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Journal of Current Ophthalmology 28 (2016) 65–68

http://www.journals.elsevier.com/journal-of-current-ophthalmology

Original research

Contralateral assessment of sub-Bowman keratomileusis (SBK) microkeratome suction duration on laser-assisted in-situ keratomileusis (LASIK) flap characteristics

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Received 16 January 2016; revised 17 March 2016; accepted 17 March 2016
Available online 20 April 2016

Abstract

Purpose: To describe the effect of prolonging the standard suction duration during laser-assisted in-situ keratomileusis (LASIK) and its effect on flap thickness and hinge length using sub-Bowman keratomileusis (SBK) microkeratome.
Methods: Fifty-six eyes (28 patients) were included and divided into 2 groups; Group-A: eyes with flatter corneas (36 eyes, 18 patients) and mean keratometric readings ranging from 40.13 to 43.71 diopters (D). Group-B: eyes with steeper corneas (20 eyes, 10 patients) with mean keratometric readings ranging from 43.85 to 46.72 D. One-Use-Plus SBK microkeratome was used for flap creation. For right eyes, flap was created immediately once suction was built up. In left eyes, the surgeon waited for 10 s after suction was built up before flap creation. Flap hinge length and flap thickness were measured using surgical caliper and ultrasonic pachymetry, respectively.
Results: Statistically significant differences were observed in corneal flap hinge size between right eyes versus left eyes, with a mean of 3.98 ± 0.48 vs. 3.78 ± 0.55 mm ($p < 0.001$). Mean flap thickness in both eyes did not prove to be statistically significantly different with either surgical technique (90.2 ± 1.68 vs. 90.07 ± 1.44 μm, $p = 0.8$). Sub-group analysis of Group-A vs. Group-B revealed hinge sizes that were significantly larger in steeper corneas ($p < 0.01$ and $p < 0.05$, respectively). However, flap thickness in both groups was unaffected by surgical procedure ($p = 0.5$).
Conclusions: Increasing suction duration increases flap hinge length and stabilizes the flap, especially in steeper corneas.

Keywords: Laser-assisted in-situ keratomileusis; LASIK; Suction; Corneal flap

Financial disclaimers: The authors of this study have no financial or commercial interest in the subjects, materials, or methods discussed in this article.
Previous presentation: This study was presented in part at the ASCRS Symposium on Keratorefractive, LASIK and Refractive Surgery in San Diego, California, USA, April 2015.
Source of support: This study did not receive any source of public or private support.
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Peer review under responsibility of the Iranian Society of Ophthalmology.

http://dx.doi.org/10.1016/j.joco.2016.03.004

Introduction

Laser-assisted in-situ keratomileusis (LASIK) remains the leading choice for the correction of refractive errors because of its high accuracy rate in achieving excellent visual outcomes, good safety records, painlessness, fast visual recovery, and because of being a relatively simple surgical technique.[1]

In LASIK surgery, the creation of corneal flap is the most critical element. Flap thickness is an important predictor for patient eligibility for LASIK. After estimating the amount of stromal tissue to be removed during ablation, the residual stromal thickness under the flap has to be thick enough to minimize the risk of corneal ectasia. Targeting thin flaps without complications like buttonholes and free caps is crucial to avoid unnecessary thick flaps which compromise the stromal bed thickness. Corneal steepness and microsuction loss have been incriminated as important causes of having corneal flaps thinner than planned with subsequent buttonholes, however which of them is to be considered the most important risk factor is still debatable.[2]

With advancement of LASIK procedure, several improvements and newer techniques have been developed for flap creation in an attempt to minimize flap associated complications and post-LASIK keratectasia, one of which is the thin flap sub-Bowman keratomileusis (SBK). When it comes to thin cornea, using microkeratome or femtosecond laser is of critical clinical application to avoid leaving thinner stromal bed than what is considered safe. It was reported that thin flap LASIK in thin corneas with central corneal thickness (CCT) of <500 μm and normal topography was as safe and effective and showed similar long-term stability as eyes with CCT of 500 μm or greater suffering no postoperative complications.[3]

In this study, we aim to present a potential factor that can affect the final LASIK flap outcome specifically assessing the relation between increasing suction duration during flap creation and the final outcome regarding flap thickness and hinge length in different corneal curvatures. We started to believe in the suction duration as an influencing factor on flap characteristics when we noticed that being extra cautious in the second eye after having free cap in the first one and by giving more time for suction to establish and hold the globe before microkeratome pass resulted in avoidance of free cap in the second eye.

Methods

Fifty-six eyes of 28 patients were prospectively recruited for this study. All patients had LASIK performed by a single surgeon (M.O.Y.). Patients were divided into 2 main groups according to their mean keratometric readings and the value of the suction ring used, where Group-A included 36 eyes of 18 patients with flatter corneas (*K*-readings, range: 40.13−43.71 D) in which the lower ring (zero ring) was used for flap creation. Group-B included 20 eyes of 10 patients with steeper corneas (*K*-readings, range: 43.85−46.72 D) in which the highest rings (+1 and +2 rings) were used. The *K* readings were measured using Oculus Pentacam (OCULUS Inc., USA). All participants were consenting adults who were recruited from the outpatient clinic of Ophthalmology Department of Ain Shams University. The study was IRB-approved through the Ethical Committee of Ain Shams University, adhered to the HIPAA act of 1996, and followed the tenets of Declaration of Helsinki.

LASIK flap with a nasal hinge was created using One-Use-Plus SBK microkeratome (Moria SA, Antony, France), and then Excimer laser ablation of corneal stroma was performed using Allegretto EX500 Excimer Laser system (Alcon, Fort Worth, Texas). For all patients, flap of the right eye was created once suction was built up, reaching the level recommended by manufacturer (135 mmHg), while for the left eye, the surgeon waited for 10 s after suction was built up, and then flap was created (Video 1).

Supplementary video related to this article can be found at http://dx.doi.org/10.1016/j.joco.2016.03.004.

Following flap creation, hinge length was measured using surgical caliber under the operating microscope, and flap thickness was measured intraoperatively using a sterilized probe of DGH 5000e Plus Ultrasonic Pachymeter (DGH. Technology Inc., Georgia, United States). Measures were obtained by averaging 5 central thickness readings of the corneal bed after flap creation and subtracting them from the average of 5 central corneal thickness readings taken just before flap creation, omitting readings that were significant outliers (defined as more than 10 microns deviation from range of readings). Analysis of flap thickness and hinge length was then performed, and a comparison of results between the 2 groups was computed.

Two analyses were performed: one comparing flap hinge size and flap thickness between both eyes of same patient and hereby assessing the effect of suction, and the other analysis was to compare hinge size and flap thickness between patients with flatter and steeper corneas integrating the corneal shape factor as a potential influencing factor. MedCalc software version 19.0 (Ostend, Belgium), and paired *t*-test were used for analysis, and $p < 0.05$ was considered significant.

Results

A statistically significant increase in corneal flap hinge sizes was found in left eyes than the right eyes (3.98 ± 0.48 vs. 3.78 ± 0.55 mm, $p < 0.001$). However, no statistically significant difference was found in mean flap thickness of both eyes in either surgical technique (90.2 ± 1.68 μm vs. 90.07 ± 1.44 μm, $p = 0.78$). Study eyes were divided into 2 groups based on the *K* readings: one group included flatter corneas (mean $K = 40.13$ to 43.71 D), and the other group included steeper corneas (Mean $K = 43.85$ to 46.72 D). Flap hinge sizes were observed to be significantly larger in steeper corneas than in flatter corneas using either surgical techniques ($p < 0.01$ and $p < 0.05$ respectively). However, flap thickness in both groups seemed unaffected by the choice of surgical

Table 1
Summary of parameters for all eyes and both subdivided groups in the right eye (OD, standard suction duration) and left eye (OS, prolonged suction duration).

		Mean preoperative *K* readings (D)	Residual stroma (μm)	Flap hinge size (mm)
All eyes (mean ± SD)	OD	43.22 ± 1.54	90.18 ± 1.68	3.78 ± 0.55
	OS	43.24 ± 1.52	90.07 ± 1.44	3.98 ± 0.48
		$p = 0.69$[a]	$p = 0.78$[a]	$\mathbf{p < 0.001}$[a]
Flatter corneas (mean ± SD)	OD	42.29 ± 0.83	90.17 ± 1.69	3.63 ± 0.60
	OS	42.36 ± 0.90	90.17 ± 1.50	3.81 ± 0.47
		$p = 0.28$[a]	$p = 1$[a]	$\mathbf{p < 0.01}$[a]
Steeper corneas (mean ± SD)	OD	44.88 ± 1.03	90.20 ± 1.75	4.05 ± 0.28
	OS	44.81 ± 1.07	89.90 ± 1.37	4.30 ± 0.28
		$p = 0.61$[a]	$p = 0.5$[a]	$\mathbf{p < 0.05}$[a]

OD = right eye; OS = left eye.
Bold values represent (significant p values < 0.05).
[a] Paired *t*-test.

technique ($p = 0.5$). Table 1 shows the summary of parameters for all eyes and both subdivided groups.

Discussion

This study was a maneuver that was found to increase hinge length more in patients having steeper corneas, an increase that could be attributed to either the rise in intraocular pressure during suction or the change in corneal surface curvature.[4]

The fact that hinge length in our study was significantly higher in patients with steeper corneas supports the hypothesis of increasing corneal curvature being the main factor. However, analysis of other potential contributing factors is yet to be conclusive. Hinge size is a very essential factor for flap stability. A well-known principle to all LASIK surgeons is the fact that the incidence of flap displacement, macrostria, and instability is higher with smaller hinges. Also, flap realignment is known to be easier with larger hinges.

The finding of increased hinge size with prolonged suction is of clinical importance, as the surgeon might recruit more suction time before passing the microkeratome whenever free cap is suspected or has even happened in the first contralateral eye. Moreover, prolonging the suction duration might be standardized for use as a prophylaxis against small hinge size and free caps.

For flap thickness, several previous studies analyzed different thicknesses to reach the optimal measure. Some authors were in favor of thick LASIK flaps for stability purposes.[5,6] On the other hand, several authors proved superior visual benefits of thin flap LASIK without increase in complications and with better ultimate visual acuity.[7–9]

In our study, corneal flap thickness appeared unaffected by suction duration in both groups, which opposes a previous finding that states that increasing suction duration increases both flap thickness and diameter. Such difference could be attributed to the different mechanisms of flap creation using Moria M2 microkeratome, the use of pig eyes rather than human eyes, and to the small sample analyzed in the aforementioned study.[10]

To our knowledge, this paper is the first to discuss the potential relationship between suction duration and flap hinge length. However, our study is not without limitations. First, the sample size is small, and the study was not powered to detect for small effects, but our confidence is strengthened by the statistically significant differences for flap hinge length between the immediate and delayed suction groups. A second limitation is the use of ultrasonic pachymetry only to measure flap thickness. However, we refrained from using anterior segment optical coherence tomography (AS-OCT) due to previous reports of overestimation in corneal thickness related to AS-OCT.[11] Third, the use of surgical caliper to measure flap hinge length might have questionable ability to capture the small reported differences in hinge length. While no validated methods to measure flap hinge length have been published, several previous studies used surgical caliper for the same measurement.[12]

In summary, prolonging suction duration appears to be a significant factor to ensure long cornea hinge in high risk corneas undergoing LASIK procedures. Corneal flaps thickness remains to be predictable regardless of duration of microkeratome suction. Given the significant effect of suction duration on hinge size, further studies on large cohorts are recommended for the establishment of more accurate guidelines and more tailored nomograms.

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