Biometry of the Cornea and Anterior Chamber in Chinese Eyes: An Anterior Segment Optical Coherence Tomography Study

Leonard H. Yuen, Mingguang He, Tin Aung, Hla M. Htoon, Donald T. Tan, and Jodhibir S. Mehta

PURPOSE. To investigate the normative data of corneal and anterior segment biometric parameters and their associations in Chinese adults, for use in preoperative assessment for corneal and anterior segment surgery.

METHODS. This cross-sectional, population-based study included 750 subjects aged ≥50 years. The subjects underwent an ophthalmic examination including imaging with anterior segment optical coherence tomography (AS-OCT). Dimensions were subsequently measured with the Zhongshan Assessment Program (ZAP). Also measured was posterior corneal arc length (PCAL), a novel parameter defined as the arc distance between scleral spurs on the posterior border of the cornea. Correlations with age, sex, height, weight, body mass index (BMI), refractive sphere and cylinder, and intraocular pressure were also measured.

RESULTS. The subjects’ mean age was 63.3 ± 7.9 years and 349 (46.5%) were men. Corneal parameters (mean ± SD) included PCAL (12.924 ± 0.544 mm), anterior chamber depth (ACD; 2.684 ± 0.309 mm), central corneal thickness (562.39 ± 31.85 μm), anterior chamber curvature (7.35 ± 0.37 mm), and posterior corneal curvature (6.65 ± 0.34 mm). A moderate correlation was observed between PCAL and ACD (R = 0.55, P < 0.001) and a poor correlation between PCAL and age, height, weight, BMI. Multivariate analysis showed a significant association between PCAL and ACD, ACC, PCC, and cylinder (P < 0.05).

CONCLUSIONS. In this Chinese population, PCAL was found to correlate moderately with ACD. The data may be useful for corneal and anterior segment procedures such as Descemet’s stripping automated endothelial keratoplasty (DSEK). The information from the study will form baseline normative data for the assessment of any surgical intervention which may be a predictive parameter for anterior chamber surgery. The information from the study will form baseline normative data for the assessment of any surgical intervention in this population group.

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300
were identified on an individual scan. The algorithm then calculated all
For each image the image file was opened, and the two scleral spurs
were processed with inbuilt software that dewarps the images (adjust-
All AS-OCT images were assessed by one ophthalmologist (LY) and
maximize visibility of anatomic location and repeatability.9,10 Consec-
tive images of only the right eye were used to ensure uniformity with
other studies9,13 and to reduce bias.
Imaging
Images were collected by using AS-OCT at the Singapore National Eye
Centre after informed consent was obtained from all participants. The
details of the AS-OCT imaging technology have been described previ-
ously.9,12 Briefly, a 1.3-μm infrared light is used to obtain high-resolution,
cross-sectional tomographic images of the anterior segment.5–7 The
image is horizontally composed of 256 A-scans in 16 mm with 1024 points per A-scan at 8 mm of depth. Each image has a maximum transverse and axial resolution of 60 and 18 μm, respectively. Scanning at 2000 axial scans per second, the machine needs approximately 1/8 second to scan an eye. Images were taken directly from the machine’s output function as 816 × 636 pixel JPEG (lossless compression) files. All selected images were temporal–nasal (i.e., horizontal) scans, to minimize visibility of anatomic location and repeatability.9,10 Consecutive images of only the right eye were used to ensure uniformity with other studies9,10 and to reduce bias.

Image Processing
All AS-OCT images were assessed by one ophthalmologist (LY) and
were processed with inbuilt software that dewarps the images (adjusting
for distortions arising from corneal optical properties). The scleral
spurs, defined as the anatomic junction between the inner wall of the
tractable meshwork and the sclera, were identified (Fig. 1).13 There is
a prominent inner extension of the sclera at its thickest part,9,13 and in
this study, it was defined as a change in curvature of the inner surface
of the angle wall, often appearing as an inward protrusion of the sclera.
For each image the image file was opened, and the two scleral spurs were identified on an individual scan. The algorithm then calculated all
parameters and the information was recorded (Fig. 1).

The ZAP (Guangzhou, China) software automatically extracted the
300 × 600 8-bit gray scale (intensities from 0 to 255) image portion of
the output file and performed noise and contrast conditioning.9 A
binary copy of the image was then produced in which pixels were
either 1’s (tissue) or 0’s (open space), depending on whether they
were brighter or darker than a calculated threshold. Algorithms
defined the borders of the corneal epithelium and endothelium and the
anterior surface of the iris. The algorithms used basic edge arguments
(five consecutive 0’s above and five consecutive 1’s below indicated an
anterior surface point) to describe the borders. The corneal border
data were fitted with polynomial curves and a line-smoothing algo-

RESULTS
A total of 750 consecutive eyes from Chinese Singaporeans
were included in the study. The mean age of the patients was
65.3 ± 7.9 (range, 50–90.0) years; 401 (53.4%) were women. The
mean ± SD PCAL was 12.92 ± 0.54 mm, ACD 2.68 ± 0.31
mm, CCT 562.39 ± 31.85 μm, ACC 7.36 ± 0.37 mm, and PCC
6.65 ± 0.34 mm. Table 1 summarizes the demographics of the
patients’ corneal parameters, stratified by age group and sex.

Posterior Corneal Arc Length
There was poor (r < 0.3) to moderately strong correlation (r =
0.6–0.8),14 between PCAL and the other corneal parameters:
ACD (r = 0.55, r² = 0.31, P < 0.001), CCT (r = –0.071, r² =
0.005, P = 0.051), ACC (r = 0.114, r² = 0.013, P = 0.002), and
PCC (r = 0.307, r² = 0.026, P < 0.001; Fig. 2). Overall, there
was a poor correlation between PCAL and age (r = –0.095, r² =
0.009, P < 0.01), height (R = 0.199, R² = 0.04, P < 0.001),
weight (R = 0.151, R² = 0.023, P < 0.001), and BMI (R =
0.48, R² = 0.020, P = 0.186; Fig. 3). PCAL also showed poor
correlation with asphericity, cylinder, and IOP (Fig. 4). Tables
2 and 3 summarize the relationship of PCAL in quartiles with measured corneal and anterior segment parameters.

Univariate and Multivariate Analyses
Table 4 shows univariate and multivariate analyses for PCAL with measured ocular, systemic, and refractive parameters. In the
univariate analysis, only CCT, BMI, and IOP were not significantly associated with PCAL (BMI was used for the
analysis instead of height and weight because of collinearity.) A
multivariate analysis with PCAL as the dependent param-
eter showed statistical significance in comparison with ACD,
ACC, PCC, CCT, and cylinder.

Sex. Logistic regression analyses showed that all corneal
parameters were significantly smaller in the women, except for
CCT, which was not significantly different between the men
and the women (OR = 0.998, P = 0.492; Table 5).

Age, Height, and Weight. The mean age of the patients
was 65.3 ± 7.9 (range, 50–90.0) years, and the mean height
and weight of the subjects was 160.2 ± 7.9 cm and 61.3 ± 10.7
kg, respectively. In the measured corneal and anterior segment
parameters, there was a decreasing trend with increasing age,
and an increasing trend with increasing height and weight,
which was somewhat expected although not always statisti-
cally significant (Table 6).

DISCUSSION
The biometric analysis of the anterior segment of the eye has
become increasingly important in the decision-making and

FIGURE 1. Appearance of the ZAP software using AS-OCT images: for
each image, the image file is opened, and the two scleral spurs are
identified and marked. Calculate OCT then measures all parameters
including the PCAL (in millimeters), as shown by the arrow in the
right image.
management of corneal and anterior segment procedures, ranging from pre- and postoperative evaluation of AC IOls and phakic intraocular lenses (pIOls),\textsuperscript{15} to potentially optimizing the size of grafts for endothelial keratoplasty procedures such as DSAEK, where the donor cornea, adherent to the posterior stroma, protrudes into the AC and may also

![Figure 2](https://iovs.arvojournals.org/pdfaccess.ashx?url=/data/journals/iovs/932961/)

**Figure 2.** Scatterplots with best fit regression line and confidence intervals between PCAL and corneal parameters: ACD ($r = 0.55, P < 0.001$), CCT ($r = -0.071, P = 0.051$), ACC ($r = 0.114, P = 0.002$), and PCC ($r = 0.307, P < 0.001$).
crowd the angle. This study was conducted to document and present the findings of corneal characteristics in Chinese eyes from Singapore and to record associations and correlations of ocular and systemic parameters with a novel parameter, PCAL.

From our study, the mean PCAL was 12.92 mm (95% CI, 12.88–12.96 mm), with a median of 12.91 mm. There was a moderate correlation with ACD ($r = 0.55$, $R^2 = 0.3185$, $P < 0.001$). Table 7 shows the relationship between ACD in quartiles and other corneal parameters. Univariate and multivariate analyses also showed a positive association between the two parameters. In our study, a shallow ACD was found to be associated with older age, hyperopic refractive error, female sex, shorter body stature, which confirms previous population-based studies on various ethnic populations (including Chinese eyes) and hospital-based investigations.16–19 

Figure 3. Scatterplots with best fit regression line with confidence intervals between PCAL against age ($r = -0.095$, $P = 0.01$), height ($r = 0.199$, $P < 0.001$), weight ($r = 0.0151$, $P < 0.001$), and BMI ($r = 0.048$, $P = 0.186$), showing no strong correlations between the parameters.

Figure 4. Scatterplots with best fit regression line with confidence intervals between PCAL against sphere (D) ($r = -0.156$, $P < 0.001$), cylinder (D) ($r = -0.103$, $P = 0.006$), and IOP (mm Hg) ($r = -0.063$, $P = 0.002$).
The linear relationship between the two variables, PCAL and ACD, can be calculated as \( y = 10.257 + 0.9939x \), where \( y = \text{PCAL} \) and \( x = \text{ACD} \). This positive relationship is visualized in Figure 5; the arc’s positive relationship with the vertical distance between the posterior cornea and the anterior lens capsule is self-explanatory. We postulate that the perpendicular height between the posterior cornea and a horizontal line from scleral spur to scleral spur would provide a stronger and more robust correlation in this instance, as the PCAL also uses the scleral spurs as landmarks (Fig. 5). As this measurement was not part of the study, we believe the best estimator of PCAL at present would be the linear equation as just stated.

There was a significant difference in PCAL between the sexes, with the men exhibiting larger dimensions than the women, 12.99 ± 0.54 and 12.86 ± 0.54 mm, respectively (\( P = 0.001 \)). This difference highlights the importance of customization of corneal surgery in men and women. Furthermore, there was a significant inverse correlation with age and in the univariate and multivariate analyses (\( P < 0.01 \)). Hence, the preoperative management of a younger man would be significantly different from that of an elderly female patient. This highlights a further need to customize surgical decisions to achieve optimal outcomes.

Currently, there is no optimal selection of donor graft size for DSAEK. This variable is left for the individual surgeon to decide, based purely empirically on a peripheral 1- to 2-mm clearance of the donor margins from the corneal limbus without taking into account vertical clearance of the donor margins from the iris and chamber angle. One of the major advantages of DSAEK is to be able to transplant a larger surface area of endothelial cells compared with standard penetrating keratoplasty (PK). A 9.0-mm graft, conventionally used in DSAEK,20–22 transfers 26% more surface area of healthy donor endothelial cells than does the standard 8.0-mm graft more commonly used in PK.23–25 However, because of the meniscal configuration of the donor graft after ALTK or manual dissection, the thickened peripheral portions of the graft are at increased risk of touching and adhering to the adjacent iris/drainage angle, especially in Chinese eyes with shallower anterior chambers, and the resultant peripheral anterior synchiae (PAS) may contribute to raised IOP after surgery and also increase the risk of allograft rejection, similar to PAS formation at the graft-host junction in PK. A solution may be to design an algorithm using PCAL dimensions, subtracting a constant to attain the maximum size graft that may be safely implanted without angle compromise with respect to both diameter and thickness of graft.

The mean radius of the ACC in our study was 7.36 mm (95% CI, 7.33–7.38), with a median of 7.33 mm. There was a significant difference between the sexes in our study: The mean ± SD for the men was 7.39 ± 0.40 mm and for the women, 7.32 ± 0.35 mm (\( P = 0.018 \)). Dubbleman et al.11 also showed a statistically significant difference between the sexes in a predominantly Caucasian population.

The mean radius of the PCC in our study was 6.65 mm (95% CI, 6.63–6.68), with a median of 6.67 mm, which is comparable to the range published in the literature. The radius of the schematic Gullstrand eye is 6.8 mm,26 whereas in the schematic eye of Le Grand and El Hage27 and Liu and Brennan,28 it is 6.5 and 6.4 mm, respectively.

Although the dimensions are both of the posterior cornea, there was only a fair correlation between PCC and PCAL (\( R = 0.307, R^2 = 0.094, P < 0.001 \)). As corneal curvatures are measured for the central 3 mm of the cornea, this measurement only provides the tangential point at 3 mm and not the entire arc length. This result also suggests that the deviation from the mean PCAL is accounted for by the variation beyond the central 3 mm of the cornea to the scleral spurs.

There was a difference between the sexes in our study for posterior corneal curvatures, the mean ± SD for the men was 6.70 ± 0.36 mm and for the women, 6.61 ± 0.31 mm (\( P = 0.001 \)). Dubbleman et al.11 also showed a statistically significant difference between the sexes, the men measuring 6.60 ± 0.03 mm and the women 6.456 ± 0.05 mm (\( P < 0.01 \)). The mean age in their study was 39 ± 14 years (cf. the mean age in our study, 63.3 ± 7.9 years). As far as we know, our results

### Table 3. Spearman Correlation (\( r \)) with PCAL as the Independent Variable

<table>
<thead>
<tr>
<th>PCAL</th>
<th>ACD</th>
<th>CCT</th>
<th>ACC</th>
<th>PCC</th>
<th>Age</th>
<th>Height</th>
<th>Weight</th>
<th>BMI</th>
<th>Sphere</th>
<th>Cylinder</th>
<th>IOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r )</td>
<td>1.000</td>
<td>0.590*</td>
<td>−0.071</td>
<td>0.114*</td>
<td>0.307*</td>
<td>−0.095*</td>
<td>0.199*</td>
<td>0.151*</td>
<td>0.048</td>
<td>−0.156*</td>
<td>−0.103*</td>
</tr>
<tr>
<td>( P )</td>
<td>(&lt;0.001)</td>
<td>(0.051)</td>
<td>(0.002)</td>
<td>(&lt;0.001)</td>
<td>(&lt;0.001)</td>
<td>(&lt;0.001)</td>
<td>(0.186)</td>
<td>(&lt;0.001)</td>
<td>(&lt;0.001)</td>
<td>(&lt;0.001)</td>
<td>(&lt;0.001)</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.01 level (two-tailed).

The results show weak to moderately strong correlations between the measured corneal and anterior segment parameters, and systematic and refractive parameters.
show the first record of a difference between the sexes in the corneal curvatures of Chinese eyes. Dubbelman et al.11 found that ACC and PCC were not age dependent (P = 0.97 and 0.26, respectively). Our results concur that there was no correlation of ACC and PCC with age (P = 0.483 and 0.609, respectively).

There was no correlation or statistically significant association between CCT and PCAL, suggesting parameter independence. There was, however, a slight decrease in corneal thickness with increasing age, which was not observed in a previous study. Dubbelman et al.11 also showed that the men had a slightly greater (∼3 μm) CCTs (581 μm) than did the women (578 μm); in our study the mean CCT in the men was 563.25 ± 32.97 μm and in the women, 561.64 ± 30.87 μm, which not a statistically significant difference.

There was a weak correlation between age and the corneal parameters, with a tendency toward a decrease in corneal dimensions with increasing age that was statistically significant with PCAL (P = 0.01), ACC (P < 0.001), and CCT (P < 0.001; Tables 2, 3, 8). Univariate regression also showed a significant inverse association between age and PCAL, ACC, and CCT (Table 4). Regression analyses showed a significantly positive association between height and corneal parameters, except for CCT (P = 0.402). A significantly positive association was also found between weight and corneal parameters, except for CCT (P = 0.054).

In addition to the aforementioned parameters, univariate analysis showed a significant association between PCAL and asphericity and cylinder (Table 4). There was no significant association with CCT, IOP, and BMI. A multivariate analysis, with PCAL as the dependent parameter, showed that only cylinder was significantly associated. Further analysis on the horizontality of the cylindrical axes compared with the horizontality of the AS-OCT scans showed no statistical significance. Cylinders were also analyzed at the 30° and 60° planes (with corresponding opposite axes) and also showed no significant difference (P > 0.05).

General systemic disorders may affect ocular surface and corneal physiology; however, the anatomic measurements in our cohort seemed to remain the same, with or without disease. Subgroup analyses showed no difference between the eyes of patients with and without diabetes, those with and without ischemic heart disease, and those with and without hypertension (Table 9).

The inclusion of patients with higher myopia in this study is important for the normative database in Singapore, and in the Chinese diaspora, as myopia is prevalent. For completeness, we performed exclusion analysis, removing high myopes (> −5.0 D) and hyperopes (>5.0 D), and found that there was no significant difference between this group and the original 750 eyes (P > 0.05). When myopes and hyperopes were then divided into two groups, except for PCAL, all parameters between the two groups were similar and showed no significant difference (Table 10). The sample for refractive sphere followed a normal distribution.

### Table 5. Differences in Parameters According to Sex

<table>
<thead>
<tr>
<th>Parameter/Sex</th>
<th>Mean</th>
<th>SD</th>
<th>Max</th>
<th>Min</th>
<th>β</th>
<th>OR</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACD, mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>2.72</td>
<td>0.30</td>
<td>3.54</td>
<td>1.99</td>
<td>−0.782</td>
<td>0.457</td>
<td>0.001*</td>
</tr>
<tr>
<td>Female</td>
<td>2.65</td>
<td>0.32</td>
<td>3.65</td>
<td>1.88</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCT, μm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>563.25</td>
<td>32.97</td>
<td>659.2</td>
<td>474</td>
<td>−0.002</td>
<td>0.998</td>
<td>0.492</td>
</tr>
<tr>
<td>Female</td>
<td>561.64</td>
<td>30.87</td>
<td>663.9</td>
<td>478</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACC, μm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7.37</td>
<td>0.40</td>
<td>8.61</td>
<td>5.36</td>
<td>−0.475</td>
<td>0.622</td>
<td>0.018†</td>
</tr>
<tr>
<td>Female</td>
<td>7.32</td>
<td>0.35</td>
<td>8.51</td>
<td>6.19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCC, mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>6.60</td>
<td>0.37</td>
<td>7.95</td>
<td>4.8</td>
<td>−0.788</td>
<td>0.455</td>
<td>0.001*</td>
</tr>
<tr>
<td>Female</td>
<td>6.61</td>
<td>0.31</td>
<td>7.95</td>
<td>5.52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCAL, mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>12.99</td>
<td>0.54</td>
<td>14.36</td>
<td>11.33</td>
<td>−0.440</td>
<td>0.644</td>
<td>0.001*</td>
</tr>
<tr>
<td>Female</td>
<td>12.86</td>
<td>0.54</td>
<td>14.44</td>
<td>11.41</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Measured corneal and anterior segment parameters are smaller in the women with statistical significance for ACD, ACC, PCC, and PCAL.

* Significant at the 0.01 level.
† Significant at the 0.05 level.

### Table 6. Correlation of Age, Height, and Weight with Measured Corneal and Anterior Segment Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Age</th>
<th>Height</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>P</td>
<td>β</td>
</tr>
<tr>
<td>ACD</td>
<td>−0.006</td>
<td>&lt;0.001*</td>
<td>0.178</td>
</tr>
<tr>
<td>ACC</td>
<td>−0.54</td>
<td>0.483</td>
<td>0.132</td>
</tr>
<tr>
<td>PCC</td>
<td>−0.44</td>
<td>0.609</td>
<td>0.007</td>
</tr>
<tr>
<td>CCT</td>
<td>−0.04</td>
<td>&lt;0.001*</td>
<td>0.051</td>
</tr>
<tr>
<td>PCAL</td>
<td>−0.089</td>
<td>0.015†</td>
<td>0.195</td>
</tr>
</tbody>
</table>

* Significant at the 0.01 level.
† Significant at the 0.05 level.

### Table 7. Relationship of ACD (in Quartiles) with Measured Corneal and Anterior Segment Parameters

<table>
<thead>
<tr>
<th>ACD (mm)</th>
<th>n</th>
<th>PCAL (mm)</th>
<th>CCT (μm)</th>
<th>ACC (mm)</th>
<th>PCC (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Quartile ≤2.28</td>
<td>189</td>
<td>12.55</td>
<td>559.2</td>
<td>7.33</td>
<td>6.59</td>
</tr>
<tr>
<td>2nd Quartile 2.28–2.68</td>
<td>191</td>
<td>12.79</td>
<td>561.2</td>
<td>7.36</td>
<td>6.66</td>
</tr>
<tr>
<td>3rd Quartile 2.68–3.17</td>
<td>184</td>
<td>13.05</td>
<td>565.04</td>
<td>7.38</td>
<td>6.67</td>
</tr>
<tr>
<td>4th Quartile ≥3.17</td>
<td>186</td>
<td>13.32</td>
<td>564.30</td>
<td>7.34</td>
<td>6.68</td>
</tr>
</tbody>
</table>

P for trend 0.000 | 0.251 | 0.533 | 0.054

* Significant at the 0.01 level.
† Significant at the 0.05 level.

### Figure 5.
The vertical distance (solid line) between the posterior cornea and the lens (ACD). The ACD varies with the vertical location of the lens. Vertical dashed line: the perpendicular height between the posterior cornea and an imaginary horizontal dashed line from scleral spur to scleral spur (circles). It is postulated that this vertical height remains constant in relation to PCAL, which also uses the scleral spurs as landmarks.
As a community-based epidemiologic study, our analyses targeted AS-OCT images collected from one ethnicity, the Chinese. Although not necessarily fully representative of all Chinese populations globally, our cohort did include native Singaporean Chinese, immigrant mainland Chinese, and expatriate Chinese (e.g., first- or second-generation Singaporean Chinese) who had immigrated from abroad to Singapore, and our sample size of 750 subjects was reasonably large, enabling statistical comparison of other parameters, using one eye of each subject, to reduce bias.

Other potential limitations of this study include the inability to detect the scleral spur, which has previously been reported. The visibility of the scleral spur was not detected in images where the internal surface of the sclera formed a smooth continuous line (with no inward protrusion of the sclera or change in its curvature) or in images with suboptimal quality. The study was also limited in that the measurements were restricted to horizontal nasal–temporal AS-OCT scans, as these have been shown to be the most consistent with respect to obtaining high-quality images for the ZAP program to analyze. AS-OCT imaging has been shown to be restricted by the inability to obtain high-quality images for the ZAP program to analyze. Hence, our results are not generalizable to younger patients. It is reassuring, however, to find similar analytic outcomes of parameters between the sexes and associations with systemic measurements.

This article serves to provide normal values of corneal dimensions and a novel parameter, PCAL, for Chinese eyes. We believe that these data will be clinically applicable for the surgical management of posterior corneal procedures (e.g., DSAEK) and in the assessment of patients requiring other forms of anterior segment or corneal surgery, including anterior chamber or iris-supported phakic IOL surgery, IOL implantation in cataract surgery, or refractive intrastral corneal implantation.

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