Age changes of the inner surface of the trabecular meshwork shown by the replica technique

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Inner surface of the trabecular meshwork in eighteen human eyes between 5 and 80 years of age were studied by means of the wet replica technique. Three different kinds of age changes can occur separately and differ not only with respect to age, but also within the same age group, and even within the same eye. They all begin mostly in small, circumscribed areas at the corneal margin and from there they can eventually encroach upon the whole circumference of the anterior chamber angle. The replica technique has definite advantages for this type of investigation.

A study of the inner surface of the normal human trabecular meshwork using the replica technique has already been presented. The same technique was used presently for the investigation of age changes in this area. Studies of age changes of the trabecular meshwork and of the zone of transition have been published by several authors using current histologic methods. Yet the wet replica technique presents many advantages in demonstration of surface changes in their general topography and pattern over large areas.

Material and methods

Eighteen human eyes ranging in age from 5 to 80 years were examined. The adult structures were studied from the thirty-fifth year up. Most of the eyes were from subjects between 60 and 80 years of age (10 eyes). None of the subjects investigated showed signs of glaucoma or diabetes. Ten eyes were obtained at autopsy, the rest of the eyes were removed due to melanoblastoma of the posterior segment. Anterior segments were fixed in 10 per cent buffered formalin for seven to eight days, rinsed in water, and divided in halves meridionally. The iris and the ciliary body were removed in such a way that the meridional portion of the ciliary muscle remained adhering to the sclera. This part was then used for making replicas; pictures were taken using an oblique illumination as previously described.

Findings

Three different categories of surface changes were found: (1) the most frequent were Hassall-Henle bodies at the periphery of Descemet's membrane. The remaining changes were of almost equal frequency: (2) beautifully curled, winding fibers at the zone of transition and at the periphery of Descemet's membrane, and...
(3) nodular, spiral, or ring-shaped swellings of uveal trabecules.

Each of these changes can occur by itself; in most cases, however, two or all three of them can co-exist within the same eye. The replica method reveals such changes showing at least one-half of the cornea and the trabecular meshwork. The degree of changes varies not only according to the age of the subject, but also within the same eye.

Hassall-Henle bodies were found from the thirty-fifth year up. Nevertheless, they can be only slightly developed even in more aged people (Fig. 1). The same variability occurs in the case of curled fibers at the zone of transition; smooth and thick fibers emerge at the periphery of the zone of transition, cross directly beneath the endothelium to the corneal margin becoming thinner and splitting up in more straight fibers (Figs. 2 and 3). Sometimes such fibers can be seen climbing over the top of Hassall-Henle bodies at the extreme corneal periphery (Fig. 4). Other terminal fibers are twisting among Hassall-Henle bodies. Jabonero's silver stain showed endothelial nuclei among the crests of curled fibers. In lower decades, such fibers have a less curled shape.

The fibers of the uveal part of the trabecular meshwork display, at first, isolated ring-shaped thickenings or nodular swellings; later on almost all of them can be grossly changed. Ring-shaped nodosities cover the whole uveal meshwork and many isolated nodular swellings are bulging at the crossings of trabeculae. Even such changes are individual; we have seen all the trabecules deformed in a 78-year-old subject (Fig. 5), whereas in both of our 80-year-old subjects, changes were localized and less marked (Table I).

Comment

All the reported changes are in accord with the description by Rohen and Lütjen-
Fig. 5. A general view of the trabecular meshwork of a person aged 78. Generalized ring-shaped and nodular swellings along all the uveal meshwork. Original magnification, ×200.

### Table I. Frequency of changes

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<th>1st</th>
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<td>+</td>
<td>++</td>
<td>+++</td>
<td></td>
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<td>Curly fibers</td>
<td>0</td>
<td>0</td>
<td>±</td>
<td>++</td>
<td>+++</td>
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<tr>
<td>Ring or nodular swellings</td>
<td>0</td>
<td>0</td>
<td>±</td>
<td>++</td>
<td>++</td>
<td></td>
<td></td>
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<tr>
<td>Number of eyes examined</td>
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<td>3</td>
<td>4</td>
<td>3</td>
<td>7</td>
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This table is, of course, only tentative; many more cases would be necessary for a satisfying statistic. All three changes are age changes, but their degree and extension are variable.

0, no changes found.
±, in some eyes only.
+, poorly developed in all eyes examined.
++, more conspicuous, but only at places.
+++ in all cases along large areas of the corneal circumference.

Drecoll. Nodular thickening were described by Speakman and later on by Wolter who believed them to be the result of a retraction and shortening of uveal trabecules by fixation. The detailed work of Rohen and Lütjen-Drecoll showed that the deformities correspond with the accumulation of the "lattice collagen" and with the thickening of the subendothelial layer. Their results are in accord with our replica findings even in respect to the "patchy" beginning of changes. Curled fibers at the zone of transition should be identical with their "curly fibrous strands" as shown in their 1968 paper (Figs. 5, A and B). We also noted an intact endothelial covering over such fibers. Such newly formed fibers are perhaps due to the higher activity of the endothelium in the aged. The only difference against the findings of Rohen and Lütjen-Drecoll seems to be in the superficial site of such fibers; some of them are climbing over the top of Hassall-Henle bodies, others are twisting among them. This is supported by the findings of Feeney and Garron who, in Figs. 1 and 4 of their paper, show collagen strands directly beneath the peripheral endothelium among the Hassall-Henle bodies.

According to Vál and Fehér, the trabecular meshwork, Schlemm's canal, ciliary muscle, and iris root represent a functional unit; Feeney and Garron stress the possibility of a functional influence of the contractions of the ciliary muscle with regard to the origin of Hassall-Henle bodies. In such case, of course, the contractions of the ciliary muscle should not act uniformly at the whole corneal margin. Our findings, as well as those by Rohen and Lütjen-Drecoll show that senile changes of the uveal meshwork, corneal periphery, and nerve net of the meshwork are at first localized to small areas.

The replica technique is useful in showing the topography and pattern of the whole periphery of the anterior chamber angle. It also shows great differences in the width of the zone of transition and the variable degree of age changes within the same eye. It supplies a general view, it is quick and easy to perform, shows sufficiently fine details, and eliminates the distorting dehydration.

**REFERENCES**

4. Wolter, J. R.: Rings and nodules on the