Anterior corneal mosaic

Further observations

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The clinical features of the anterior corneal mosaic were described in an earlier communication (Bron, 1968). It is the purpose of this present study to add to these observations and to unify them in a single hypothesis as to the origin of the pattern.

The corneal mosaic may be observed in several ways:

(1) Induced by rubbing the cornea through the lids:

- (a) as an entoptic pattern (Bull, 1894).
- (b) as a groove pattern on the corneal surface:
 - (i) seen by reflectography (Fischer, 1928).
 - (ii) seen on slit-lamp examination in the zone of specular reflection from the tear film.
 - (iii) seen in the presence of fluorescein in the conjunctival sac (Schweitzer, 1967; Bron, 1967).
- (c) as a pattern seen against the red reflex of the fundus (Hirschberg, 1901; Cogan, 1951; Bron, 1967).

(2) Induced by flattening the corneal surface (Bron, 1967; Norn, 1968):

- (a) as a pattern seen in the presence of fluorescein during applanation tonometry.
- (b) as a pattern seen against the red reflex when a glass plate is pressed against the corneal surface.

(3) Induced by manipulation of the cornea, as a ridge pattern visible when the tear film has evaporated from the corneal surface.

The entoptic pattern and the ridge patterns are assumed to be the same as the anterior corneal mosaic pattern in a given cornea, since the shape and dimensions of the polygons are similar in each case. By direct observation and photography the remaining forms of mosaic pattern can be shown to be identical to each other.

The ridge pattern, which has not been previously reported, is here described in detail.

The polygonal ridge pattern

This is seen only when the fluid film over the corneal surface is minimal or absent, which explains why it has not been observed in the course of routine clinical examination of the cornea. During corneal surgery, however, when the lids are held open and the tear film has time to evaporate, the pattern may be consistently seen as a delicate reticular ribbing raised like the veins of a leaf on the surface of the cornea. These ridges may be seen without manipulation in a small proportion of corneae, especially if the ocular tension is low, but certain procedures accentuate their prominence and make them easily visible to the naked eye.

Light pressure with a blunt instrument on the surface of the intact cornea during surgery reveals the ribbed pattern in the impressed area and in its close proximity. The details of the pattern remain constant whenever a similar stimulus is reapplied and, therefore, are independent of the chance stress lines incidentally induced by direct pressure.

The ridges can be seen constantly in any cataract operation once the section has been cut and the eye opened, and they are particularly pronounced if any area of the corneal surface becomes concave. They may be seen during lamellar corneal dissection especially while the cornea is being dissected from its bed. Once free, the disc may show the surface pattern with little manipulation, and it is then best observed by retroillumination (Fig. 1).

FIG. 1 *Lamellar corneal disc viewed by retroillumination from the glass slide which supports it (Disc cut by microkeratome)*

In the enucleated eye the ridges may be induced as easily as in the living eye. When the enucleated eye is soft, this pattern is evident where the corneal curve is flattened or concave. If the pressure in the eye is then raised the ridges disappear as the cornea resumes its convex shape (Fig. 2).

FIG. 2 *Enucleated eye. Epithelium removed*

(a) Ocular tension lowered; polygonal ridge pattern seen in Bowman's membrane

(b) Ocular tension raised. The ridges have disappeared and Bowman's membrane shows a smooth patina

The ridges may be induced by local pressure as in the living eye, and however induced this pattern can be preserved by appropriate fixation (Fig. 3). Neoprene casts may be prepared from such specimens (Fig. 4).

FIG. 3 *Polygonal ridge pattern seen in a formalin-fixed eye. The epithelium is intact*

FIG. 4 *Neoprene cast of polygonal ridge pattern*

Problems of dehydration, shrinkage, and photography, however, make it difficult to match the various forms of mosaic pattern seen in the living eye with that seen in the enucleated eye, where comparison is possible.

Induction of the ridge pattern in the living or enucleated eye by the procedures mentioned is not prevented by removal of the corneal epithelium. This is of great importance in attempting to identify the site of the structure responsible for the anterior corneal mosaic. It clearly points to a subepithelial site, as has already been inferred from indirect observations (Bron, 1968).

Explanatory hypothesis

On the basis of these clinical and laboratory observations a unified hypothesis may be put forward which satisfactorily explains the various ways in which the anterior corneal mosaic appears.

It is suggested that the mosaic may result from a particular arrangement of fibres in Bowman's membrane. These either form an actual network or are so orientated as to produce, when relaxed, a reticular wrinkling of the membrane. This arrangement possibly imparts elastic properties to the network which is assumed to be under tension at normal intraocular pressure. Manipulations which release the tension cause contraction of the network and the tissues attached to it, resulting in the formation of ridges. In these circumstances the epithelium, which is firmly attached to Bowman's membrane, also manifests this ridge pattern.

Relaxation of the above framework could be produced either by low ocular tension, or by flattening of the convex surface of the cornea; this would explain the pattern seen against the red reflex in soft eyes, the ridges produced on impressing the cornea with a blunt instrument, and the pattern seen in the cornea during cataract surgery and lamellar dissection during keratoplasty. The pattern observed during appplanation of the cornea could be similarly explained and it seems likely that fluorescein in the tear film is expressed away from the ridges to form the dark lines of the fluorescent appplanation pattern.

The groove pattern is less readily explained. It seems at first paradoxical that the grooves and ridges may occupy the same sites at different times. It is therefore worth emphasizing certain differences in the manifestations of these two forms of the mosaic pattern (Fig. 5). First, the groove pattern is seen only in the presence of the epithelium. Secondly,

FIG. 5 Induction of mosaic pattern. Diagrammatic representation T = Tear film; E = Epithelium; B = Bowman's membrane

- (a) Normal ocular tension. There are no ridges and no grooves
- (b) Low ocular tension. Ridges are raised in Bowman's membrane and in the epithelium; the tear film is smooth over the ridges
- (c) Low ocular tension. The tear film has evaporated and the surface ridges are visible
- (d) Normal ocular tension. The ridges are induced and the epithelium is compressed over the ridges as a result of rubbing the lid against the cornea
- (e) Cessation of lid rubbing. Ridges absent. Epithelium thinned to form grooves over sites of previous ridges. Tear film follows grooves. Mosaic pattern visible by reflectography and fluorescein
- (f) Later stage after cessation of lid rubbing. Tear film smooth. Epithelial grooves still present. Mosaic pattern visible with fluorescein but not by reflectography

the grooves appear only after the removal of the stimulus required to induce them and then gradually fade, whereas the ridges are maintained as long as the stimulus is applied.

The groove pattern can then be explained as follows: application or rubbing of the cornea through the lids induces the ridge pattern (Fig 5a). Compression and thinning of the epithelium then occurs over the ridges (Fig 5b). When the pressure on the cornea is released, the ridges disappear abruptly but a groove pattern persists in the epithelium in the distribution of the ridges (Fig. 5c). Re-expansion of the compressed epithelium would then follow and the grooves would gradually be obliterated. It is possible that initially the tear film follows the surface undulations of the epithelium (Fig 5d) but that the surface of the tear film becomes smooth some time before the disappearance of the epithelial grooves (Fig. 5e), thus explaining the shorter duration of the reflectographic pattern compared to the duration of the groove pattern seen in the presence of fluorescein.

Visualization of the pattern against the red reflex is assumed to be due to optical changes occurring when the grooves or ridges are formed. This could be due to a realignment of surface structures round the reticular network producing local changes in refractive index.

Summary

Methods of inducing the anterior corneal mosaic pattern are described and a polygonal ridge pattern is reported in detail. The relationship between the ridge and groove patterns of the cornea is discussed. It is suggested that the underlying basis of the anterior corneal mosaic is a reticular structure, having elastic properties situated within or in close proximity to Bowman's membrane.

We wish to thank Professor Norman Ashton and Professor B. R. Jones for their helpful advice during the preparation of this paper and Mr. Derek Ainslie for the microkeratome sections of the cornea which he kindly provided. We are also grateful to Miss E. FitzGerald for secretarial help.

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