Comparison of Placido disk to Scheimpflug generated data in Topography-guided normalization in Keratoconus combined with CXL (Athens Protocol)



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Revisiting the Diagnosis and Progression criteria of Keratoconus

- Traditionally:
- Visual acuity
- Refraction
- Pachymetry
- Keratometry
- Anterior inferior asymmetry
- Amsler-Krumeich criteria





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34y/o female MD with KCN: 2 years now asymptomatic: No change? 20/20, no keratometric change



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ORIGINAL RESEARCH

Revisiting keratoconus diagnosis and progression classification based on evaluation of corneal asymmetry indices, derived from Scheimpflug imaging in keratoconic and suspect cases

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Purpose: To survey the standard keratoconus grading scale (Pentacam®-derived Amsler-Krumeich stages) compared to corneal irregularity indices and best spectacle-corrected distance visual acuity (CDVA).

Patients and methods: Two-hundred and twelve keratoconus cases were evaluated for keratoconus grading, anterior surface irregularity indices (measured by Pentacam imaging), and subjective refraction (measured by CDVA). The correlations between CDVA, keratometry, and the Scheimpflug keratoconus grading and the seven anterior surface Pentacam-derived topometric indices - index of surface variance, index of vertical asymmetry, keratoconus index, central keratoconus index, index of height asymmetry, index of height decentration, and index of minimum radius of curvature - were analyzed using paired two-tailed t-tests, coefficient of determination (r2), and trendline linearity.

Results: The average \pm standard deviation CDVA (expressed decimally) was 0.626 \pm 0.244 for all eyes (range 0.10-1.00). The average flat meridian keratometry was (K1) 46.7 ± 5.89 D; the average steep keratometry (K2) was 51.05 ± 6.59 D. The index of surface variance and the index of height decentration had the strongest correlation with topographic keratoconus grading (P < 0.001). CDVA and keratometry correlated poorly with keratoconus severity.

Conclusion: It is reported here for the first time that the index of surface variance and the index of height decentration may be the most sensitive and specific criteria in the diagnosis, progression, and surgical follow-up of keratoconus. The classification proposed herein may present a novel benchmark in clinical work and future studies.

Keywords: diagnosis and classification, Pentacam topometric indices, Amsler-Krumeich keratoconus grading, surface variance, vertical asymmetry, keratoconus index, central keratoconus index, height asymmetry, height decentration, minimum radius of curvature

Introduction

Keratoconus is described as a degenerative bilateral, progressive, noninflammatory corneal disorder characterized by ectasia, thinning, and increased curvature.^{1,2} It is associated with loss of visual acuity particularly in relation to progressive cornea irregularity,34 and usually is manifested asymmetrically between the two eyes of the same patient.5.6 Occasionally, the patient may present with symptoms of photophobia, glare, and monocular diplopia.

The problem of specificity and sensitivity of keratoconus assessment, particularly the diagnosis of early signs of ectasia and/or subclinical keratoconus, and for monitoring the progression of the disease, has been extensively studied.7 The commonly used

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Figure 2 Box plots of measured parameters versus keratoconus grading, as produced by the Oculyzer™ software, showing median level (indicated by _), average symbol ([]), 95% medianeconfidnce range box (black line boxes), and interquartile intervals range box (red line boxes). (A) CDVA versus keratoconus grading. (B) ISV versus keratoconus grading. (C) IVA versus keratoconus grading. (D) KI versus keratoconus grading. (E) CKI versus keratoconus. (F) IHA versus keratoconus grading. (G) IHD versus keratoconus grading. (H) Rmin versus keratoconus grading.

Abbreviations: CDVA, best spectade-corrected distance visual acuity: CKI, central keratoconus index: IHA, index of height asymmetry: IHD, index of height decentration: ISV, index of surface variance: IVA, index of vertical asymmetry; KC1, keratoconus grading Stage I; KC1-2, keratoconus grading Stage II; KC2, keratoconus grading Stage II, KC2-3, keratoconus grading Stage II-III; KC3, keratoconus grading Stage III; KC3-4, keratoconus grading Stage III-IV; KC4, keratoconus grading Stage IV; KI, keratoconus index; Pl. prediction interval; Rmin, minimum radius of curvature

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When looking at the topometric parameters that same patient has progressed a lot!



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The Athens Protocol 4 steps: same day PTK > topoPRK > MMC > CXL (10mW/cm² × 10 min)

1- _{PTK}

2- topo

-guided

PRK



Figure 4.1: Epithelium removed with 50 micron PTK

100

Figure 4.2: TC at treatment plan



Figure 4.3: Topography-guided PRK to correct part of the refractive error (TCAT treatment plan) maximal thickness removal 50 microns



Figure 4.4: MMC solution 0.02% for 20 seconds

4-: CXL



3- 30" MMC



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5.50





Purpose

- To compare the efficacy of two alternative corneal topography data sources employed in the topography - guided part of the clinical keratoconus management with the Athens Protocol (AP) procedure, namely
- a Placido-disk imaging device and
- a Scheimpflug imaging device,



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 by analysis of one-year refractive, topometric and visual rehabilitation changes.

Kanellopoulos AJ and Asimellis G: Clinical Ophthalmology. 2013;7: 1385–96 Comparison of Placido disc and Scheimpflug image-derived topography-guided excimer laser surface normalization combined with higher fluence CXL: the Athens Protocol, in progressive keratoconus.



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Methods

- One hundred eighty-one (181) consecutive keratoconic prints ints subjected to the Athens Protocol procedure, from which one eye was randomly selected, were studied pre-operatively and 1, 3, 6, and 12-months postoperatively for:
 - \checkmark visual acuity,
 - \checkmark keratometry, and
 - \checkmark anterior segment corneal indices.
- Two groups were formed, depending on the primary source for the topo-guided photoablation, namely a Placido disc, for group A (Topo), and a Scheimpflug rotating camera, for group B (Ocu).
- The one-year changes in visual acuity, keratometric, and anterior segment topometric indices were studied for both groups.





Results

- Visual acuity changes: group A (Topo), +0.12 ± 0.20 (range +0.60 to -0.45), and for group B (Ocu), +0.15 ± 0.20 (range +0.75 to -0.30), respectively.
- Keratometry changes:
 - group A, (Topo), K1 (flat keratometry) changed from 45.202±3.782 D to 43.022±3.819, or a change of -2.18 D, and K2 (steep keratometry) changed from 48.670±4.066 D to 45.865±4.794 D, or a change of -2.805 D.
 - group B (Ocu), K1 (flat keratometry) changed from 46.213±4.082 D to 43.190±4.398 D, or a change of -3.023 D, and
 K2 (steep keratometry) changed from 50.774±5.210 to 46.380±5.006 D, or a change of -4.394 D.
 - For group A (Topo), the index of surface variance was reduced to -5.07% and the index of height decentration to -26.81%, and for group B (Ocu), the index of surface variance was reduced to -18.35% and the index of height decentration to -39.03%, respectively. This negative change is indicative of corneal surface becoming less irregular (ISV) and the 'cone' becoming more central (IHD) in the post-operative assessment.





IHD & ISV vs low and high keratoconus stage



ISV PreOperative vs PostOperative (Group B, Ocu), low IHD subgroup



0.22 0.20 0.18 0.16 values) 0.14 (IHD 0.12 ⊗ 0.118 Data 0.10 0.08 s 0.072 0.06 0.04 0.02 PreOperative PostOperative

IHD PreOperative vs PostOperative (Group B2, Scheimpflug High)

ISV PreOperative vs PostOperative (Group B, Ocu), high IHD subgroup



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Conclusions



- Of the two sources of primary topography-guided corneal data, the Scheimpflug rotating camera (Oculyzer II) appears to provide statistically significant better improvement when compared to the Placido disk topographer (Vario Topolyzer).
- Overally, the Athens Protocol procedure, aiming to both arrest the keratoconus ectasia progression, as well as to improve corneal topometry and visual performance, demonstrates impressive refractive, keratometric and topometric results.





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Conclusions

- The Scheimpflug camera-driven topography guided treatments appear to provide better improvement when employed instead of the Placido topographer for topography-guided treatments.
- The Athens Protocol procedure demonstrates safe and notable refractive, keratometric and topometric results.
- The observed changes, as well as keratometric flattening and topometric improvement are suggestive of the overall postoperative improvements.



