Measurement of central corneal thickness in health and disease

Central corneal thickness (CCT) is an important parameter in refractive surgery, in the assessment of corneal disease, and for risk profiling in ocular hypertension and glaucoma (Copt et al., 1999). CCT can be measured using a number of modalities including optical pachymetry, ultrasound pachymetry, Scheimpflug imaging, optical coherence tomography (OCT), and even magnetic resonance imaging (Wolffsohn and Davies, 2007). A variety of factors may be important determinants of CCT. Some of these factors include acute and chronic corneal disease, patient age, gender, refractive error, and ethnic origin. CCT has been described to be a predictor for the development of primary open-angle glaucoma and the progression of glaucomatous visual field defects in the Ocular Hypertension Treatment Study and other investigations. CCT may be the most consistent predictor of the degree of glaucomatous damage (Jonas et al., 2005). Over the last decade wide range of new and sophisticated instruments have been developed for the determination of corneal thickness, such as the different optical laser interferometers, confocal microscope, ultrasonic biomicroscope, scanning slit pachymeter, and noncontact specular microscope.

Pachymetry has been adopted for use before and after intraocular surgery, refractive surgery, as a method to assess donor corneas and the outcomes of cornea transplant surgery. Corneal pachymetry can be used as a screening method for a range of systemic, ocular, and corneal diseases. Corneal pachymetry can be measured in several different ways. Noncontact anterior segment-OCT (AS-OCT) equipment has been developed that offers high resolution cross-sectional imaging of the cornea and allows both central and regional pachymetry, as well as sophisticated goniometry of the irido-corneal angle and other anterior segment structures (Kim et al., 2008). Evaluation of CCT is important in a wide range of disorders, such as ectatic dystrophies, contact-lens-related complications, glaucoma, dry eye, and diabetes mellitus (Modis et al., 2001). Automated noncontact specular microscopy evaluates the endothelial status and determines corneal thickness at the same time.

Doughty and Zaman (2000) determined the “normal” CCT value in human corneas based on reported literature values for within-study average CCT values, and used this as a reference to assess the reported impact of physiological variables (especially age and diurnal effects), contact lens wear, pharmaceuticals, ocular disease, and ophthalmic surgery on CCT. A meta-analysis of possible association between CCT and IOP measures of 133 data sets, regardless of the type of eyes assessed, revealed a statistically significant correlation; a 10% difference in CCT would result in a 3.4 mm Hg difference in IOP. For eyes with chronic diseases, the change was 2.5 mm Hg for a 10% difference in CCT, whereas a substantial but highly variable association was seen for eyes with acute onset disease. The meta-analysis confirmed that, eyes with low CCT values may result in low tonometry readings and high CCT values can result in elevated tonometry readings. A prospective observational study by two modalities revealed strong correlation but a significant difference between mean ultrasound pachymetry (US) and AS-OCT CCT. There was a reproducible systematic difference between CCT measurements taken with ultrasound and OCT (Kim et al., 2008).

In this issue of Saudi Journal of Ophthalmology, Al-Ageel and Al-Mummar (2009) have compared CCT measurements taken with Pentacam, noncontact specular microscope (NCSM), and US in 94 normal and 72 post-laser in situ keratomileusis (LASIK) eyes in prospective manners and has assessed the agreement between the three devices. In their normal eyes, the mean CCT taken with Pentacam, NCSM, and US was 552.60 μm, 511.90 μm, and 533.30 μm, respectively. The average values of CCT taken with the three instruments were significantly different. In post-LASIK eyes the mean CCT with Pentacam, NCSM, and US was 483.02 μm, 450.70 μm, and 469.50 μm, respectively. The average values of CCT taken were significantly different for Pentacam vs. NCSM and Pentacam vs. US, but not significant for NCSM.
vs. US. Clinical agreement between three instruments showed that in normal eyes, the mean values and paired differences of the three CCT devices were found to be independent. In post-LASIK eyes, there was significant association between the difference and the mean of the Pentacam and NCSM, and US and NCSM. Their study demonstrated that there were significant differences in the CCT measured with Pentacam, NCSM, and US in normal and post-LASIK eyes. The measurements with Pentacam were significantly thicker than the other methods in both groups. The measurements with US were significantly thicker than NCSM in normal eyes and not significant in post-LASIK eyes. All the three devices showed good correlation with each other. Results from Al-Ageel and Al-Muammar’s study are in agreement with a study by Modis et al. (2001), in which CCT measurements with non-contact specular microscopic, contact specular microscopic, and ultrasonic pachymetry demonstrated that each of the instruments was reliable but could not be used interchangeably. Their present observations confirm that currently available pachymetry devices are reliable in their measurements but cannot simply be used interchangeably. These results further confirm the validation of pachymetry devices; good precision with uncertain accuracy. Therefore, the main clinical relevance of their study is that for refractive procedures and for long-term patient’s follow-up one certain instrument is recommended. The differences between devices can result from their distinct operating principles. Modis et al. (2001) evaluated CCT values in normal and postkeratoplasty corneas with noncontact specular device, the Tomey contact specular microscopic pachymetry, and compared with ultrasonic values as the “common standard.” Their different pachymeters provided reliable measurements within a similar range of standard deviation. However, the results indicated that the different instruments did not result in comparable thickness values. The noncontact specular microscopic measurements were significantly smaller than the ultrasound results, which were significantly smaller than the contact specular microscopic values. This tendency was present in normal and in postkeratoplasty eyes. Other studies also disclosed the reliability of different ultrasonic and specular microscopic instruments, but they documented significantly different results comparing the different pachymetry devices (Wheeler et al., 1992; Bovelle et al., 1999; Al-Mezaine et al., 2008).

References

Imtiaz A. Chaudhry, MD PhD FACS
Senior Academic Consultant,
Oculoplastic and Orbit Division,
King Khaled Eye Specialist Hospital,
P.O. Box 7191,
Riyadh 11462,
Saudi Arabia
E-mail address: ichaudhry@kkesh.med.sa