Letter to the Editor

Optical coherence tomography epithelial mapping for keratoconus screening

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Dear Editor

We read with great interest the paper titled "a review of artificial intelligence applications in anterior segment ocular diseases" [1] and would like to point out an issue concerning the importance of optical coherence tomography (OCT)-derived epithelial thickness mapping in keratoconus screening [2]. Different factors, such as age, sex, area of measurement, use of contact lenses, best-corrected visual acuity, corneal curvature radius, and presence of ectatic corneal disorders, affect the thickness of the corneal epithelium [3-6].

Reinstein et al. described uneven epithelial thickness mapping of the cornea in normal human eyes using very high-frequency digital ultrasound scanning [7]. Haque et al., for the first time, compared epithelial thickness mapping across four meridians in normal corneas with those of rigid gas-permeable contact lens wearers and keratoconic corneas measured with the Humphrey – Zeiss OCT 2000 system and reported the thinnest epithelium in the inferior temporal meridian in eyes with keratoconus [8]. Subsequently, maps of corneal epithelial thickness have been introduced as a surrogate modality to evaluate normal and ectatic corneas.

Corneal epithelial thickness maps revealed good repeatability in a study by Li et al. involving 145 normal and 35 keratoconic eyes. They found apical epithelial thinning in keratoconic eyes and deviation from the normal epithelial pattern with a high accuracy using the root-mean-square pattern deviation variable [6]. OCT-derived epithelial maps correlate well with pentacam-derived topometric asymmetry indices of height decentration and surface variance in keratoconic eyes, indicating the importance of epithelial imaging for evaluating eyes with keratoconus and ectasia [9]. Similarly, OCT-derived epithelial maps have been suggested for the early detection of form fruste keratoconus [10]. Using epithelial thickness maps of 36 eyes of 36 patients with form fruste keratoconus, Temstet et al. found that the epithelial thickness in the thinnest corneal zone was located inferiorly. This corresponded to the zones of maximum posterior elevation and minimum epithelial thickness [10]. Epithelial thickness maps can be used to differentiate stable keratoconus from progressive keratoconus. Despite no significant differences between full corneal mapping of eyes with stable and progressive keratoconus, a significantly thinner inferior paracentral region of the corneal epithelium was detected in the latter group [11].

Additionally, OCT-derived epithelial maps can differentiate eyes with ectasia from those with pseudo-ectasia [12]. Comparing corneal epithelial thickness maps of 21 eyes with keratoconus or form fruste keratoconus and 15 eyes with contact lens warpage, Schallhorn et al. found inferior thinning and superior corneal epithelial

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thickening in the former. In most eyes with keratoconus, agreement was found between the locations of the minimum epithelial thickness and the maximum axial power and between the minimum epithelial thickness and the maximum mean power. In contrast, in most eyes with corneal warpage, agreement was found between the maximum epithelial thickness and the maximum axial power and between the maximum epithelial thickness and the maximum mean power [12].

Regardless of the type of commercially available anterior-segment OCT strategy, studies have confirmed the excellent measurement repeatability and reproducibility of this imaging modality [13, 14]. Recently, Kundu et al. introduced an artificial intelligence-driven model for detecting early keratoconus. They incorporated OCT-derived epithelial thickness along with other data in this model. This artificial intelligence-derived model efficiently classified eyes with asymmetric ectasia as subclinical and form fruste keratoconus [15].

The aforementioned evidence suggests that corneal epithelial thickness maps derived from OCT reports as an adjunctive assessment could be helpful in screening and diagnosing keratoconus. However, further population-based studies are required to confirm the accuracy and cost-effectiveness of data derived from this imaging approach as an artificial intelligence model based on age, sex, and race adjustment.

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REFERENCES

1. Heidari Z, Baharinia M, Ebrahimi-Besheli K, Ahmadi H. A review of artificial intelligence applications in anterior segment ocular diseases. Med Hypothesis Discov Innov Optom.2022; 3(1): 22-33. https://doi.org/10.51329/mehdioptometry146
2. Yang Y, Pavlatos E, Chamberlain W, Huang D, Li Y. Keratoconus detection using OCT corneal and epithelial thickness map parameters and patterns. J Cataract Refract Surg. 2021;47(6):759-766. doi: 10.1097/j.jcrs.0000000000000498 pmid: 33181629
3. Hashmani N, Hashmani S, Saad CM. Wide Corneal Epithelial Mapping Using an Optical Coherence Tomography. Invest Ophthalmol Vis Sci. 2018;59(3):1652-1658. doi: 10.1167/iovs.17-23717 pmid: 29625491
4. Vega-Estrada A, Mimouni M, Espla E, Alió Del Barrio J, Alio JL. Corneal Epithelial Thickness Intrasubject Repeatability and its Relation With Visual Limitation in Keratoconus. Am J Ophthalmol. 2019;200:255-262. doi: 10.1016/j.ajo.2019.01.015 pmid: 30689987
5. Ma Y, He X, Zhu X, Lu L, Zhu J, Zou H. Corneal Epithelium Thickness Profile in 614 Normal Chinese Children Aged 7-15 Years Old. Sci Rep. 2016;6:23482. doi: 10.1038/srep23482 pmid: 27004973
6. Li Y, Tan O, Brass R, Weiss JL, Huang D. Corneal epithelial thickness mapping by Fourier-domain optical coherence tomography in normal and keratoconic eyes. Ophthalmology. 2012;119(12):2425-33. doi: 10.1016/j.ophtha.2012.06.023 pmid: 22917888
7. Reinstein DZ, Archer TJ, Gobbe M, Silverman RH, Coleman DJ. Epithelial thickness in the normal cornea: three-dimensional display with Artemis very high-frequency digital ultrasound. J Refract Surg. 2008;24(6):571-81. doi: 10.3928/1081597X-20080601-05 pmid: 18581782
8. Haque S, Jones L, Simpson T. Thickness mapping of the cornea and epithelium using optical coherence tomography. Optom Vis Sci. 2008;85(10):E963-76. doi: 10.1097/OPX.0b013e318188892c pmid: 18832971
9. Kanellopoulos AJ, Asimellis G. OCT corneal epithelial topographic asymmetry as a sensitive diagnostic tool for early and advancing keratoconus. Clin Ophthalmol. 2014;8:2277-87. doi: 10.2147/OPTH.S67902 pmid: 25429197
10. Temstet C, Sandali O, Bouheraoua N, Hamiche T, Galan A, El Sanharawi M, et al. Corneal epithelial thickness mapping using Fourier-domain optical coherence tomography for detection of form fruste keratoconus. J Cataract Refract Surg. 2015;41(4):812-20. doi: 10.1016/j.jcrs.2014.06.043 pmid: 25840306
11. Serrao S, Lombardo G, Calì C, Lombardo M. Role of corneal epithelial thickness mapping in the evaluation of keratoconus. Cont Lens Anterior Eye. 2019;42(6):662-665. doi: 10.1016/j.clae.2019.04.019 pmid: 31060894
12. Schallhorn JM, Tang M, Li Y, Louie DJ, Chamberlain W, Huang D. Distinguishing between contact lens warpage and ectasia: Usefulness of optical coherence tomography epithelial thickness mapping. J Cataract Refract Surg. 2017;43(1):60-66. doi: 10.1016/j.jcrs.2016.10.019. Erratum in: J Cataract Refract Surg. 2017;43(10):1367-1368 pmid: 28317679
13. Hwang ES, Schallhorn JM, Randleman JB. Utility of regional epithelial thickness measurements in corneal evaluations. Surv Ophthalmol. 2020;65(2):187-204. doi: 10.1016/j.survophthal.2019.09.003 pmid: 31560871
14. Georgeon C, Marciano I, Cuyaubère R, Sandali O, Bouheraoua N, Borderie V. Corneal and Epithelial Thickness Mapping: Comparison of Swept-Source- and Spectral-Domain-Optical Coherence Tomography. J Ophthalmol. 2021;2021:3444083. doi: 10.1155/2021/3444083 pmid: 34650817
15. Kundu G, Shetty R, Khamar P, Mullick R, Gupta S, Nuijts R, et al. Universal architecture of corneal segmental tomography biomarkers for artificial intelligence-driven diagnosis of early keratoconus. Br J Ophthalmol. 2021:bjophthalmol-2021-319309. doi: 10.1136/bjophthalmol-2021-319309 pmid: 34916211