Central and Peripheral Corneal Thickness in Full-Term Newborns by Ultrasonic Pachymetry

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To establish a standard of normality, the authors studied the central and peripheral (superior, inferior, nasal, and temporal) corneal thickness of 152 healthy, white race, full-term newborns (304 eyes) between 1 and 6 days old, using ultrasonic pachymetry. The mean central corneal thickness (CCT) was 585 ± 52 μm (ranging from 446-706 μm). The mean peripheral corneal thickness (PCT), significantly thicker than CCT (P = 0.0001), was: superior (SCT) 696 ± 55 μm, inferior (ICT) 744 ± 62 μm, nasal (NCT) 742 ± 58 μm, and temporal (TCT) 748 ± 55 μm. The SCT was significantly thinner than the ICT, NCT, and TCT (P = 0.0001). Differences among ICT, NCT, and TCT were not statistically significant. The mean CCT of the 1-day-old group was 611 ± 58 μm, this being thicker than those of the other age groups (P = 0.0001). The differences between male and female babies and between right and left eyes were not statistically significant. This is the first study on peripheral corneal thickness at the limbus in the four meridians in live newborns. Invest Ophthalmol Vis Sci 33:3080-3083, 1992

Corneal edema is a main clinical sign of primary congenital glaucoma. This corneal edema could be easily measured by using ultrasonic pachymetry. However, the standards for normal newborn corneal thickness are not well described.

As far as we know, there are only five articles in the literature about central corneal thickness (CCT) in newborns. Until now, no one has published data about peripheral corneal thickness (PCT) at the limbus in the four meridians in live newborns.

The purpose of this study was to establish a standard of normality of corneas of newborns in CCT and PCT in four points: superior (SCT), inferior (ICT), nasal (NCT), and temporal corneal thickness (TCT). These values could be used as a reference in the early diagnosis and control of corneal edema in primary congenital glaucoma.

Materials and Methods

We examined 304 eyes of 152 healthy, white race, full-term newborns in the first 6 days of the post-natal period. Subjects were from the normal newborn nursery at the Hospital Clínico Universitario, Zaragoza, Spain. Each infant was the product of an uncomplicated delivery. The results of complete physical examinations on each infant by a pediatrician were normal. The ophthalmic portion included an external examination, testing of pupil reactivity, and visualization of the red reflex. Birth weight ranged from 2550-3970 g (mean weight ± standard deviation, 3277 ± 304 g). All infants were at least 37 weeks’ gestation by Dubowitz assessment. The mean age was 2.25 ± 1.42 days when measurements were taken. There were 75 girls and 77 boys. Parental consent was obtained.

Corneal thickness was measured with a DGH-2000 ultrasonic pachymeter (DGH Technology, Inc., San Diego, CA) with a sound velocity of 1640 m/sec. The infants lay in a supine position with an assistant holding their heads firmly. After anesthesia with topical proparacaine, a spring wire speculum was inserted with care so as not to damage the cornea. Corneal thickness measurements were taken centrally and in four peripheral points: superior (12 o’clock), inferior (6 o’clock), nasal (3 o’clock in right eye and 9 o’clock in left eye), and temporal (9 o’clock in right eye and 3 o’clock in left eye), setting the probe tip at a tangent to the limbus (Fig. 1). Given that the width (diameter) of the transducer head was 1.5 mm, the ultrasound beam was located at 0.75 mm from the limbus in the peripheral points. We took three readings in each corneal point and averaged them. Every 10 sec, a drop of balanced salt solution was instilled to avoid corneal thickness decrease. Room temperature was 25° C. All readings were taken between 1:30 and 2:30 PM to avoid possible diurnal variation in corneal thickness. All measurements were made by the same person (LR).

We used the Komolgorov-Smirnov test to prove that our data presented a normal distribution. Values are given as mean ± standard deviation, and significance was tested by the t-test and analysis of variance. The level of significance chosen was P < 0.01.
Results

The mean CCT of the 304 eyes was 585 ± 52 μm, ranging from 446–706 μm. The mean PCT at the four points was: SCT, 696 ± 55 μm, range 549–833 μm; ICT, 744 ± 62 μm, range 590–891 μm; NCT, 742 ± 58 μm, range 558–891 μm; and TCT, 748 ± 55 μm, range 557–902 μm. The CCT was significantly thinner than the PCT (P = 0.0001, paired t-test). The SCT was significantly thinner than the ICT, NCT, and TCT (P = 0.0001, paired t-test). Differences among ICT, NCT, and TCT were not statistically significant.

Table 1 and Figure 2 show CCT, SCT, ICT, NCT, and TCT in relation to the days of the post-natal period. The mean corneal thickness of the 1-day-old group in the five points was: CCT, 611 ± 58 μm; SCT, 713 ± 61 μm; ICT, 761 ± 69 μm; NCT, 756 ± 64 μm; and TCT, 760 ± 62 μm. These measurements were significantly thicker than those of the other age groups (P = 0.001, 0.007, 0.005, 0.008, and 0.004, respectively, variance analyses). From the second day on, there were no statistically significant differences.

Table 2 shows CCT, SCT, ICT, NCT, and TCT in male and female babies. Corneas in male newborns were thicker than in female newborns, but these differences were not significant (unpaired t-test).

Table 3 shows CCT, SCT, TCT, NCT, and TCT in right and left eyes. Differences were not significant (paired t-test).

No statistical correlation was found between corneal thickness and birth weight.

Discussion

There is little information regarding infant corneal thickness. We found a mean CCT of 585 ± 52 μm in a series of 152 newborns (304 eyes). Our data about CCT are similar to those obtained by other authors, although there are slight differences that might be a

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**Table 1. Mean central and peripheral corneal thickness ± SD (μm) and days of the post-natal period**

<table>
<thead>
<tr>
<th>Days</th>
<th>n</th>
<th>CCT</th>
<th>SCT</th>
<th>ICT</th>
<th>NCT</th>
<th>TCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>108</td>
<td>611 ± 58</td>
<td>713 ± 61</td>
<td>761 ± 69</td>
<td>756 ± 64</td>
<td>760 ± 62</td>
</tr>
<tr>
<td>2</td>
<td>114</td>
<td>573 ± 60</td>
<td>685 ± 62</td>
<td>737 ± 72</td>
<td>736 ± 64</td>
<td>744 ± 61</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>567 ± 16</td>
<td>695 ± 41</td>
<td>739 ± 45</td>
<td>741 ± 45</td>
<td>747 ± 40</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>572 ± 28</td>
<td>691 ± 39</td>
<td>725 ± 35</td>
<td>732 ± 43</td>
<td>738 ± 38</td>
</tr>
<tr>
<td>5</td>
<td>18</td>
<td>567 ± 32</td>
<td>680 ± 38</td>
<td>728 ± 32</td>
<td>726 ± 37</td>
<td>732 ± 40</td>
</tr>
<tr>
<td>6</td>
<td>16</td>
<td>561 ± 36</td>
<td>681 ± 31</td>
<td>724 ± 34</td>
<td>722 ± 35</td>
<td>731 ± 27</td>
</tr>
</tbody>
</table>

n, number of eyes. CCT, central corneal thickness. SCT, superior corneal thickness. ICT, inferior corneal thickness. NCT, nasal corneal thickness. TCT, temporal corneal thickness.
result of the different sound velocity\textsuperscript{10} or the different model of pachymeter\textsuperscript{11} employed.

We found a statistically significant difference between the corneal thickness of the 1-day-old group and that of the other age groups. Ma\textsuperscript{4} also found this difference.

No statistical correlation was found between corneal thickness and birth weight. Other authors\textsuperscript{2,3,5,6} also failed to reveal this correlation. Ma\textsuperscript{4} however, found somewhat of correlation, given that the light-weight baby group in his study (1750–2250 g) had an average value of 707 \(\mu\)m (CCT), which was significantly different from that of the heavier babies.

In relation to peripheral corneal thickness in live newborns, only Portellinha and Belfort\textsuperscript{6} gave some values (650 ± 62 \(\mu\)m), but they did not set the probe tip at a tangent to the limbus, and they measured only the nasal-inferior sector.

As far as we know, the data in the present report are the first obtained on peripheral corneal thickness at the limbus in the four meridians in live newborns.

Barraquer\textsuperscript{12} proposes that infant corneas are thicker in the center than in the periphery, but this supposition apparently is not based on scientific measurements (he does not give any reference). In the present study, we demonstrate that corneal configuration in newborns is similar to that of the adult cornea: peripheral corneal thickness is thicker than central corneal thickness. Based on our observations, the peripheral corneal thickness/central corneal thickness ratio could indicate ocular maturity—the greater the ratio the greater the development of the eye. Moreover, corneal periphery in newborns does not have the same thickness in all its points. SCT (696 ± 55 \(\mu\)m) is significantly thinner than ICT (744 ± 62 \(\mu\)m), NCT (742 ± 58 \(\mu\)m), and TCT (748 ± 55 \(\mu\)m; \(P = 0.0001\), paired t-test). Steinberg and associates\textsuperscript{13} in a series of 48 adult eyes that employed ultrasonic pachymetry with a speed of sound of 1640 m/s, found an average peripheral corneal thickness of 710 \(\mu\)m, and there was no difference in the average thickness of the four meridians. Therefore, the SCT in newborns might not be fully developed at birth.

The increase in corneal thickness in the 1-day-old group may have resulted from the fact that the eyes remain closed for a long time. The decreasing thickness after the first day may suggest that a hydration control becomes operative.

From our study, we establish a standard of normality in central and peripheral corneal thickness in newborns.

### Table 2. Mean central and peripheral corneal thickness ± SD (\(\mu\)m) and sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>(n)</th>
<th>CCT</th>
<th>SCT</th>
<th>ICT</th>
<th>NCT</th>
<th>TCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>154</td>
<td>598 ± 54</td>
<td>699 ± 59</td>
<td>748 ± 65</td>
<td>744 ± 60</td>
<td>752 ± 58</td>
</tr>
<tr>
<td>Female</td>
<td>150</td>
<td>581 ± 50</td>
<td>693 ± 51</td>
<td>740 ± 59</td>
<td>740 ± 56</td>
<td>744 ± 52</td>
</tr>
</tbody>
</table>

\(n\), number of eyes. CCT, central corneal thickness. SCT, superior corneal thickness. ICT, inferior corneal thickness. NCT, nasal corneal thickness. TCT, temporal corneal thickness.

### Table 3. Mean central and peripheral corneal thickness ± SD (\(\mu\)m)

<table>
<thead>
<tr>
<th>Eye</th>
<th>(n)</th>
<th>CCT</th>
<th>SCT</th>
<th>ICT</th>
<th>NCT</th>
<th>TCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>152</td>
<td>585 ± 52</td>
<td>694 ± 52</td>
<td>745 ± 64</td>
<td>745 ± 62</td>
<td>748 ± 55</td>
</tr>
<tr>
<td>Left</td>
<td>152</td>
<td>585 ± 52</td>
<td>698 ± 58</td>
<td>743 ± 60</td>
<td>739 ± 54</td>
<td>748 ± 55</td>
</tr>
</tbody>
</table>

\(n\), number of eyes. CCT, central corneal thickness. SCT, superior corneal thickness. ICT, inferior corneal thickness. NCT, nasal corneal thickness. TCT, temporal corneal thickness.
borns that appears to be important as an indicator of ocular maturity and in the early diagnosis and control of corneal edema in primary congenital glaucoma.

**Key words:** corneal thickness, full-term newborns, ultrasonic pachymetry

References