

Morphometric study of the cornea in human embryos

Andrzej Styszyński, Małgorzata Bruska, Witold Woźniak

Department of Anatomy, Karol Marcinkowski University School of Medical Sciences, Poznań, Poland

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Morphometric study was conducted on 28, serially sectioned staged human embryos. The cornea is of equal thickness during its early development (stages 15–17). During developmental stages 18 and 19 (7th week) it is thicker in the central part. In the last embryonic week the peripheral part of the cornea becomes thicker than its central part. The performed study elucidates structural differentiation during development of the cornea.

key words: human eye, development, embryonic period, cornea, morphometry

INTRODUCTION

Most of the interest in the development of the human cornea has been concentrated on the early differentiation and structure of that eye coat [1–3,5,10,15–17]. Morphometric studies on the eyes of human embryos and fetuses have been very few, frequently at various periods of development, and no line of continuity could be established to allow the growth of the organ as a whole to be followed. O’Rahilly and Bossy [9] established the growth curve of the human embryonic and fetal eyeballs, basing on linear measurements and the volume of the eyes. Staflova [11] related the size of the eye to the age of human embryos and fetuses, showing that the development of the eye is very stable as compared to other organs.

Harayama et al. [4] measured the diameters of the cornea and eyeball in 220 human fetuses aged from 12 to 28 weeks.

In our previous morphometric studies [12,13] the human embryonic retina and lens were investigated.

In the present study we measured the thickness of the cornea in 28 human embryos aged from 36 to 56 days and correlated our data with histological findings.

MATERIAL AND METHODS

The study was conducted on 28 staged human embryos from the collection of the Department of Anatomy, University School of Medical Sciences in Poznań. All embryos were embedded in toto in paraffin and sectioned serially. The age of the embryos was estimated according to the criteria of the Carnegie Embryological Institute and expressed in postovulatory days and in developmental stages. Serial sections, 5 μm thick, were stained with hematoxylin and eosine. Morphometric studies included the thickness of the cornea in its centre and at its periphery. Measurements were made, with a Leica Image Processing and Analysis System, for 5 consecutive sections and for each section the cornea was measured in 10 different axes. Thus in each embryo 50 measurements were made from which the main value was calculated (Table 1).

RESULTS

The cornea appears in human embryos at stage 15. In these embryos the restored surface ectoderm forms the anterior epithelium of the cornea, which has its own basement membrane. By stage 19 mesenchyme grows between the surface ectoderm and

Table 1. Thickness of cornea in relation to embryonic age

Stage	C-R Length in mm	Age in days	Thickness of cornea in mm	
			Centre	Periphery
15	8.0	36	0.008 ± 0.001	0.009 ± 0.001
15	8.0	36	0.011 ± 0.001	0.010 ± 0.001
15	8.5	36	0.010 ± 0.001	0.009 ± 0.001
15	9.0	36	0.010 ± 0.001	0.008 ± 0.001
16	10.0	38	0.011 ± 0.001	0.010 ± 0.001
16	10.0	38	0.010 ± 0.001	0.011 ± 0.001
16	10.0	38	0.012 ± 0.001	0.009 ± 0.001
16	11.0	38	0.009 ± 0.001	0.012 ± 0.001
16	11.0	38	0.010 ± 0.001	0.012 ± 0.001
16	12.0	38	0.009 ± 0.001	0.010 ± 0.001
17	12.0	41	0.009 ± 0.001	0.008 ± 0.001
17	13.0	41	0.010 ± 0.001	0.010 ± 0.001
17	13.0	41	0.011 ± 0.001	0.009 ± 0.001
17	14.0	41	0.013 ± 0.001	0.011 ± 0.001
18	15.0	44	0.012 ± 0.001	0.009 ± 0.001
18	16.0	44	0.011 ± 0.001	0.010 ± 0.001
19	17.0	46	0.024 ± 0.002	0.021 ± 0.002
19	18.0	46	0.023 ± 0.002	0.022 ± 0.002
20	20.0	49	0.019 ± 0.002	0.024 ± 0.002
20	20.0	49	0.018 ± 0.002	0.023 ± 0.002
20	21.0	49	0.020 ± 0.002	0.026 ± 0.003
21	22.0	51	0.022 ± 0.002	0.035 ± 0.003
21	23.0	51	0.021 ± 0.002	0.034 ± 0.003
22	25.0	53	0.033 ± 0.003	0.047 ± 0.004
22	26.0	53	0.028 ± 0.003	0.045 ± 0.004
23	30.0	56	0.081 ± 0.007	0.093 ± 0.008
23	30.0	56	0.074 ± 0.006	0.088 ± 0.007
23	31.0	56	0.079 ± 0.006	0.085 ± 0.007

lens epithelium, forming substantia propria, which becomes thicker on periphery to the end of the embryonic period.

Results of the performed study (Table 1) show that the thickness of the cornea in its centre and at the periphery is almost equal by stage 17 (41 postovulatory days). The cornea becomes thicker in the centre in embryos of developmental stages 18 and 19 (44 and 46 postovulatory days). During the 8th week of the embryonic period (stages 20–23, 51–56 postovulatory days) the cornea becomes thicker at its periphery as compared to its central portion.

DISCUSSION

The cornea is formed from the surface ectoderm, mesenchyme, and neural crest cells. From the surface ectoderm is derived the external corneal epithelium. The mesenchyme gives rise to the substantia propria, and the neural crest cells migrate from the lip of the optic cup through the embryonic connective tissue and differentiate into the corneal epithelium. Formation of the cornea is induced by the lens vesicle [14]. This induction results in the transformation of a typical surface ectoderm into a transparent, multilayered structure with a complex extracellular matrix and cellular contribution from several sources.

In human embryos at stage 15 the early cornea consists of the anterior epithelium, which is transformed basal ectodermal cells [6–8]. In developmental stages 16 and 17 the cornea consists of the anterior epithelium, mesostroma and mesothelium [1, 15]. Our study showed that at these stages the thickness of the cornea is equal throughout its whole surface.

During stage 18 and 19 the mesenchyme, constituting the future substantia propria of the cornea, invades the interval between the surface ectoderm and the lens epithelium, and the posterior epithelium of the cornea becomes clearly distinguishable [6–9]. This developmental event is expressed in greater thickness of the centre of the cornea, which is evident in our morphometric study.

In the last week of the embryonic period (stages 20–23) the substantia propria of the cornea increases in thickness and is formed by 5 to 6 layers. It becomes thicker on periphery. This was confirmed in the present investigations.

It has to be pointed out that differences in thickness between the centre and periphery of the adult cornea are already marked in the last embryonic week.

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