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# Post-LASIK keratectasia in the context of a thicker than intended flap detected by anterior segment optical coherence tomography

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**Abstract**

The corneal flap created in LASIK is responsible for most of its advantages in comparison with surface ablation. However, lamellar dissection of the corneal layers in LASIK can also result in serious complications such as corneal ectasia. A 23-year-old man underwent LASIK for correction of −4.75 −2.00@15 in the right eye and −4.50 −2.00@160 in the left eye with a preoperative thinnest corneal thickness of 518 µm/right eye and 513 µm/left eye in 2009. An intended flap thickness and ablation depth in both eyes were 160 µm and 94 µm, respectively, and subsequently, residual stromal bed thickness was 264 µm/right eye and 259 µm/left eye. Several years after surgery, he was referred for the decreased vision. His corrected-distance visual acuity was 0.50 in both eyes. A scissoring reflex was found in retinoscopy. Orbscan imaging was compatible with keratoconus. Anterior segment optical coherence tomography was performed to measure the LASIK flap. It was much thicker (200 µm) than intended (160 µm), and therefore, the residual stromal bed thickness was much thinner. In summary, keratectasia may develop in cases where thicker than expected flaps result in excessive thinning of the residual stromal bed. The obtained results from this case emphasize and remind the importance of intraoperative measurement of flap thickness and using femtosecond and new criteria for patient selection to avoid post-LASIK keratectasia.

**Keywords**

LASIK, keratectasia, keratoconus, flap thickness, residual stromal bed thickness

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## Introduction

The corneal flap created in LASIK is responsible for most of its advantages compared to surface ablation, including less postoperative pain and faster visual recovery. However, lamellar dissection of the corneal layers in LASIK can also result in serious complications such as corneal ectasia, which occurs several years after operation, leading to progressive thinning and protrusion of the treated area of the cornea, resulting in recurring myopic astigmatism and impaired visual function.[1] Although corneal ectasia was reported after incisional corneal surgery in 1994,[2] it was first reported after excimer corneal ablation in 1998,[3,4] 10 years after the advent of excimer photorefractive keratectomy (PRK) and 7 years after the introduction of LASIK.

Keratectasia is a known complication of LASIK. A considerable number of cases have been reported in the refractive surgery literature.[5,6] Several risk factors that predispose to the occurrence of corneal ectasia after refractive surgery have been described, such as high myopia, forme fruste keratoconus, and low residual stromal bed thickness (RSBT), but cases with mild myopia, normal topography, and residual stromal bed more than 300 µm may also develop ectasia.[5–14] Although the upper limit of myopia suitable for treatment by LASIK has been arbitrarily set as less than 12.00 dioptre (D), keratectasia after LASIK has been reported in cases treated for much lower degrees of myopia from 4.00 to 7.00 D.[15]

Inferior corneal steepening was noted in some of these cases preoperatively. In the absence of refractive instability

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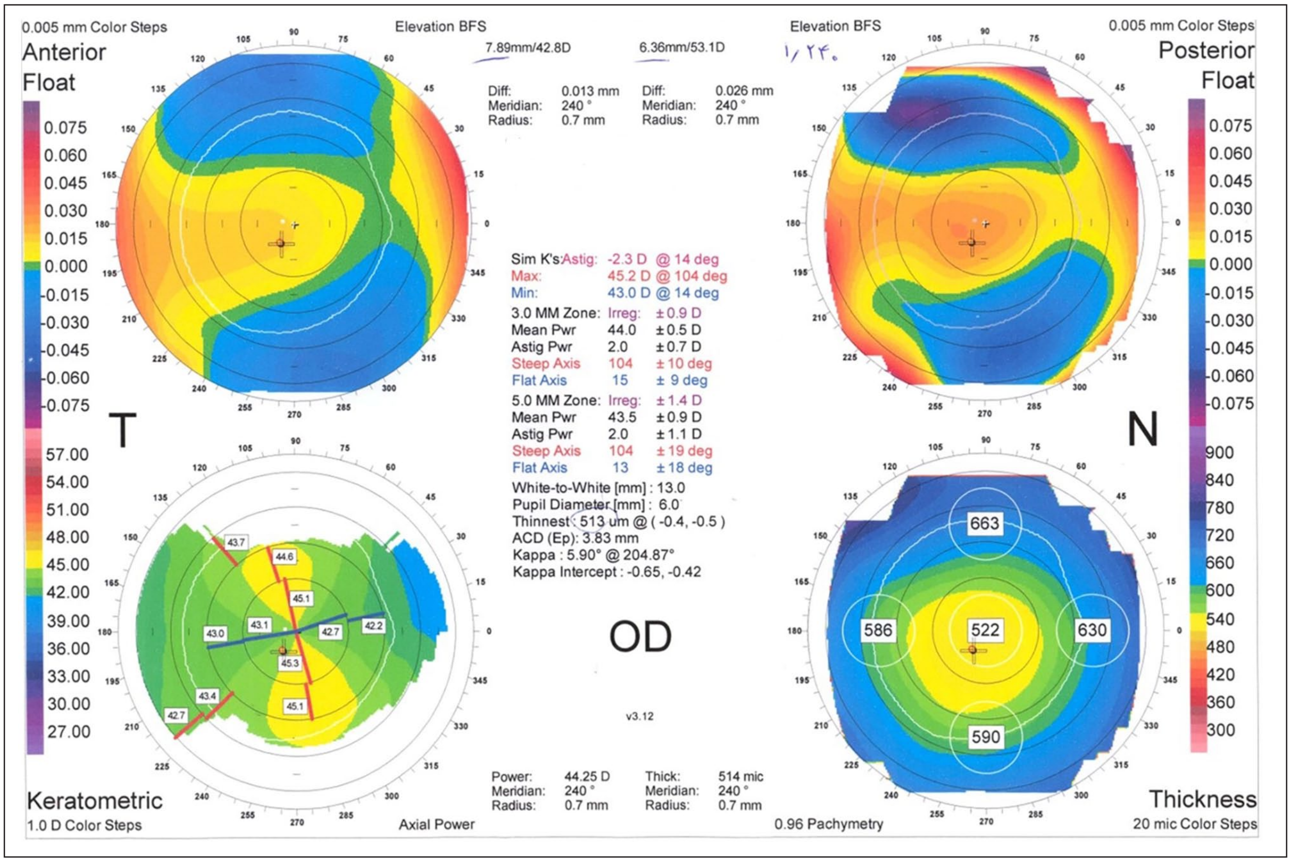


**Figure 1.** Preoperative Orbscan of the right eye showing no significant risk factor for LASIK.

or slit-lamp microscopic features of keratoconus, these corneal changes have been called forme fruste keratoconus.[16]

We describe a patient with bilateral keratectasia 3 years following LASIK to correct moderate myopic astigmatism with normal preoperative topographies and thicker than expected flaps based on the criteria at the time of surgery.

## Case presentation

A 23-year-old man with stable refraction underwent LASIK in 2009. The preoperation manifest refraction was −4.75 −2.00@15 and −4.50 −2.00@160 in the right eye (RE) and left eye (RE), respectively. The preoperative keratometry of the RE was 45.2@104 and 43.00@14 D and in the LE was 46.00@71 and 43.5@161 D. This patient provided written informed consent for the case details and images to be published. Based on our hospital policy, Institutional Review Board (IRB) was not required as it was a case report.

This case had no history of obesity, eye rubbing habit, apnoea, allergy, and familial history of keratoconus. White-to-White was 13.0 mm/RE and 12.1 mm/LE. The preoperative thinnest corneal thickness (TCT) was 518 μm in the RE and 513 μm in the LE in Orbscan (512 μm/RE and 510 μm/LE with ultrasound pachymetry). The intended flap thickness was 160 μm in both eyes with Moria CB microkeratome, and the ablation depth was 94 μm in both eyes with Nidek EC-5000 excimer laser machine.

Optical and transition zone diameters were 6.0 and 7.5 mm in both eyes. Intraoperative ultrasound pachymetry or corneal hysteresis measurements were not performed before ablation with the excimer laser. His preoperative imaging, including corneal topography and Orbscan (Figures 1 and 2), showed symmetric bowtie patterns without skewed axes.

Three years after surgery, he was referred for the decreased vision that could not be corrected with spectacles. A scissoring reflex was found in retinoscopy. His corrected-distance visual acuity was 0.5 in both eyes, with subjective refraction of −0.50 −2.50@35/RE and −1.00 −3.00@135/LE. Orbscan imaging was compatible with keratoconus with significant anterior and posterior elevation and inferior steepening in both eyes (Figures 3 and 4). The anterior segment optical coherence tomography (AS-OCT) (Visante; Carl Zeiss Meditec) revealed a central flap thickness of 190 μm in the RE and 203 μm in the LE, which was much thicker than the intended flap thickness of 160 μm. The thicker than expected flap along with deep ablations resulted in excessive thinning of the residual stromal bed (Figures 5).

## Discussion

This case is an example of avoiding LASIK with microkeratomes and why nowadays shift towards femtosecond occurs, in which the results are reliable and repeatable in terms of flap thickness.

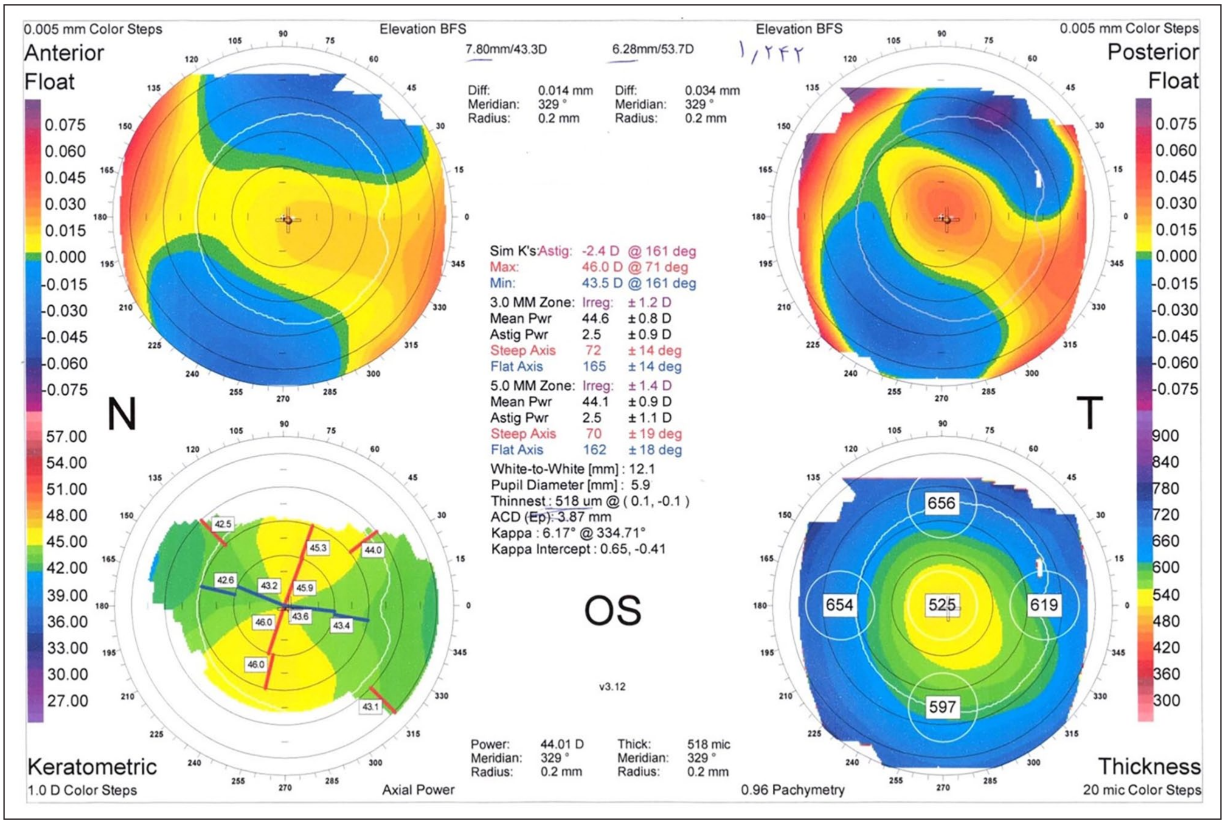


**Figure 2.** Preoperative Orbscan of the left eye showing no significant risk factor for LASIK.

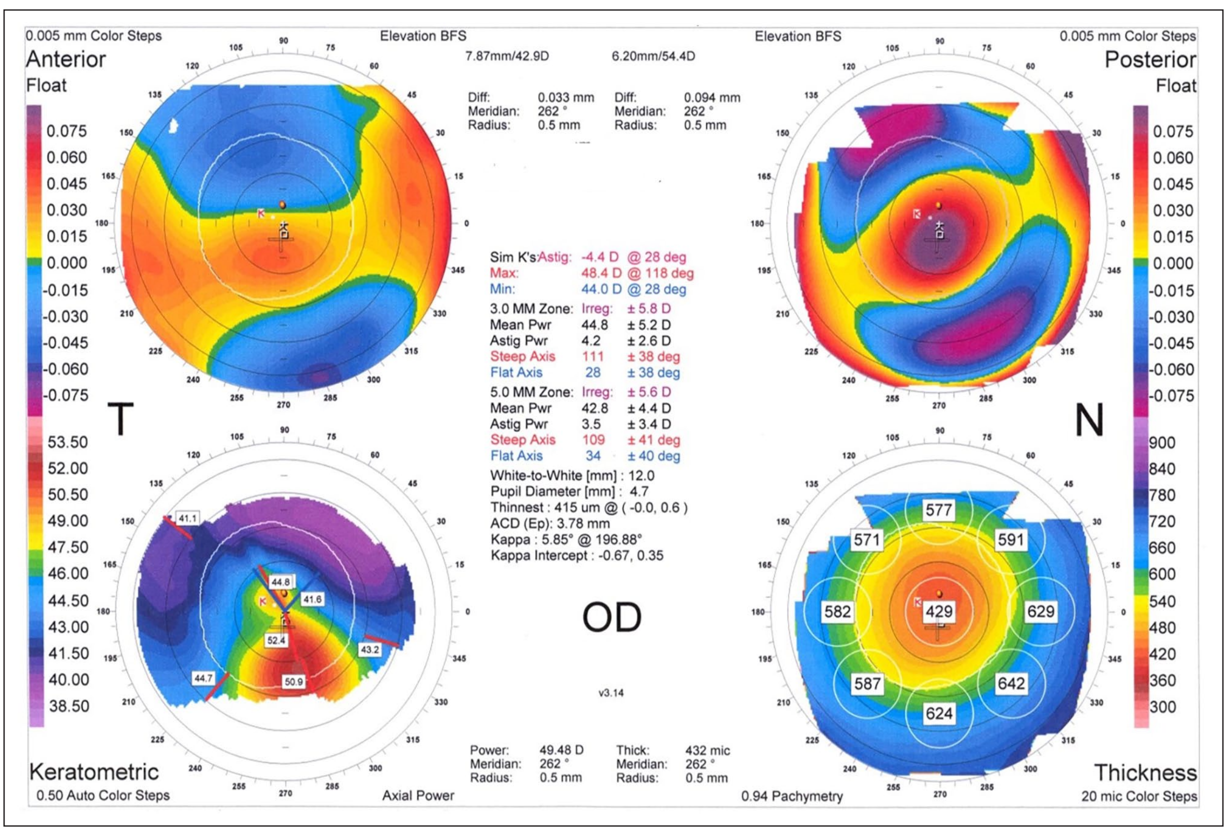


**Figure 3.** Postoperative Orbscan of the right eye showing advanced keratectasia.

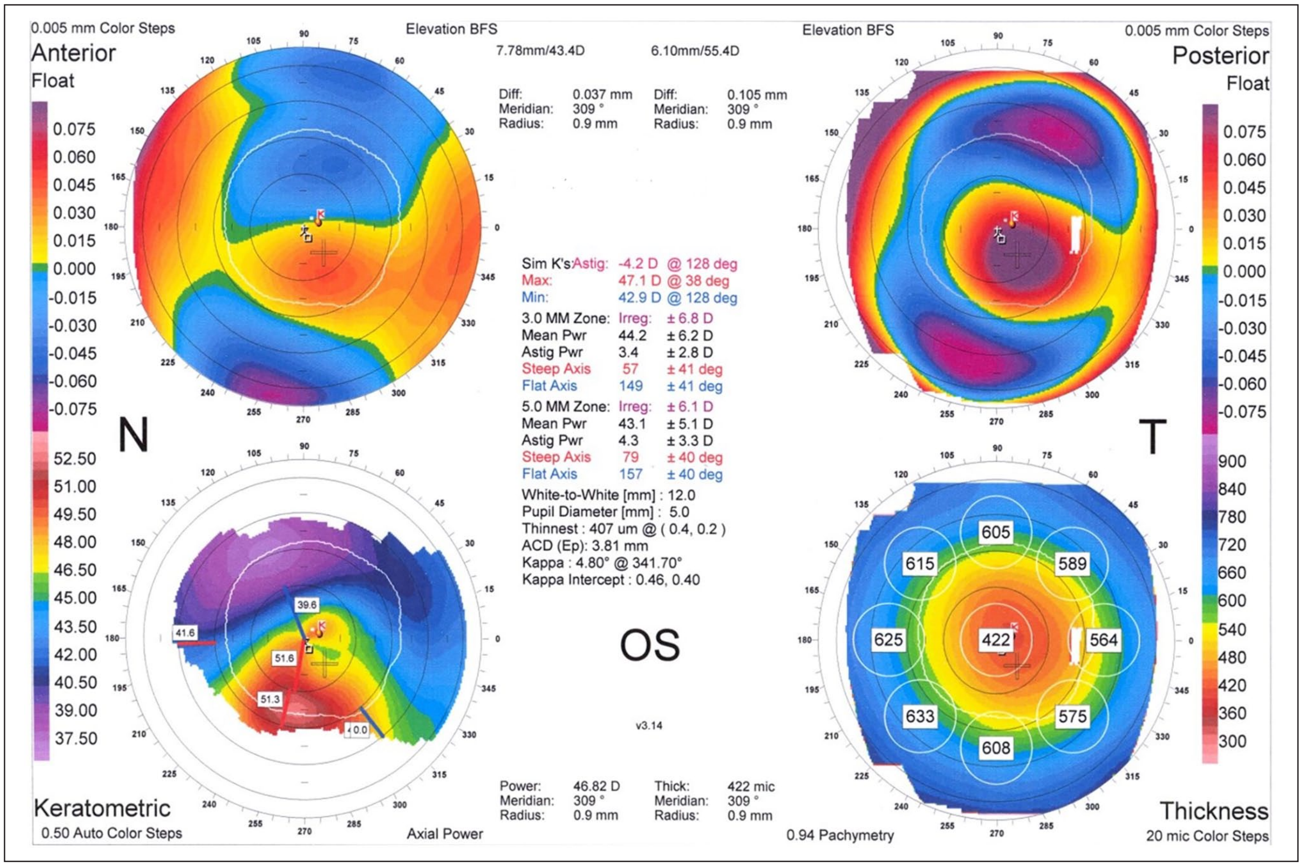


**Figure 4.** Postoperative Orbscan of the left eye showing advanced keratectasia.

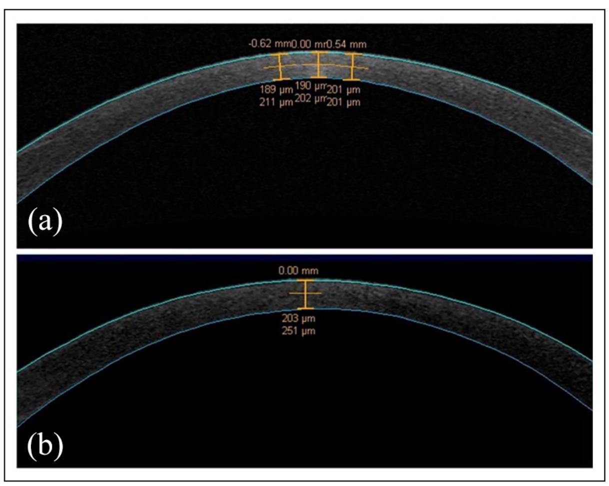


**Figure 5.** (a) Postoperative optical coherence tomography of the right eye showing a thicker than intended flap. (b) Postoperative optical coherence tomography of the left eye showing a thicker than intended flap.

In this case, estimated RSBT was 258 µm/RE and 256 µm/LE (RSBT = TCT–(flap thickness + ablation depth)). Measured percent tissue altered (PTA) calculated by the formula 'PTA = (flap thickness + ablation depth) / preoperative CCT' was 49.5% in the RE and 49.0% in the LE. Although current evidence suggested that RSBT was >310 µm and PTA was <40%, this case was operated 12 years ago. At the time of surgery, the patient selection criterion was RSBT of more than 250 µm. Therefore, this patient was selected in accordance with the guideline of that time that nowadays this case is not a good candidate for LASIK.

The question is as follows: Had this patient developed progression of forme fruste keratoconus not detected in preoperative imaging, or did he have a thicker than intended flap leading to a lower than expected RSBT?

Although a clear answer to these questions is not easy, the latter scenario seems to be more probable regarding the preoperative topography. In this case, AS-OCT imaging was performed to measure the LASIK flap. It was in favour of the latter hypothesis by detecting the much thicker flaps (200 µm) than intended, leading to a thinner RSBT. This case reveals the fact that ectasia can occur due to a microkeratome surprise (thicker than expected flaps). Therefore, in the presence of a normal, symmetrical topographic pattern, low myopia, and normal corneal thickness (above 510), a thicker than expected flap can be the reason for the development of post-LASIK ectasia.

Regarding the Randleman ectasia risk score system,[12] this patient had a score of '3' that shows a moderate risk for keratectasia after LASIK. However, the major issue in the Emory Risk Factor scoring system is that 88% of cases in their database did not have intraoperative flap measurements.[12] Therefore, it is likely that a number of the cases in their review with normal topographies had thicker than expected flaps. This would be the main risk factor for their ectasia, and the other preoperative characteristics were incidental findings.

Another critical issue is the validity of different devices for measuring corneal thickness before refractive surgery.[17] Although the ultrasound pachymetry has been used as the gold standard for measuring corneal thickness before and after refractive surgery, it has been shown that optical devices may have significant errors in estimating corneal thickness especially following refractive surgery, which should be considered in case of thin cornea or low RSBT before primary refractive surgery and before considering enhancement by re-operation.

Very-high-frequency(VHF) ultrasound scanning system (Artemis 2; Ultralink LLC), OCT system, and high-frequency ultrasound biomicroscopy have been introduced for the measurement of CCT, corneal flap thickness created by microkeratomes, femtosecond IntraLase, and even detection of post-LASIK pathologies such as Salzmann-like nodular corneal degeneration with good correlation between them.[18–22] Both mechanical microkeratome and femtosecond laser for LASIK flap cutting were reported as effective and safe methods to myopia correction with stable refractive outcomes for both groups. In the concept of flap thickness predictability, the femtosecond laser has benefits over mechanical microkeratome such as better contrast sensitivity function, fewer induced higher order aberrations, and longer tear breakup time.[23]

Moshirfar et al.[24] reported that thicker flap than the anticipated flap could be potentially the contributing risk factor to ectasia when eyes without any preoperative risk factor develop ectasia. The noteworthy issue is the potential for epithelial remodelling after ablative refractive surgeries and the fact that the thicker flap measurement would not absolutely correspond with a thinner than anticipated residual bed. However, epithelial remodelling usually occurs following surface ablation rather than LASIK.

## Conclusion

Although the Randleman scoring criteria identified this patient with normal preoperative corneal topographies as being at moderate risk of ectasia, the main reason for the ectasia was not the preoperative characteristic but rather a deeper than expected flap. Furthermore, the obtained results from this case emphasize and remind the importance of intraoperative measurement of flap thickness and using femtosecond and new criteria for patient selection to avoid post-LASIK keratectasia.

### Declaration of conflicting interests

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### Ethical approval

Our institution does not require ethical approval for reporting individual cases or case series.

### Informed consent

Written informed consent was obtained from the patient(s) for their anonymized information to be published in this article.

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### References

1. Farah SG, Azar DT, Gurdal C, et al. Laser in situ keratomileusis: literature review of a developing technique. *J Cataract Refract Surg* 1998; 24: 989–1006.
2. Wellish KL, Glasgow BJ, Beltran F, et al. Corneal ectasia as a complication of repeated keratotomy surgery. *J Refract Corneal Surg* 1994; 10(3): 360–364.
3. Speicher L and Göttinger W. Progressive Keratektasie nach Laser-in-situ-Keratomileusis (LASIK). *Klin Monatsb Augenheilkd* 1998; 213: 247–251.
4. Seiler T, Koufala K and Richter G. Iatrogenic keratectasia after laser in situ keratomileusis. *J Refract Surg* 1998; 14: 312–317.
5. Javadi MA, Mohammadpour M and Rabei HM. Keratectasia after LASIK but not after PRK in one patient. *J Refract Surg* 2006; 22(8): 817–820.
6. Mohammadpour M and Jabbarvand M. Risk factors of Ectasia after LASIK. *J Cataract Refract* 2008; 34(7): 1056.
7. Giri P and Azar DT. Risk profiles of ectasia after keratorefractive surgery. *Curr Opin Ophthalmol* 2017; 28(4): 337–342.
8. Wolle MA, Randleman JB and Woodward MA. Complications of refractive surgery: ectasia after refractive surgery. *Int Ophthalmol Clin* 2016; 56(2): 127–139.
9. Mohammadpour M. Corneal ectasia after LASIK in one eye and uneventful PRK in the fellow eye. *J Cataract Refract Surg* 2007; 33(10): 1677–1678.
10. Mohamadpour M, Khorrami-Nejad M, Kiarudi MY, et al. Evaluating the ectasia risk score system in cancelled laser in situ keratomileusis candidates. *J Ophthalmic Vis Res* 2020; 15(4): 481–485.
11. Ong HS, Farook M, Tan BB, et al. Corneal ectasia risk and percentage tissue altered in myopic patients presenting for refractive surgery. *Clin Ophthalmol* 2019; 13: 2003–2015.
12. Randleman JB, Russell B, Ward MA, et al. Risk factors and prognosis for corneal ectasia after LASIK. *Ophthalmology* 2003; 110(2): 267–275.
13. Binder PS. Ectasia after laser in situ keratomileusis. *J Cataract Refract Surg* 2003; 29: 2419–2429.
14. Klein SR, Epstein RJ, Randleman JB, et al. Corneal ectasia after laser in situ keratomileusis in patients without apparent preoperative risk factors. *Cornea* 2006; 25(4): 388–403.

15. Amoils SP, Deist MB, Gous P, et al. Iatrogenic keratectasia after laser in situ keratomileusis for less than -4.0 to -7.0 diopters of myopia. *J Cataract Refract Surg* 2000; 26(7): 967–977.
16. Miyata K, Kamiya K, Takahashi T, et al. Time course of changes in corneal forward shift after excimer laser photorefractive keratectomy. *Arch Ophthalmol* 2002; 120(7): 896–900.
17. Kiraly L, Stange J, Kunert KS, et al. Repeatability and agreement of central corneal thickness and keratometry measurements between four different devices. *J Ophthalmol* 2017; 2017: 6181405.
18. Konstantopoulos A, Hossain P and Anderson DF. Recent advances in ophthalmic anterior segment imaging: a new era for ophthalmic diagnosis. *Br J Ophthalmol* 2007; 91(4): 551–557.
19. Stahl JE, Durrie DS, Schwendeman FJ, et al. Anterior segment OCT analysis of thin IntraLase femtosecond flaps. *J Refract Surg* 2007; 23(6): 555–558.
20. von Jagow B and Kohnen T. Corneal architecture of femtosecond laser and microkeratome flaps imaged by anterior segment optical coherence tomography. *J Cataract Refract Surg* 2009; 35(1): 35–41.
21. He X and Donaldson KE. Superficial keratectomy for Salzmann nodular degeneration following laser in situ keratomileusis. *Can J Ophthalmol* 2019; 54(3): e149–e151.
22. Paranjpe V, Galor A, Monsalve P, et al. Salzmann nodular degeneration: prevalence, impact, and management strategies. *Clin Ophthalmol* 2019; 13: 1305–1314.
23. Xia LK, Yu J, Chai GR, et al. Comparison of the femtosecond laser and mechanical microkeratome for flap cutting in LASIK. *Int J Ophthalmol* 2015; 8(4): 784–790.
24. Moshirfar M, Smedley JG, Muthappan V, et al. Rate of ectasia and incidence of irregular topography in patients with unidentified preoperative risk factors undergoing femtosecond laser-assisted LASIK. *Clin Ophthalmol* 2014; 8: 35–42.