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Abstract

The axial length of the eye, the radius of the anterior corneal surface, and the diameter of the cornea were measured on 40 eyes of 20 New Zealand White rabbits. The ultrasonographic measurements of the axial length of the eye showed a mean value of 15.12 $\pm$ 0.51mm (15.33 $\pm$ 0.50mm in males, 14.96 $\pm$ 0.46mm in females). The mean corneal radius was 7.26 $\pm$ 0.26mm (7.18 $\pm$ 0.9mm in males, 7.32 $\pm$ 0.33 mm in females); the mean value of the difference in corneal curvature between two principle meridians was 0.21 $\pm$ 0.12mm; and the mean horizontal and vertical diameters of the cornea were 13.41 $\pm$ 0.34mm and 13.02 $\pm$ 0.30mm, respectively. Although the diameter of the cornea of rabbits was bigger than that of humans (average, horizontal 11.75mm, vertical 10.55mm), the axial length of the eye was 0.7 times that of humans (23-24mm), and the radius of corneal curvature was relatively smaller than that in humans (7.7-7.8mm).

KEYWORDS: rabbit eye, bulbus oculi, radius of cornea, axial length

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Measurements of Axial Length and Radius of Corneal Curvature in the Rabbit Eye

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The axial length of the eye, the radius of the anterior corneal surface, and the diameter of the cornea were measured on 40 eyes of 20 New Zealand White rabbits. The ultrasonographic measurements of the axial length of the eye showed a mean value of 15.12 ± 0.51 mm (15.33 ± 0.50 mm in males, 14.96 ± 0.46 mm in females). The mean corneal radius was 7.26 ± 0.26 mm (7.18 ± 0.9 mm in males, 7.32 ± 0.33 mm in females); the mean value of the difference in corneal curvature between two principle meridians was 0.21 ± 0.12 mm; and the mean horizontal and vertical diameters of the cornea were 13.41 ± 0.34 mm and 13.02 ± 0.30 mm, respectively. Although the diameter of the cornea of rabbits was bigger than that of humans (average, horizontal 11.75 mm, vertical 10.55 mm), the axial length of the eye was 0.7 times that of humans (23-24 mm), and the radius of corneal curvature was relatively smaller than that in humans (7.7-7.8 mm).

Key words: rabbit eye, bulbus oculi, radius of cornea, axial length

The rabbit is a classic experimental laboratory animal for ocular research as it is cheap and easy to handle and manipulate. A large amount of rabbit data were found in the ophthalmic literature. Thickness of the lens and depth of the vitreous were measured by ultrasonography in rabbit eyes (1). Furthermore, rabbits are very useful in corneal refractive surgical studies (2-4), and have been widely used also for keratoplasty research (5).

The rabbit, however, has drawbacks as an experimental animal for refractive corneal surgery, since the cornea is thinner, floppier and more elastic than that in humans and also lacks Bowmann's layer. The rabbit cornea heals much more rapidly than humans, and vascularizes more easily. The corneal endothelium heals readily in rabbits with considerable mitotic activity, in contrast with no mitotic activity in the adult human corneal endothelium (6).

The aims of the present study were to determine the axial length of the eye, the radius of the anterior corneal surface and the diameter of the cornea to provide basic data for the surgical procedures performed in the rabbit eye.

Materials and Methods

Forty eyes of 20 New Zealand White rabbits at 5 months of age (2-3 kg weighing, 9 males, 11 females) were used for this research. The horizontal and vertical diameters of the cornea were measured with a millimetric ruler. The radius of curvature of the cornea was determined by Javal Keratometer (Carl Zeiss Jena, DDR, Germany) in along the two main axes. The mean value of the corneal radius in each eye was calculated from the mean values for the two axes.

We also determined corneal astigmatism, which was defined as differences between the radius in two axes. Local anesthesia was induced with oxybuprocaine hydrochloride (Benoxinate 0.4 % Thilo(R)) eye drop. The axial length of each eye was measured three times by scan SONOMED 2000 ocular ultrasound (10 MHz) (Sonomed Inc; Lake Success, NY, USA) and an average value was calculated.

The Mann-Whitney U-test was used for data compari-

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son.

Results

The ocular axial length was 14.96 ± 0.46 mm (mean $\pm$ SD) in female rabbits and 15.33 ± 0.50 mm in male rabbits, with a pooled average of 15.12 ± 0.51 mm (Table). The eye length in females was significantly greater than that in males ($P < 0.025$). The average radius of the corneal curvature was 7.32 ± 0.33 mm in females and 7.18 ± 0.09 mm in males, with the average of both being 7.26 ± 0.26 mm (Table). Corneal astigmatism was found in 19 eyes of 11 female and 15 eyes of 9 male rabbits. The corneas in the remaining eyes were spheric.

The average corneal astigmatism was 0.20 ± 0.14 mm in females and 0.15 ± 0.11 mm in males, with the average of both being 0.18 ± 0.13 mm (Table). Of the total 34 astigmatic eyes, 24 (71 %) had with-the-rule astigmatism while 10 (29 %) had against-the-rule astigmatism. The horizontal diameter of the cornea was 13.5 ± 0.31 mm in females and 13.31 ± 0.35 mm in males, with a pooled average of 13.41 ± 0.34 mm (Table). The vertical diameter of the cornea was found to be 12.96 ± 0.26 mm in females and 13.11 ± 0.32 mm in males, with the average of both being 13.02 ± 0.30 mm (Table). No significant difference ($P > 0.05$) in the measurements was observed between females and males except with regard to the axial length of the eye.

Table Measurements in rabbit eyes

	No of eyes	Range	Mean ± SD	U prime	*P* value
		Axial length of the eye (mm)			
Male	18	14.57-16.30	15.33 ± 0.50	276.5	< .05
Female	22	14.00-15.66	14.96 ± 0.46		
Total	40	14.00-16.30	15.12 ± 0.51		
		Curvature radius of the cornea (mm)			
Male	18	7.05 7.33	7.18 ± 0.09	221	NS
Female	22	6.90 8.05	7.32 ± 0.33		
Total	40	6.90 - 8.05	7.26 ± 0.26		
		Corneal astigmatism as keratometric difference between two principal meridians (mm)			
Male	18	0 - 0.4	0.15 ± 0.11	243	NS
Female	22	0 - 0.5	0.20 ± 0.14		
Total	40	0 - 0.5	0.18 ± 0.13		
		Horizontal diameter of the cornea (mm)			
Male	18	13 14	13.31 ± 0.35	261	NS
Female	22	13 - 14	13.50 ± 0.31		
Total	40	13 - 14	13.41 ± 0.34		
		Vertical diameter of the cornea (mm)			
Male	18	13 14	13.11 ± 0.32	228	NS
Female	22	12 - 13.5	12.96 ± 0.26		
Total	40	12 14	13.02 ± 0.30		

NS: Not significant

Discussion

The radius of the curvature of the rabbit cornea (7.26 ± 0.26 mm) was found to be lower than the average measure of 7.7–7.8 mm in eyes of adult humans, indicating that the rabbit cornea had about 3.5 diopter more refractive power. Optically, the steeper curvature of the rabbit cornea can be balanced by the shorter axial length of the rabbit eye (1–1.5 mm shorter). However, the axial length of the rabbit eye (15.12 ± 0.51 mm) was markedly shorter than the human length of 23–24 mm (7). Therefore, the rays of light focusing on the rabbit retina may be explained by the fact that the rabbit lens is almost spherical and has greater refractive power (1). The refractive power of the cornea in male rabbits was greater than that of females, while the axial length of the male rabbit eyes was greater than that of females, contrary to what was expected from human correlation data. These facts suggest that other refractive factors must compensate. The difference in the curvature between the two principal meridians creates corneal astigmatism. In with-the-rule astigmatism, the vertical meridian is steepest as it occurs more frequently in humans. In against the-rule astigmatism, the horizontal meridian is steepest. The astigmatism in the rabbit cornea shows a similar tendency to that in the human cornea.

The horizontal (13.41 ± 0.34 mm) and vertical (13.02 ± 0.30 mm) diameters of the rabbit cornea were found to be greater than the average horizontal (11.75 mm) and vertical (10.55 mm) diameters of the human cornea. Like humans, the horizontal diameter of the cornea was found to be greater than the vertical diameter. Since the rabbit cornea is thinner than humans, experimental radial keratotomy in rabbits is rather restricted (7). The large rabbit cornea, however, allows incisions to be placed more peripherally and diopters to be gained in spite of the cornea.

In conclusion, the results obtained in this study would be of value for future experimental refractive surgery and intraocular lens implantation done on rabbit eyes.

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