also consistent with the previously reported reduced [K+] of these corneas.11

Measurement of QO2 at various temperatures permitted calculation of corneal Qa. The Qa progressively increases from 1.56 at stage 40 to 2.03 in the 2-week-old hatched chick (Table I). This last value compares favorably with the Qa value obtained in adult rabbit cornea (1.96)7 and indicates that the metabolism of the hatched chick cornea, but not the embryonic cornea, is similar to that of other biological systems.

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Choroid tension and facility of aqueous outflow. ROBERT A. MOSES AND WALTER J. GRODZKI, JR.

Tension of the choroid of enucleated eyes was adjusted by incising the sclera and lengthening the eye. The facility of outflow increased in direct proportion to choroid stretch. The present results are compared with reported results of anterior chamber deepening and lens depression in vitro and with accommodation and goniospasm in vivo. Choroid stretch in the enucleated eye is less efficient in increasing outflow facility than is equivalent choroid movement in accommodation. Anterior chamber deepening and lens depression also appear to be relatively inefficient means of enhancing outflow facility, although goniospasm appears to be relatively efficient. The suggestion is made that traction of the ciliary body on the trabecular mesh in an axipetal direction is more efficient in enhancing outflow facility than is traction in the meridional direction.

Considerable evidence exists that ciliary muscle contraction increases the facility of aqueous outflow. Thus Armaly and Jepson found an increase of facility with accommodation, and the facility-increasing effect of miotic drugs is well known. Increase of facility of outflow is also known to occur during perfusion of the anterior chamber when the anterior chamber deepens, presumably in part due to traction on the ciliary body through the zonules by the retroplaced lens. The effect of lens depression was quantitated by Van Buskirk and Grant, who showed that facility is directly related to retrodisplacement of the lens. Traction on the ciliary body by the zonules during lens depression is backward and inward toward the axis of the eye, simulating to some degree ciliary muscle tension on the trabecular mesh. The present report describes an attempt to simulate ciliary muscle contraction by tensing the choroid.

Materials and methods. Nineteen enucleated human eyes 1 to 5 days post-mortem were used. The steps in preparation of the eye for perfusion (Fig. 1) are as follows:

1. Mark a circle 17 mm. in diameter on the anterior sclera parallel to the limbus.
2. Place a 5 mm. trephine hole in the cornea,
Fig. 1. Eye prepared for perfusion with stretched uvea. U, Uvea bridging gap in sclera; S, continuous suture in sclera; G, Grant perfusion fitting in cornea; P, tubing to perfuser; R, rubber; Sf, stone; M, micrometer.

remove the iris by traction, and insert a Grant fitting. Perfuse at the selected pressure.

3. Place the cornea in light contact with a tube around the perfusion fitting, and pour dental impression rubber into the tube to form a cast of the cornea which incorporates the perfusion fitting. Tube is held in upper arm of a C-frame.

4. Pour dental stone in cup around posterior portion of the eye to just anterior to the eye equator. Cup of dental stone is held by lower arm of C-frame.

5. Lower intraocular pressure to 3 to 4 mm Hg below atmospheric pressure, and incise sclera to uvea along the circle marked in step 1.

6. Unite sclera with continuous suture.

The eye is now ready for the perfusion experiments. These invariably begin with the sclera sewn closed.

Increased choroid tension is developed as follows. Lower intraocular pressure, loosen suture, and separate sclera by moving arm of clamp a measured amount. Adjust suture to bridge scleral gap, and perfuse. This step is repeated with opening or closing of the scleral gap as necessary to satisfy the protocol. It is desirable to lower intraocular pressure when making suture adjustments so that the uvea is drawn inward away from the sclera where it is less likely to be punctured or dragged into needle holes by the suture. Perfusion pressures were 20 or 30 mm Hg developed by an Armaly Servoperfuser. Scleral separation was 0.5, 1.0, or 1.5 mm. In most cases the eye was subjected to one perfusion pressure and one scleral separation.

Results. Stretching the choroid increased facility of outflow in all cases. The increase in facility was proportional to the scleral gap (Fig. 2). The least-
squares fit regression line is: Increase of facility = 0.027 + 0.134 (mm. scleral separation), r = 0.60, p <0.001.

Discussion. Accommodation and miotic drugs increase facility of outflow, presumably by increasing tension on the scleral spur-trabecular mesh or perhaps by some spreading action on the lamellae of the mesh. Four experimental procedures which vary the facility are alteration of anterior chamber depth, lens depression, goniospasms, and choroid tensing. Tension on the spur-procedures which vary the facility are alteration of choroidal stretch. In the present experiment, deepening of the anterior chamber and lens depression probably are somewhat similar in mechanism; in both, an element of posterior traction on the mesh modifies the axipetal force of the circular elastic elements and zonules (Fig. 3, B). Goniospasms would appear to exert an axipetal force similar to circular ciliary muscle contraction (Fig. 3, C). Choroidal tensing, on the other hand, tends to pull posteriorly on the trabecular mesh (Fig. 3, D).

Quantitative data are available with which to compare the effects of accommodation and choroidal tensing on facility of outflow. Armaly and Jepson found that accommodation of 4.00 D increased facility 0.100 nl min.~1 mm. Hg~1 and since we have estimated that the ora serrata advances 0.05 mm. per diopter accommodation, it may be said that in accommodation, facility increases 0.530 nl min.~1 mm. Hg~1 per millimeter of choroidal stretch. In the present experiment, facility increased 0.134 nl min.~1 mm. Hg~1 per millimeter of choroidal stretch or only one-fourth the increase in facility per millimeter of choroidal stretch found in accommodation. Chamber deepening is associated with increase of facility of 0.130 nl min.~1 mm. Hg~1 per millimeter deepening (Becker and Constant, 1962; Francois et al., 1972; and Francois et al., 1972). Lens depression is associated with only 0.036 nl min.~1 mm. Hg~1 per millimeter depression, and therefore chamber deepening and lens depression are not equivalent (Fig. 3). Although the data for quantitative comparison of the efficiency of different force applications are not available, it would appear that chamber deepening and lens depression are, like choroid tensing, relatively inefficient methods for augmenting facility of outflow compared to accommodation. Goniospasm, in spite of the seemingly weak structure of the peripheral iris and in spite of the fact that in this procedure, traction is made on perhaps only one quadrant of the ciliary body, seems to increase facility substantially. Accommodation and goniospasm both increase axipetal forces. One might speculate that axipetal tractions on the trabecular mesh-spar are more efficient in augmenting facility than are more posteriorly directed traction.

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