitov 1932). In at least 43 per cent. of this number blindness is due to leukoma, for to this cause may be put down all cases of blindness from trachoma (20.64 per cent.), from small-pox (10.63 per cent.), from diseases of the cornea (8.43 per cent.), and from blennorrhœa of the newly born (3.45 per cent.); it is also necessary to add some cases of blindness due to trauma. Of this number—about a hundred thousand—a great many cases are not fit for the operation of corneal transplantation owing to various complications, such as glaucoma, atrophy of the eye, staphyloma, symblepharon, and persisting trachoma. Yet the number of cases in which the operation is indicated still amounts to many thousands. The number of candidates for corneal transplantation would be increased even more by those who, though afflicted with leukoma in both eyes, have not been registered as being blind because their vision is above 1/200. Such cases lend themselves particularly well to the operation of corneal transplantation, for these leukomata contain remnants of corneal tissue. Furthermore, since the transplantation of the cornea successfully competes with iridectomy, the number of candidates for the operation may indeed be enormous.

In view of the great success already achieved in the work with corneal transplantation it seemed high time to attempt to find a new source of transparent corneas if the serious difficulty of supply was to be overcome. It was only natural for me first of all to turn my attention to the dead body. For some time cadavers' eyes, from adults as well as from foetuses, had been employed in a few single cases by several surgeons. Some used corneas immediately or during the first hours after death (Fuchs 1901, Schimanovsky 1913, Magitot 1912, Saveliev 1927). Other surgeons removed the eyes from the stillborn 10–36 hours after death. Only in the case reported by Magitot (1912), however, was a permanently transparent union of the transplant established by fairly long observation. These data were of course far too meagre, and the use of cadavers' material on a large scale, as a substitute for living material, to meet the demands for transplantation had not previously been considered by anybody.

This then was the state of affairs when I studied the problem in 1931. Its solution I based on the remarkable case reported by Morax and Magitot (1912) who obtained a permanently transparent union of the cornea removed from a living person and preserved in the donor's blood at a temperature of minus 6° C. for eight days.

METHOD

From the very beginning of my investigation on the feasibility of transplanting cadavers' cornea I employed corneas taken from cadaver-eyes preserved for many hours before the operation at a relatively

low temperature. The eyes were obtained: (1) from bodies of those who had not died from infectious diseases nor malignant tumours—syphilis was excluded by serological tests before or after death and sometimes also by autopsy; (2) after death from accidents or suicide, brought into the medico-judicial morgue—syphilis was excluded by serological tests, and the absence of acute infections by the anamnesis and sometimes by autopsy.

The enucleated eyes were in some cases placed in a sterile jar with a tight-fitting stopper, cornea upwards; sometimes the jar was filled with the donor's fresh clotted blood while in still other cases the blood was citrated. The jars were kept in an ice-chest at 4°–6° C. On the day of operation the jar containing the eye, surrounded by ice, was brought into the operation room, where it remained for about an hour before the cornea was excised and transplanted. The corneas of eyes preserved in this manner usually appeared to be somewhat dimmed, the epithelium being slightly stippled. The eyes were kept for periods varying from 10–56 hours, while in one case it was six days. Before excising the transplant the cornea was washed with a fresh aqueous solution, brilliant green (1 : 1000).

RESULTS

From 1932 till January, 1936, I have performed 95 operations of the partial penetrating transplantation of corneas prepared in this way (Filatov 1934, 1935a). In nearly all of these cases I used my own operative technique.

I employed either an FM 1 or an FM 3 trephine and covered the transplant with a flap of conjunctiva (Filatov 1934a and b, 1935b and c).

tissue film had formed on the posterior surface of the transplant, must not be referred to the total number of eyes operated on, but only to 49 of them, since in 46 eyes the leukomata were greatly complicated by glaucoma, buphthalmos, applanation, subatrophy of the eye, &c.; in such eyes there is no hope at all of obtaining a transparent union. While the operation is performed in the last resort as a concession to the supplications of the patients, it is necessary to keep separate records for such eyes.

Out of the 18 operations in which transparent union was recorded, 14 cases have been under observa-

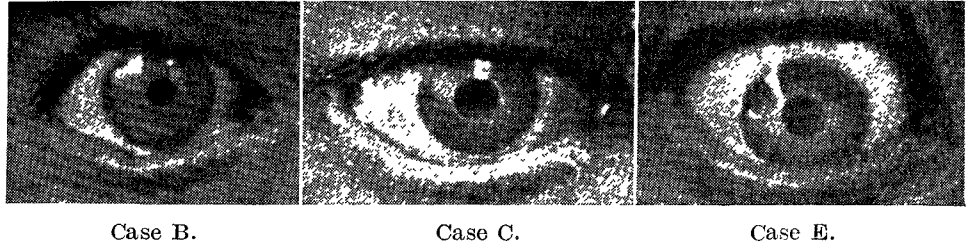


FIG. 1.—Corneal grafts from the living.

tion for over nine months, the remaining 4 cases having been followed up for a shorter time. Some of these 18 cases of transparent union are summarised below and illustrated by untouched photographs:—

CASE 1.*—Leukoma due to scrofulous keratitis. Vision before operation: perception of hand movements. Transplantation of cadaver's cornea on March 17th, 1935. The eye had been taken from the cadaver 12 hours after death and subsequently preserved for a further 25 hours at 4°–6° C.

Result.—Vision = 3/60, on eccentric fixation (amblyopia). Fundus oculi clearly visible. Length of observation (Oct. 1st, 1936) 1½ years (Fig. 2).

CASE 2.*—Leukoma developed after an ulcer. Vision: perception of hand movements. Transplantation of

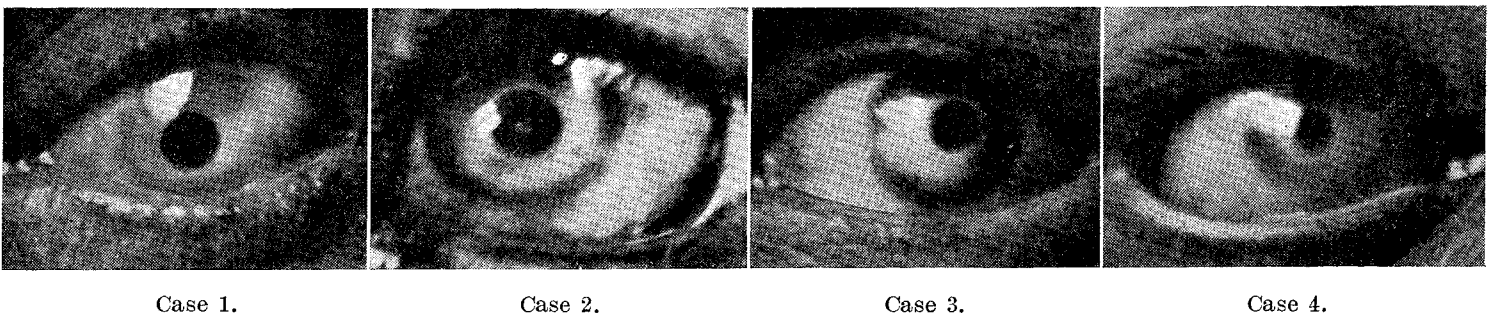


FIG. 2.—Corneal grafts from cadavers. The eyelids are retracted to display the cornea.

There was not a single case of necrosis of the transplant. The post-operative course was pretty much the same as in transplantation from living eyes.

The following were the results of the 95 operations.

There were 46 cases of non-transparent union and 17 cases of half transparent union. In one of these cases a greyish film has formed on the posterior surface of the transplant.

In 4 cases, in one of which the transplantation was performed after six days' preservation of the eye, the union was transparent, but a connective tissue film had formed in each case on the posterior surface of the transplant.

Lastly, there were 18 cases of transparent union. By this I mean that the details of the anterior chamber could be clearly made out at least through a part of the transplant or that there was a good light reflex through it.

The 18 cases of transparent union, and also those cases of transparent union in which a connective

cadaver's cornea on Dec. 12th, 1935. The eye taken from the cadaver had been preserved for 27 hours.

Result.—Vision = 0.4. Fundus oculi clearly visible. Anterior pole cataract distinctly visible. Length of observation (Nov. 1st, 1936) 10½ months (Fig. 2).

CASE 3.—Leukoma formed after a thermic burn. Vision before the operation: perception of hand movements. Transplantation of cadaver's cornea on Oct. 28th, 1934. The eye had been removed from the cadaver 3 hours after death and subsequently preserved for 27 hours.

Result.—Vision = 0.4. Anterior pole cataract. Fundus oculi clearly visible. Length of observation (Nov. 1st, 1936) 2 years (Fig. 2).

CASE 4.—Aged 12. Leukoma after parenchymatous keratitis. Vision before the operation: able to count fingers held before her face. The eye had been taken from a cadaver 12 hours after death and subsequently preserved for 26 hours.

* Cases 1, 2, and 5 were demonstrated at the All-Union Meeting of Ophthalmologists of the U.S.S.R. in June, 1936.

Result.—Vision = 0.1 with a -9 D lens. Fundus oculi distinctly visible. Period of observation (Oct. 1st, 1936) 2½ years (Fig. 2).

CASE 5.*—Leukoma after parenchymatous keratitis. Vision before the operation = 0.02. Transplantation of cadaver's cornea on Oct. 28th, 1935. Eye removed from the cadaver 2 hours after death, preserved a further 28 hours.

Result.—Vision = 0.9. Length of observation (Nov. 1st, 1936) 12 months.

The cases cited above bear witness to the fact that a cornea from a cadaver's eye, preserved at a temperature of 4°–6° C., is perfectly suitable for transplantation. Analysing my material and taking into account the quality of the leukomatous substratum, in which the transplant from the cadaver is placed, I have gained the impression that the results of transplantation from cadavers' eyes are not inferior to those obtained with grafts from living eyes. For a final opinion it is of course still necessary to follow up the more remote results of the operations. On the other hand it may be said that the present results in my series of cases that have been under observation from 1½ to 2½ years, would already seem to justify the expectation that the more remote results will be favourable.

Investigations are being made in my laboratory on the retention of vitality by the cornea under various conditions of preservation. Experiments carried on by Dr. Bazhenova have shown that the cornea of rabbits' eyes may show a good tissue growth when planted in vitro even after ten days' preservation at a temperature of 2° C. In collaboration with Bazhenova I have obtained a tissue culture from dried cornea. Working in my laboratory Velter has shown in rabbits the possibility of transparent union of the cornea taken from eyes, preserved at a temperature of +2° C. for as long as fifteen days. My pupil, Dr. Pupenko, has brought forth evidence for migration of cells and their formation into clusters in the cornea (and in other tissues) after preservation of the material for eight days at a temperature of 2° C.

CONCLUSIONS

The cornea from eyes of human cadavers, removed some hours after death and preserved at a temperature of 4°–6° C., is suitable for homoplastic transplantation in man, the transplant retaining permanent transparency after union with the substratum.

The new source of material for transplantation opens up great possibilities for further investigations on corneal grafting.

In connexion with the transfusion of preserved cadavers' blood, first applied to dogs by Prof. W. N. Shamov and to man by Prof. Yudin, the successful transplantation of preserved cadavers' corneas is of great interest not only from a clinical but also from a general biological point of view.

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EFFECT OF CALCIUM AND VITAMINS A AND D ON INCIDENCE OF PREGNANCY TOXÆMIA

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THE following experiment, carried out at St. Mary Abbotts Hospital,* London, during 1936, was devised to determine whether the mere addition of calcium and vitamins A and D to the dietaries of patients attending the antenatal clinic would have any effect on the incidence of toxæmic symptoms.

Apparently healthy women, not more than twenty-four weeks' pregnant, were divided by the sister into two groups when they first attended at the clinic, no attention being paid to their previous obstetric histories. They were divided at random in the following manner:—

An equal number of blue and white beads were placed in a box. Each woman accepted for the experiment was asked to draw a bead from the box. Those who drew blue beads were placed in Group A while those who drew white beads were placed in Group B. The beads drawn out were placed in a separate container.

The patients in Group A were requested to take daily, for the remainder of their pregnancies, calcium lactate 20 grains, vitamin A (11,000 international units) and naturally occurring vitamin D (450 units); while those in Group B served as controls. The oil containing the vitamins was supplied in capsules, of which four were to be taken every day, while the calcium lactate was distributed in the form of tablets. No advice concerning diet was given to either group of patients.

Each group contained 50 women. In Group A 25, and in Group B 26, were primigravida. The symptoms were recorded by independent antenatal officers who had no knowledge as to which patients were receiving the additional substances. All patients developing albuminuria, showing hypertension, or suffering from excessive vomiting, or œdema were admitted into the antenatal ward. Those suffering from insomnia or severe headaches were also advised to go into hospital.

RESULTS

The results obtained are shown in Tables I and II. The symptoms of the patients admitted for albuminuria and hypertension are not included, so that the heading "symptoms" refers to patients

* This obstetric unit is affiliated to the British Postgraduate Medical School, Hammersmith, London.

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