ANATOMY OF
THE CORNEA

THESIS

SUBMITTED IN PARTIAL FULFILMENT OF THE
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OPHTHALMOLOGY

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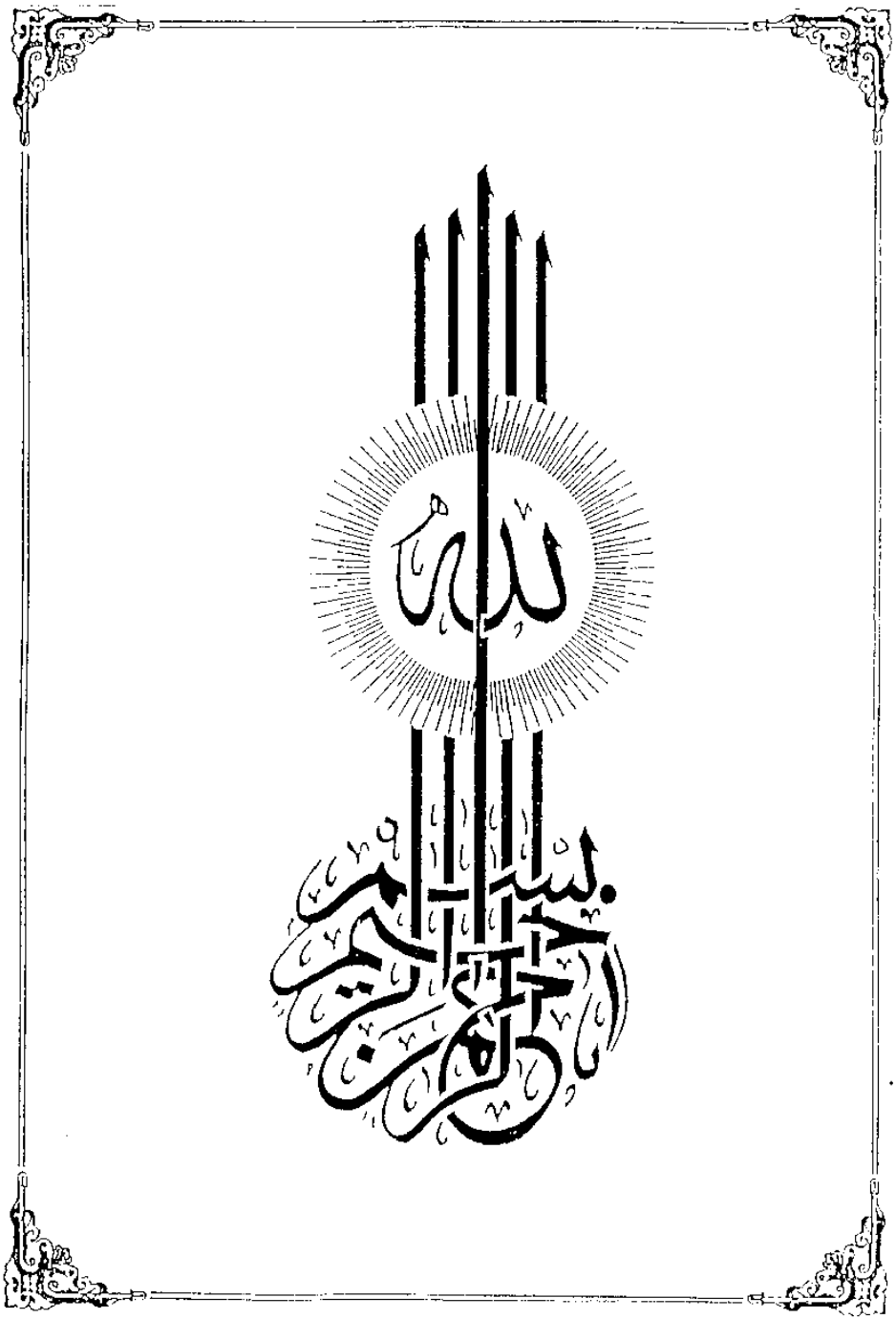

C O N T E N T S

EMBRYOLOGY

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During the fifth week of pregnancy (5 to 8 mm. stage) the cells of the associated mesoderm extend into the optic cup beyond its anterior margin to become aligned beneath and in close relation to the single layer of surface ectoderm (Fig. 1). By the end of the sixth week, (10 to 14 mm. stage) the early corneal endothelium has appeared, originating near the surface ectoderm from the deepest layer of the mesoderm. It first appears as a single layer of cells which differentiates from the periphery toward the centre of the future cornea. The ectoderm covering this developing mesoderm now consists of two layers of cells that will eventually differentiate into the corneal epithelium (Fig. 2). During this period of gestation a second wave of mesoderm extends in to form the primitive corneal substantia propria; this activity is restricted initially to the periphery. Near the end of the seventh week the mesodermal cells have extended across the entire cornea, and numerous collagen fibrils can be identified in the matrix of the cornea. During the eighth week (28 to 30 mm. stage), the primitive cornea and the sclera can be distinguished from each other as collagen fibres become more abundant in the corneal matrix than in that of the sclera, continued development of the epithelium and stroma during the twelfth week (50 to 70 mm. stage) causes the

Fig. 1.- THE DEVELOPMENT OF THE CORNEAL STROMA.
In an embryo of 23 mm. The cellular corneal stroma begins to become evident made up of mesodermal cells migrating from the region of the rim of the optic cup (G. Leplat).
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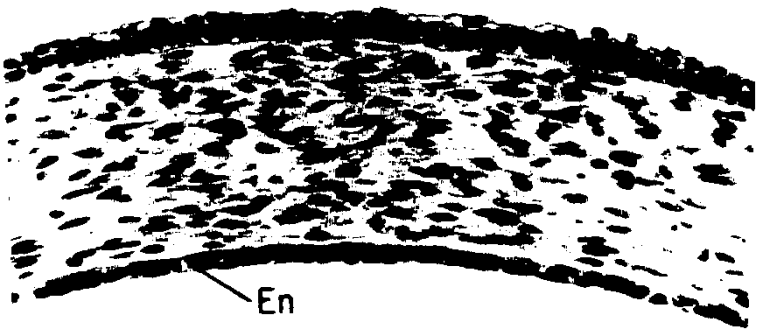

FIG. 2.- THE DEVELOPMENT OF THE CORNEA
At the 30 mm. stage. Note that the epithelium consists of two layers and the endothelium, En, of a single layer (A.N. Barber).
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FIG. 3.- THE DEVELOPMENT OF THE CORNEA.
In a 90 mm. foetus. Showing the beginnings of differentiation of the deeper layers of the corneal stroma (F. Vrabee).
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cornea to become thicker than the sclera and the limbal region becomes apparent. (Fig. 3).

During the fourth month (70 to 110 mm. stage) Bowman's layer and Descemet's membrane appear, the latter at about the 60 to 75 mm. stage and the former at about 103 mm. stage, but Descemet's membrane may be evident as early as the 50 mm. stage (third month) (Fig. 4, 5). The shorter radius of curvature of the cornea compared to that of the sclera becomes evident at this time. The corneal collagen fibrils have reached their full thickness by the 85 mm. stage (Schwartz, 1961). Further differentiation of the two layered epithelium commences during the sixth month (16-20 mm. stage) with the formation of a layer of polyhedral cells between the two layers. At this time the horizontal diameter of the cornea is around 5.00 mm. It increases to 6.5 mm. during the seventh month (200 to 240 mm.), when the corneal curvature has reached its final dimensions.

During the final months of pregnancy, there is a slight increase in corneal thickness and diameter, so that at birth the cornea measures 10 mm. in diameter. After birth it continues to develop and reaches its full dimensions by the end of the first year (Hogan et al., 1971).

FIGS. 4 and 5.- THE DEVELOPMENT OF THE CORNEAL MEMBRANES (George Smeler).

FIG. 4.- The superficial layers of the cornea. From a 6 month's human foetus, showing the 3-layered epithelium and the presence of Bowman's membrane (B).

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FIG. 5.- The deep layers of the cornea. From a 6 months' human foetus, showing the endothelium and Descemet's membrane. Below is the subcapsular epithelium of the lens with the well-developed capsule ; note the shallowness of the anterior chamber.

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GROSS STRUCTURE

GROSS STRUCTURE OF THE CORNEA

The word cornea is derived from Greek Corneus meaning horny. The cornea is a concavo convex clear transparent tissue with a smooth and brilliant surface. Its curvature is somewhat greater than the rest of the globe. It is curved in a meniscus form which fits with a bevelled margin into the anterior scleral foramen like the manner in which a watch glass is set in its rim. There is a slight furrow (the sulcus scleral) which separates it from the sclera (Duke Elder, S., 1960; Wolff, E., 1976; Thomas, C., 1955).

The cornea and the sclera are structurely continous and even histologically. It is very difficult to tell where one ends and the other begins. The line of junction between the two is best seen (with the naked eye) when an eye which has just been removed from the living is divided by a meridional section (Wolff, E., 1976).

Viewed from in front, the cornea is elleptical with the bigger diameter in the horizontal plane. This difference is due to the fact that the sclera and the conjunctiva overlap the cornea more above and below than laterally.

the corneal diameter	Wolff	Duke Elder	Hogan
horizontal diameter	12 mm.	11.7 mm.	11.7 m.
vertical diameter	11 mm.	10.8 mm.	10.6 m.

From behind, the cornea appears circular, and it is about 11.7 mm. in diameter (Fig. 6).

The central one third, or optic zone is almost spherical while the periphery, especially on the Nasal side is somewhat flattened and more so above than below so as to approximate an elleptical form (Gullstrand, 1911).

Microscopic measurements of the cornea vary somewhat as reported by different authers, but the most accurate data are those derived from the optical observations. The tissue swells during fixation, so that histologic measurements show considerable variations, particularly those of thickness. Measurements of the diameter, thickness and radius of the curvature of the cornea also show physiologic variations with age (Thomas, C. 1955).

New born :

Druault and Druault (1946) reported a thorough study of the eyes of the new born in whome the cornea averages 9 to 10 mm. in diameter.

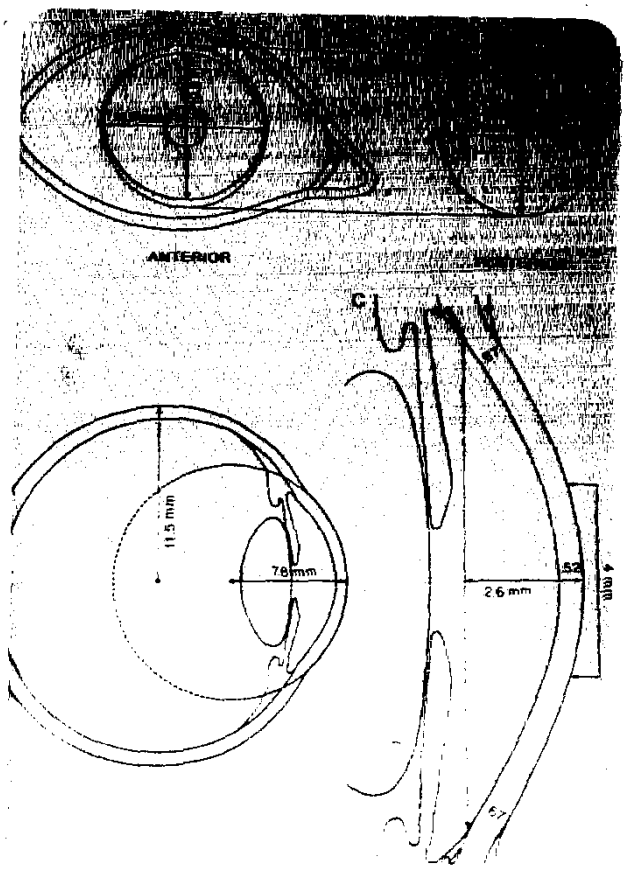

Fig. 6.- These three diagrams show: A, the elliptical shape of the anterior and the round shape of the posterior corneal edges ; also the vertical and horizontal diameters of the anterior and the posterior cornea.

B, The radius of curvature of the cornea and of the sclera.

C, The corneal height and the central 4 mm. of the cornea which is optically important, also the comparative thickness of the central and peripheral cornea.

"Histology of the Human Eye. An Atlas and Text Book. (Hogan et al., 1971)

Hymes (1929) showed the average horizontal corneal diameter of the new born for both males and females to be 9.9 or approximately 10 mm.

According to De Vries, (1946) the average radius is 6.6 to 7.2 mm. but Diekmann, (1946) reported higher values of 7.37 to 7.44 mm.

The thickness of the cornea of the newborn, according to Von Hipple (1946) shows considerable variation from 0.40 to 1.00 mm.

Baratz (1946) studied the cornea during the first month of life and found that it is relatively thick in the new born and gets thinner later. His average measurements were as follows: 0.52 mm. during the first four weeks, 0.29 mm. from one to six months and 0.23 mm. at the age of 11 to 12 months.

Changes with Growth :

Hymes (1929) found that practically all postnatal growth of the cornea occurs during the first half year of life and the structure usually reaches its adult diameter of approximately 11.8 mm. between 6 and 12 months after birth. He obtained no significant sex variation in the absolute diameter.

Other authers are of the opinion that the development of the cornea continues for a longer period. According to Grod (1910) the diameter reaches its final dimensions around the age of two years but Priestly Smith (1934) and Baratz (1946) believed that it continues to develop until the age of about five years.

In their study of the growth of various components of the human eye ball, Wilmer and Scamon, (1956) reported that the average corneal volume of the new born is 97.2 cu. mm., and of the adult 144.8 cu. mm., that is the volume of the adult cornea is approximately one and half times (1.49) that of the new born. The anterior surface of the cornea increases from 132 to 194 sq. mm. between birth and maturity. It is generally recognised that the eye ball as a whole increases somewhat less than three times its size from birth to maturity.

Hence the corneal segment shows only half as much increase as does the remainder of the eye. The relatively large cornea in the eye of the infant reflects this of course. The cornea undergoes a decline in its proportionate extent in relation to the remainder of the eye from 12 percent to less than 7 percent in contrast to the sclera and other structures which show an increase in propotionate size between infancy and maturity (Thomas, C.