EXPERIMENTAL CHANGES IN THE MICROCIRCULATION OF THE EYE

A. P. Krasnikova

UDC 617.7-089-092.9-07:617.7-005-07

Experiments on rabbits revealed high adaptability of the microcirculation of the eye following transplantation of the muscle and conjunctive tissue of the eyelid into the iris, choroid, and retina.

The clinical effect of operations to graft muscle to the vascular membrane and retina of the eye is probably due to invasion of blood vessles. However, the first experiments to transplant the lateral rectus muscle to the vascular membrane for retinitis pigmentosa and experimental subscleral transplantation of a graft from the frontalis muscle [1] were not analyzed morphologically.

Accordingly, in the present investigation the adaptability of the microcirculation of the eye was studied in experiments on rabbits.

EXPERIMENTAL METHOD

In experiments on 20 rabbits a pedicle graft was taken from the circular muscle of the upper eyelid together with the conjunctiva. By this technique, additional sources of blood supply from the external carotid arterial system can be taken to the membranes of the eye. Five eyes on which no operation was performed were used as the controls. Under local epibulbar anesthesia with 0.5% xylocaine solution and retrobulbar anesthesia with 1% procaine an incision was made in the region of the limbus through which the graft of muscle and conjunctiva was taken into the anterior chamber of the eye until it was in contact with the surface of the iris. The graft was sutured to the cornea. In another series of experiments the graft of muscle and conjunctiva was taken through an incision in the superolateral quadrant of the sclera. The experimental rabbits were decapitated two months later and the blood vessels quickly injected through the common carotid artery with black ink or with oil paint dissolved in pinene. The contrast material was injected into the vessels from a 20-ml syringe by gentle application of pressure to the plunger. The lumen of the vessels was measured by a screw-adjusted AM-9-2 micrometer.

EXPERIMENTAL RESULTS

The microcirculatory systems of the membranes of the eye possess high adaptability. The cornea of the corresponding segment is vascularized by invasion of newly formed blood vessels from the pericorneal vascular plexus. In all the experiments the newly formed corneal vessels are irregular in diameter and have numerous anastomoses, and their lumen varies from 15 to 48μ.

After grafting of muscle to the iris, capillaries are the first to grow. They were formed in the region of contact between the graft and the iris and their lumen was 3-4μ. The shape and diameter of the blood vessels of the iris were considerably modified in the region of the grafted tissue. The greater arterial circle of the iris became tortuous and the lumen of the vessels forming it increased to 200μ (in the normal state 82μ).

Department of Eye Diseases, Stabropol' Medical Institute. Department of Normal Anatomy, N. I. Pirogov Second Moscow Medical Institute. (Presented by Academicain of the Academy of Medical Sciences of the USSR A. M. Chernukh.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 73, No. 3, pp. 18–20, March, 1972. Original article submitted July 14, 1970.

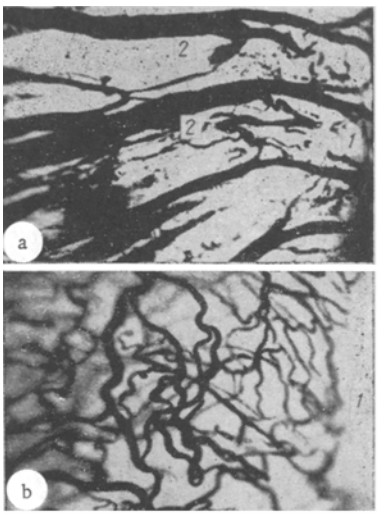

Fig. 1

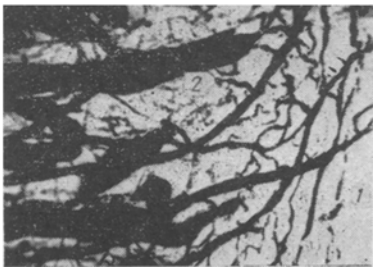

Fig. 2

Fig. 1. Blood vessels of the iris of grafted (a) and control (b) rabbits: 1) pupillary zone; 2) arteriole. Vessels injected with black ink, 80×.

Fig. 2. Venules of the iris: 1) pupil; 2) venule. Vessels injected with black ink, 80×.

Arterioles with a greatly enlarged lumen (up to 90–110μ in diameter) leave the arterial circle to enter the tissue of the iris (Fig. 1a). In the pupillary zone of the iris these vessels constrict to 40μ, while in the region of the sphincter they acquire the normal diameter of 6–25 μ. In control rabbits the vessles of the iris are uniform in diameter (Fig. 1b). In all probability the additional inflow of blood along the newly formed anastomoses corresponds to dilatation of the arterioles.

Smooth-muscle fibers of the sphincter in the pupillary zone of the iris help to maintain the normal lumen of the blood vessels in this zone, especially since the pupil constricts as a result of the operation. Adaptive changes in the vessels of the iris thus depend to some extent on the specific nature of its structure. The sphincter pupillae, whose function is to regulate the inflow of light to the retina, and which is in constant movement, thus influences the lumen of the vessels.

An increased inflow of blood into the artery causes stretching of the vessel wall not only diametrically, but also longitudinally, with the resulting appearance of bending of the arterioles at an angle at the places where they give off branches into the deeper layer of the iris.

Dilatation of the arterioles and precapillaries, ensuring an abundant supply of blood at high pressure, provides for the more rapid replacement of the blood in the capillaries and thus improves exchange processes between the blood and tissue in the membranes of the eye.

The diameter of the venules is considerably widened: in the region of the sphicter it is 6–25 μ, and outside the papillary zone 62–121 μ (Fig. 2). In the flat part of the ciliary body the venules are oval-shaped with a central constriction, or bulb-shaped. The diameter of the lumen of these dilated portions (179–235 μ) is several times greater than normal (50–105 μ).

After transplantation of muscle and conjunctival tissue into the posterior segment of the eye newly formed capillaries of the vascular membrane are irregular in diameter, anastomose widely with each other, and form sinusoidal dilatations where they give off branches. Their lumen varies from 4 to 16 μ. An anastomosis 35 μ in diameter is formed between the vessels of the graft and the vascular membrane of the eye. Vessels injured at operation acquire anastomoses with neighboring branches through these dilated capillaries.

After the grafting of muscle tissue into the membranes of the eye the terminal loops of the retinal vessels, which increase considerably in length, run up to the site of the graft and sink into the newly formed tissue. The diameter of the retinal vessels is not appreciably increased.

Invasion of blood vessels from the graft into the membranes of the eye was observed in 12 of 20 cases, i.e., in 60% of the experiments.

The results show that new blood vessels can enter the membranes of the eye from other sources of blood supply and they provide morphological evidence in support of the clinical value of operations of this type.

LITERATURE CITED

1. D. B. Voloshinov, in: Proceedings of a Scientific Conference to Commemorate S. V. Ochapovskii's 90th Birthday [in Russian], Krasnodar (1968), p. 150.