New technologies aid in diagnosis of subclinical keratoconus

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in Berlin

W I T H O U T any real criteria to describe the entity known as
subclinical keratoconus, clinicians are having difficulty recognising the
early stages of this condition.

Addressing a special symposium on wavefront aberrations at the Joint Meeting of the European Society of Ophthalmology and the
German Ophthalmology Society (SOE/DOG,) Jens Bühren MD,
Goethe University Eye Clinic, Frankfurt, Germany, presented a
trial in which he demonstrated the feasibility of corneal first-surface
wavefront analysis in discriminating eyes with subclinical keratoconus
from normal eyes.

“The clinically inconspicuous fellow eye of an eye with early
keratoconus reveals significant corneal first surface differences
compared to normal eyes and could therefore be considered to have
subclinical keratoconus. Zernike coefficients that describe vertical asymmetry (prism, coma)
discriminated best between normal and keratoconic eyes. Analysing the
corneal first-surface aberrations is therefore useful to detect
subclinical keratoconus in patients applying for refractive surgery,” he
reported.

The prospective study involved 13 clinically inconspicuous eyes of
13 patients with first diagnosis of keratoconus in the contralateral eye
and a paracentral inferior/superior difference (PISD, i.e. 3.0mm zone) of
less than 1.4 D. These patients had no symptoms, no clinical signs and
did not wear contact lenses for at least four weeks.

The investigators included another 23 eyes of 18 patients with
first diagnosis of keratoconus; PISD >1.4 D, mild-moderate symptoms,
no clinical signs and no contact lens wear to serve as positive controls.

Finally, 150 healthy eyes of 87 LASIK patients who had preoperative
corneal topographies served as negative controls.

Dr Bühren implemented an axial-keratometric map (O-Scan II,
Bausch&Lomb) to obtain topographic data. He performed
Zernike decomposition (6.0mm zone) of the corneal surface up to
the 7th order using VOl-L-Pro 6.28 (Sarver and Associates).

Abnormal HOAs common in subclinical keratoconus

Dr Bühren found that there were significant differences in the pattern
of corneal higher order aberrations between clinically inconspicuous
fellow eyes and the normal control eyes for the coefficients Z1-1 and
Z3-1 and for the RMS value of total higher order aberrations (HOA),
the RMS value of 3rd order and the RMS value of coma, Z1-1, Z3-1, Z5-1,
and Z7-1.

Total HOA RMS, Z1-1, Z3-1 and RMS of coma were able to
differentiate between early keratoconus and normal eyes with
maximal sensitivity and specificity (Az ROC =0.99; cut-off
point: -0.25µm), followed by vertical prism (Z1-1; Az ROC =0.98; cut-off
point: -0.50µm) and the RMS value of Z1-1, Z3-1, Z5-1, and Z7-1 (Az
ROC =0.95; cut-off point: 0.59µm).

Based on these coefficients, approximately 90% of eyes with
subclinical keratoconus could be discriminated from normal eyes, Dr
Bühren observed.

Avoiding post-LASIK keratectasia

He noted that LASIK performed in eyes with subclinical keratoconus
could provoke iatrogenic keratectasia, probably one of the
surgery’s most feared complications. He said the study results might help to serve as
preliminary guidelines in diagnosing subclinical keratoconus and help in
decision-making in terms of which eyes applying for LASIK should be
accepted, rejected or postponed.

LASIK surgeons are aware of the potential association between
subclinical keratoconus and post-
LASIK keratectasia. Markus
Kohlhaas MD, who is involved in a
related study at his institute in
Dresden, Germany in which he is
retrospectively examining 14
keratectasia (pooling
lystressed.

Dr Bühren proposed to use
discriminant analysis to construct a
multi-modal metric with weighted
input from corneal front and back
surface data and total ocular
wavefront data. This analysis could
improve the definition and diagnosis of the earliest stages of
keratoconus.

In addition, biomechanical analysis
(investigating corneal hysteresis) and
retrospective analysis of eyes with
iatrogenic keratectasia (pooling
together data for analysis), could be
helpful approaches to gain a better
understanding of subclinical
keratectasia. This is important since
there may be other conditions (e.g.
pellucid marginal degeneration)
that contain the risk of keratectasia.

Session co-moderator Martin
Wenzel MD, Krankenhaus der
Barmherzigen Brüder, agreed that
more work needed to be done, in
particular retrospective analyses. He
was interested in whether any of
the 150 normal eyes showed signs of
early keratoconus, retrospectively.

Dr Bühren explained that there
were indeed overlaps. He said that
although he was able to classify keratoconus correctly in 94% of the
cases, there were in fact some eyes
that had vertical asymmetry and
coma that were less than 0.2 µm.

The 18-month follow up, however,
did not reveal any further cases. He
suggested that perhaps other
asymmetries might be caused by
keratoconus and urged for multi-
modal investigations with
pachymetry as well as
biomechanical investigations.

“The corneal surface described
by Zernike polynomials and
wavefront is one example of using
Zernike polynomials to give a
reproducible description of
complex shapes. In keratoconic
eyes, the dominant wavefront error
is vertical asymmetry (coma).
Corneal wavefront aberrations of
clinically inconspicuous fellow eyes
in patients with early keratoconus
can serve as a model of subclinical
keratoconus,” Dr Bühren said.

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