THE CORNEAL TEMPERATURE AS AN INDEX OF INTENSITY OF THE CIRCULATION IN THE ANTERIOR SEGMENT OF THE EYE

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During recent years the temperature of the eye has been regarded in the ophthalmological literature as an index of the intensity of the circulation in its tunica vasculosa [1-5].

In the present investigation changes in the corneal temperature were studied in relation to the state of the blood flow or the circulation of aqueous humor.

EXPERIMENTAL METHOD

Experiments were carried out on 16 rabbits, in 12 of which, under urethane anesthesia, diathermy coagulation of the posterior long ciliary arteries was carried out: one artery in the right eye (the nasal or the temporal), both arteries in the left eye. The corneal temperature was measured by means of the pointed detector of a type TÉMP-60 medical semiconductor electrothermometer at 5 places: in the center and at 4 points immediately next to the limbus – dorsally, ventrally, medially, and laterally. The measurements were made on four successive days before the operation, immediately after the operation, and thereafter for 30 days (daily for the first ten days, and subsequently on the 12th, 15th, 20th, 25th, and 30th days) under local amethocaine anesthesia, maintaining the same strict order of the points of measurement, and in the same room with an air temperature of 22-23°, with uniform illumination and pressure of the detector on the cornea. The animals were sacrificed at various times after the operation, after which the blood vessels were injected so that the morphological picture of the vessels of the eye could be examined in the postoperative period. Control rabbits underwent a similar operation with measurements of the temperature, with the difference that diathermy coagulation of the sclera was carried out at a distance of 3-4 mm away from the long ciliary arteries.

EXPERIMENTAL RESULTS

In normal conditions the corneal temperature of the rabbits lay between the following limits: limbus – from 28.1 to 33.8°, mean 30.4°; in the center of the cornea – from 27-34°, mean 29.4°. The temperature of the limbus was on the average 1° higher than the temperature of the center of the cornea, but the difference between these temperatures varied from 0.2 to 2.8°. Only in two measurements was the temperature of the center of the cornea higher than the mean temperature of the limbus, by 0.2 and 0.1° respectively.

The exclusion of one posterior long ciliary artery had only a very slight effect on the absolute values of the corneal temperature: the temperature curves following coagulation of one long ciliary artery (Fig. 1B) differed only slightly from the control curves (Fig. 1A). The difference between the temperature at the limbus and in the center of the cornea also showed little change. However, the results of these experiments clearly revealed a decrease in the corneal temperature at the limbus on the side of the coagulated artery by comparison with the temperature on the intact side. The difference between the temperature at the limbus of the cornea at opposite points of its horizontal meridian was 0-2.2° in normal conditions, but immediately after coagulation of the long ciliary artery the difference increased to 3.7°. As a rule, moreover, the temperature was higher on the side of the intact artery. The dynamics of the mean difference between these temperatures in the postoperative period is illustrated in Fig. 1C.

A close connection was found between these changes in the corneal temperature and the morphological changes in the vascular system of the anterior segments of the eye. Immediately after coagulation of one long ciliary artery, ischemia of the iris and the ciliary processes developed on the side of the operation, and as was seen above, this was reflected in the temperature of the corresponding side of the cornea.

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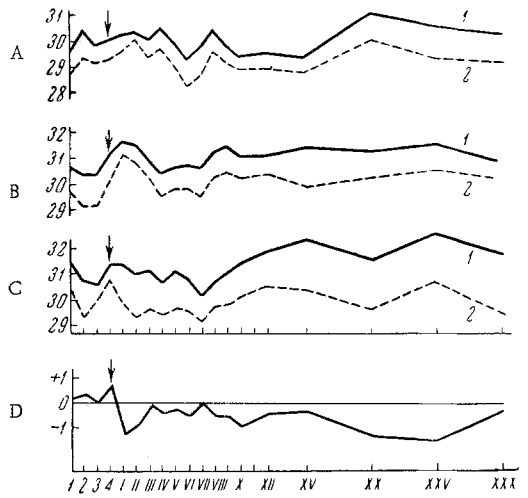

Fig. 1. Mean corneal temperature of the rabbit's eye in control animals with coagulation of the sclera without disturbance of the blood flow in the ciliary arteries (A), and after diathermy coagulation of one posterior long ciliary artery (B) and two long ciliary arteries (C). D) Mean deviation of the corneal temperature at the limbus on the side of diathermy coagulation of the posterior long ciliary artery from the temperature of the limbus on the side of the intact vessel. 1) Temperature of limbus; 2) temperature of the center of the cornea. The Arabic numbers denote the days before the operation and the Roman numbers the days after the operation.

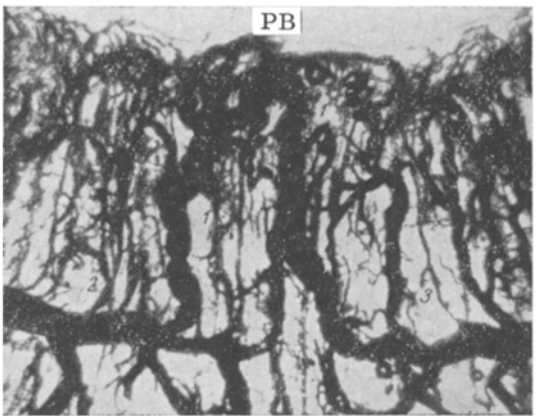

Fig. 2. Arterial arch (1) developing in the iris and joining the circular arteries of the iris on the sides of the coagulated (2) and intact (3) long ciliary arteries. Experiment lasting ten days. PB) Pupillary border of the iris. Photomicrograph. Magnification objective 24×, ocular 5×.

Meanwhile, the development of collateral blood vessels to the ischemic area began, mainly on account of dilatation of anastomoses between the circular arteries of the iris on the opposite sides (Fig. 2). As a result of this, the inact long ciliary artery became the main source of supply of the whole of the iris and the ciliary body. The intensity of the blood flow in this artery was much greater than on the side of the coagulated vessel, and this also was reflected in the difference in temperatures of the cornea on the corresponding sides.

The main effect of diathermy coagulation of two posterior long ciliary arteries was a decrease in the corneal temperature immediately after the operation, the mean temperature at the limbus falling by 0.6° and in the center of the cornea by 1.1°. The subsequent changes in the corneal temperature are shown in Fig. 1C, and consisted mainly of an increase in the difference between the mean temperature of the limbus and the center of the cornea. In some cases this difference on the first day after the operation reached 4.1°, and on the second day 3.3°.

The principal morphological changes in the vascular system of the eye after coagulation of two long ciliary arteries was marked destruction of the blood vessels of the iris and ciliary processes, possibly responsible for the decrease in intensity of formation of the aqueous. Hence, the decrease in the corneal temperature immediately after the operation was due, in the author's opinion, to two factors: first, a decrease in the intensity of the blood flow in the vessels of the iris and ciliary body, and second, to a decrease in the flow of aqueous in accordance with the generally accepted scheme (posterior chamber – pupil – anterior chamber of the eye). In the center of the cornea the temperature fell more than at the limbus, because after coagulation of the long ciliary arteries the limbus of the cornea is the primary place of development of collateral blood channels to the iris and ciliary body, formed by transcleral anastromoses. The marked dilatation of the blood vessels arising in these circumstances near the limbus of the cornea, together with the vascularization of the cornea from the limbus, developing in some cases, and the associated increase in the intensity of the blood flow in this region naturally had more effect on the temperature here than in the center of the cornea, where the flow of aqueous had more influence on this index.

It may be concluded from the facts described above that the corneal temperature, measured by an electrothermometer at various points while maintaining identical conditions of measurement, may be used as an index of changes in the intensity of the blood flow in the system of the long ciliary and anterior ciliary arteries. The advantages of measurement of the corneal temperature over its determination in other parts of the eye are the absence of vessels in this region, removing a source of error connected with placing the detector at a point at a varied distance from large blood vessels, and the accessibility of the part for measurement, excluding injury to the eye and making repeated and frequency measurements possible.

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