Qualifying Patients for LASIK Using Tomography

How to approach screening patients for refractive surgery.

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The preoperative screening and selection of refractive surgery patients are arguably the most important part of the procedure. It is imperative that refractive surgeons attempt to identify patients at risk of developing post-LASIK ectasia before they undergo the procedure. The ability to detect early ectatic disease is greatly improved by careful screening using the Pentacam Comprehensive Eye Scanner (Oculus Optikgeräte GmbH).

The Pentacam is a rotating Scheimpflug device that obtains three-dimensional measurements of the cornea. As a tomographer, it creates a three-dimensional corneal reconstruction, which characterizes the elevation and curvature of the cornea's front and back surfaces, provides pachymetric mapping, calculates the total corneal refractive power, and performs anterior segment biometry.[1] The device generates maps using a variety of color scales. Careful attention must be paid to the type of scale (that is absolute vs relative) used in each case to ensure proper interpretation of the results. Inappropriate scale selection can hide valuable corneal findings.

ELEVATION MAPS

First, an evaluation of the tangential, anterior, and posterior elevation maps is performed. These maps are printed together to facilitate refractive surgery screening. The tangential map's curvature and dioptric values help identify astigmatism and can also point to the location of corneal defects such as a keratoconic cone. With the exception of regular, symmetric bowtie astigmatism or an essentially spherical cornea, certain patterns identified by the tangential map may be risk factors for corneal ectasia. This map also compares the superior and inferior symmetric opposites within the central 5 mm of the cornea. If the superior number is more than 2.50 D greater than the inferior number, or if the inferior number is more than 1.50 D greater than the superior number, there may be an increased risk for corneal ectasia.[2]

The anterior and posterior elevation maps show the elevations and depressions of the cornea compared to a reference. Elevation data are viewed by comparing the patient's raw data to a standard reference surface. The best-fit sphere (BFS) or the best-fit toric ellipsoid is the known reference point of the central 8 mm of the cornea, subtracted from the elevation map.[3] This subtraction of the known shape helps to emphasize the variability in the patient's cornea.[3] The elevation map should be evaluated for the magnitude of the elevation in both the anterior and posterior apices. Elevation can be examined above the BFS to determine if there is displacement of the steepening. The elevation map should show well-centered anterior and posterior apices with a minimal amount of elevation at the BFS.[4] Also, the central 5-mm circle on the elevation map should be examined. Values of greater than 12 µm on the anterior elevation map and 15 µm on the posterior elevation map are considered abnormal.[2]

THICKNESS MAPS

Next, users can review the thickness map. On a normal cornea, the central area is uniformly thick; for a cornea at risk of ectasia, the thinnest location is often displaced inferiorly or inferotemporally. To assess the thickness map, the user compares the superior and inferior values, the thinnest location of both eyes, and the location of the thickest and thinnest pachymetry readings. The difference between the thinnest location of both eyes and the difference between the superior and inferior values should be less than 30 µm.[2]

The Pentacam's Belin/Ambrósio Enhanced Ectasia

Display Software or BAD increases sensitivity and specificity when screening patients. The BAD display shows the baseline elevation map, the exclusion map, and the difference maps.

Understanding the results of the BAD printout requires understanding the concept of the enhanced BFS. It is based on the idea that, if an abnormal portion of the cornea falls within the BFS, it will have an effect on the elevation map. For example, if keratoconus is present, the protrusion will steepen the BFS, which will then lessen the difference on the elevation map and may cause falsely negative screenings. By creating an exclusion zone encompassed by the thinnest 4 mm of cornea, the enhanced BFS approximates a more normal peripheral cornea. This causes a more significant and evident elevation map where the protruding area is more pronounced.

HOW TO READ ELEVATION MAPS

When reading the elevation maps, the user should begin by looking at the baseline elevation map of the anterior and posterior cornea, which is based on the BFS. Next, he or she views the exclusion map, which shows the data based on the enhanced BFS for both the anterior and posterior cornea. This map may appear very similar or very different from the baseline map using the BFS. The change in the BFS is relatively small in normal eyes and larger in eyes with ectasia. Then, the operator views the difference maps, which illustrate the change in elevation compared to the previous two elevation maps. These maps contain only three colors that correspond to the amount of elevation. Green demonstrates a small change in elevation from baseline to the exclusion map, which is typical of a normal eye. Yellow shows a suspicious amount of change, and red exemplifies a large amount of change.[3]

The BAD software enhances the interpretation of the pachymetric values in terms of screening for ectasia and keratoconus. The display shows the pachymetric values at the apex and the thinnest points. Displacement distance and direction are calculated; in patients with keratoconus, this difference from the central point is higher. The corneal thickness spatial profile is a graphical representation of this parameter. Keratoconic eyes show a more rapid progression of thickening from the thinnest point to the periphery. The corneal thickness spatial profile and the percentage thickness increase show the average progression in a normal population compared to the patient's data.

The BAD software also performs a regression analysis that uses the following parameters: the change in the anterior elevation, change in the posterior elevation, corneal thickness at the thinnest point, thinnest point displacement, and pachymetric progression. A final overall map reading titled D is reported for each of these individual parameters and as an aggregate of the individual parameters; it is reported as a variation from the mean.[5] The D reading is then color-coded based on its distance from the mean, indicating the level of suspicion or risk for ectasia.

BAD-3 was developed in 2011. It includes a new parameter called *Ambrósio's relational thickness* or *ARTmax*. ARTmax improves the sensitivity and specificity for detecting keratoconus by taking the ratio of the thinnest pachymetry to the pachymetry progression index. The pachymetric progression index is calculated for meridians over the entire 360º of the cornea. BAD-3 also includes a database of hyperopic patients. This enhancement helps to decrease the false-positives, because hyperopic patients have been shown to have higher values on the posterior elevation map.[6]

CONCLUSION

Using the Pentacam for the preoperative assessment of LASIK patients provides the clinician with information that is quantitatively and qualitatively informative in stratifying risk. In conjunction with a detailed history and ophthalmic examination, in our estimation, the Pentacam utilizing the BAD software can be considered the standard of care in refractive surgery screening and patient selection. ■

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