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Comparative study between LASIK procedures using ultra-thin Moria sub-Bowman keratomileusis (SBK) 90, Moria M2 90 microkeratomes, and femto-LASIK regarding visual acuity

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Abstract

Introduction: Laser-assisted in situ keratomileusis (LASIK) is the most frequently performed refractive surgical procedure for the treatment of myopia. Astigmatism and hyperopia. The development of a corneal flap, the initial phase of LASIK, is the most crucial step and has the most impact on the visual result of the whole surgery. The flap generation is followed by excimer laser ablation of the exposed stroma, and then the flap is relocated. There are three ways to accomplish a narrow flap.

Aim of the study: To compare the changes in visual acuity of the eyes in the three groups.

Subjects and Methods: The study represents a comparative study. Patients were separated into three groups. In group A, the mechanical microkeratome ultra-thin Moria SBK 90 was used to create the flap with superior hinge, the suction ring chosen based on the corneal curvature nomogram, the used blade was intended to produce 90 m flap, the same blade for both eyes starting with the right eye, the flap was lifted, excimer laser ablation was done by ALLEGRETTO Wavelight EX500.

Results: There was no statistically significant difference between the three groups in the visual acuity of the eyes.

Conclusion: Different LASIK procedures didn’t have direct impact on the visual acuity of eyes.

Keywords: LASIK procedures; Sub-Bowman keratomileusis; Visual acuity.

1. Introduction

Myopia, hyperopia, and astigmatism are commonly treated by laser-assisted in situ keratomileusis, which is the most common kind of refractive surgery [1]. The results of the LASIK surgery are entirely dependent on how successfully the surgeon was able to make a corneal flap. When the flap has been created, the exposed stroma is ablated using an excimer laser, and the flap is then replaced [2]. A thin flap can be accomplished in three different ways. The first uses a Moria M2 microkeratome with a 90-mm head, while the second uses a Moria Plus microkeratome with sub-bowman keratomileusis. Recently, the femtosecond laser has been used by combining the ultrafast energy pulses to generate photo-disruption of tissue at a predetermined depth with little collateral tissue damage and inflammation [3]. The M2 microkeratome is a mechanical, automated, rotative, and 360° hinge-position microkeratome with disposable heads. For a corneal flap with a superior hinge of 8.5–9.0 mm in diameter, a 90-mm head is employed [4]. Sub-Bowman Keratomileusis (SBK) is a type of LASIK procedure in which the flap is thinner [4]. The Moria-Plus SBK microkeratome forms a corneal flap with a nasal hinge of 8.5–9.0 mm in diameter. This device is utilized to test a central flap thickness of 110 m with a head accuracy of 90 m [5].

The current study aimed to compare the impact of the above-mentioned techniques on visual acuity.

2. Subjects and methods

2.1. Subjects

The study included 30 patients, who were recruited between July, 2016 and July, 2019. All procedures were done at ELOYON ELDAWLY hospital, Cairo, Egypt. They were divided into three groups according to the LASIK procedures to be applied:

Group A (10 eyes): patients who would get ultra-thin Moria SBK 90.

Group B (10 eyes): patients who would receive a classic thin Moria M2 90 microkeratome,

Group C (10 eyes): patients who would obtain femto-LASIK.

Inclusion criteria

All patients were adults (ages >18 years), had refraction stability, suffered from myopia with spherical equivalent (more than 2 D and less than 10 D), and myopic astigmatism (less than 4 D). All recruited patients didn't experience any previous refractive surgery and had at least 20/25 distant vision with optimal correction in both eyes.

Exclusion criteria

Patients with a thin cornea (less than 500 microns by Pentacam), an ecstatic cornea (e.g., keratconus and related disorders), glaucoma, pregnancy, autoimmune and systemic collagen disease (e.g., rheumatoid arthritis and SLE), signs of previous viral keratitis, or post-segment gross pathology were excluded from the study.

2.2. Methods

All eyes were targeted for emmetropia and topical anesthesia. Benoxinate hydrochloride 0.4% was instilled before surgery.

In group A, the superior hinged flap was made using an ultrathin mechanical mirokeratome (Moria SBK 90), the suction ring was chosen using a nomogram based on the curvature of the cornea, and the blade used was designed to make a 90-millimeter (m) flap. After the flap was lifted, excimer laser ablation was performed using an Allegretto Wavelight ® EX500 (Alcon Laboratories Inc., Fort Worth, TX, USA).

In group B, the mechanical mirokeratome Moria M2 (Moria Inc., Antony, France) was used to create the flap with superior hinge, the suction ring selected according to the nomogram based on the corneal curvature, the used blade was intended to produce 110 m flap, the same blade for both eyes starting with the right eye, the flap was lifted, excimer laser ablation was done by Allegretto Wavelight ® EX500 (Alcon Laboratories Inc., Fort Worth, TX, United States).

In group c, the Intralase femtosecond laser (IntraLase *TM* FS200, Abbott Medical Optics Inc., CA, United States) was used for flap creation with flap diameter according to the nomogram, 120° side cut angle, 45° hinge angle, superior hinge position, laser raster pattern, spot/line separation of 12/10, stromal energy of 1.8 microjoules, and side cut energy of 2.4 microjoules. At first, beginning on one side of the cornea, the cleavage plane moves over the entire cornea thanks to the laser software. When the first horizontal cleavage plane has been established, the pattern switches to a vertical orientation, traveling through the basement membrane and the epithelium, and finally generating a flap edge at a user-defined angle through a radial pattern of shorter pulses. Diameter, thickness, angle of side cut, hinge size, placement, and all energy parameters for creating the flap are all determined by software, and the bed must be at least 300 microns thick. The corneal flaps in all the groups were adjusted using a balanced saline solution rinse.

2.3. Statistical Analysis

The information was analyzed using SPSS for the Social Sciences, version 20.0. The statistical distribution was characterized by means and standard deviations (SD). Quantitative information was shown as percentages and frequencies. ANOVA was used to compare more than two means; the paired sample t-test of significance was used to compare samples that were related; and the Chi-square (x2) significance test was used to evaluate proportions among qualitative components. The confidence interval was set to 95%, while the allowable margin of error was set at 5%. Hence, the *P-value* <0.05 was considered significant.

3. Results

In the current study, the results of the myopia with spherical equivalent didn't reveal any significant impact of the different optical procedures as shown in Table 1.

Table 1: Comparison between groups according to spherical error.

Variables	Femto-Lasik *(n=10)*	MOREA *(n=10)*	SBK *(n=10)*	ANOVA	*P-value*
Preoperative	-4.18±3.81 (-10 to 0)	-4.08±1.80 (-6.5 to -2)	-2.06±1.41 (-4.75 to -0.5)	1.971	0.160
After one month	-0.75±0.61 (-1.5 to 0.25)	-0.58±0.47 (-1.25 to 0.5)	-0.13±0.95 (-1.25 to 1.75)	1.634	0.219
After three months	-0.50±0.29 (-1 to -0.25)	-0.32±0.19 (-0.75 to -0.25)	-0.06±0.59 (-0.75 to 1.25)	2.175	0.141

The preoperative mean cylinder was -0.72±1.27 with range (-4 to -0.5) in the femto-LASIK group; mean cylinder was -1.41±0.99 with range (-3.5 to -0.5) in the MOREA group; and mean cylinder was -2.40±1.33 with range (-4 to -1) in SBK group (*P = 0.225*). After one month, the mean cylinder was -0.59±0.44 with range (-1.5 to -0.25) in the femto-LASIK group, the mean cylinder was -0.75±0.46 with range (-1.75 to -0.25) in the MOREA group, and the mean cylinder was -0.78±0.40 with range (-1.5 to -0.25) in the SBK group (*P= 0.652*). After 3 months mean cylinder was -0.59±0.50 with range (-1.75 to -0.25) femto-LASIK group, the mean cylinder was -0.57±0.35 with range (-1.25 to -0.25) in the MOREA group and mean cylinder was-0.65±0.29 with range (-1.25 to -0.25) in the SBK group with (*P = 0.908*) (Table 2).

Table 2: Comparison between groups according to cylinder error.

Variables	**Femto-Lasik *(n=10)***	**MOREA *(n=10)***	**SBK *(n=10)***	**ANOVA**	***P-value***
Preoperative	-1.72±1.27 (-4 to -0.5)	-1.41±0.99 (-3.5 to -0.5)	-2.40±1.33 (-4 to -1)	1.588	0.225
After one month	-0.59±0.44 (-1.5 to -0.25)	-0.75±0.46 (-1.75 to -0.25)	-0.78±0.40 (-1.5 to -0.25)	0.436	0.652
After three months	-0.59±0.50 (-1.75 to -0.25)	-0.57±0.35 (-1.25 to -0.25)	-0.65±0.29 (-1.25 to -0.25)	0.097	0.908

There was no statistically significant difference in the uncorrected distance visual acuity of the groups (Table 3). The preoperative mean of the uncorrected distant visual acuity (UDVA) was 1.03±0.22 with a range of 0.7 to 1.3 in LOGMAR in the femto-LASIK group; 1.04±0.37 with a range of 0.4 to 1.3 in LOGMAR in the MOREA group; and 0.98±0.24 with a range of 0.5 to 1.3 in LOGMAR in the SBK group (*P = 0.880*). After one month, the mean of UDVA was -0.03±0.05 with a range of -0.1 to 0 in LOGMAR in the femto-LASIK group, -0.01±0.06 with a range of -0.1 to 0.1 in LOGMAR in the MOREA group, and -0.06±0.07 with a range of -0.1 to 0.1 in LOGMAR in the SBK group (*P = 0.181*). After three months, the mean of UDVA was -0.02±0.04 with a range of -0.1 to 0 in LOGMAR in femto-LASIK group, 0.02±0.04 with a range of 0 to 0.1 in LOGMAR in the MOREA group, and -0.01±0.07 with a range of -0.1 to 0.1 in LOGMAR in the SBK group (*P = 0.254*).

Table 3: Comparison of uncorrected distant visual acuity between groups.

Variables	Femto-Lasik *(n=10)*	MOREA *(n=10)*	SBK *(n=10)*	ANOVA	*P-value*
Preoperative	1.03±0.22 (0.7 to 1.3)	1.04±0.37 (0.4 to 1.3)	0.98±0.24 (0.5 to 1.3)	0.128	0.880
After one month	-0.03±0.05 (-0.1 to 0)	-0.01±0.06 (-0.1 to 0.1)	-0.06±0.07 (-0.1 to 0.1)	1.819	0.181
After three months	-0.02±0.04 (-0.1 to 0)	0.02±0.04 (0 to 0.1)	-0.01±0.07 (-0.1 to 0.1)	1.444	0.254

Finally, there was no statistically significant difference between groups according to best corrected distant visual acuity (Table 4). The mean of the preoperative findings of the best corrected distant visual acuity (BCDVA) was -0.01±0.03 with a range of -0.1 to 0 in logmar in the femto-LASIK group, 0.02±0.04 with a range of 0 to 0.1 in logmar in the MOREA group, and 0.00±0.07 with a range of -0.1 to 0.1 in the SBK group (*P = 0.392*). After one month, the mean of BCDVA was - 0.01±0.06 with a range of -0.1 to 0.1 in logmar in the femto-LASIK group, 0.02±0.04 with a range of 0 to 0.1 in logmar in the MOREA group, and 0.01±0.06 with a range of -0.1 to 0.1 in the SBK group (*P = 0.438*). After three months, the mean of BCDVA was 0.00±0.07 with a range of -0.1 to 0.1) in logmar in the femto-LASIK group, 0.02±0.04 with a range of 0 to 0.1 in logmar in the MOREA group, and 0.01±0.06 with a range of -0.1 to 0.1 in the SBK group (*P = 0.731*).

Table 4: Comparison of uncorrected distant visual acuity between groups.

Variables	Femto-Lasik *(n=10)*	MOREA *(n=10)*	SBK *(n=10)*	ANOVA	*P-value*
Preoperative	-0.01±0.03 (-0.1 to 0)	0.02±0.04 (0 to 0.1)	0.00±0.07 (-0.1 to 0.1)	0.969	0.392
After one month	-0.01±0.06 (-0.1 to 0.1)	0.02±0.04 (0 to 0.1)	0.01±0.06 (-0.1 to 0.1)	0.851	0.438
After three months	0.00±0.07 (-0.1 to 0.1)	0.02±0.04 (0 to 0.1)	0.01±0.06 (-0.1 to 0.1)	0.318	0.731

4. Discussion

According to the refractive outcome, there was no statistically significant difference between groups. In our study, we compared the changes in visual acuity, refractive outcomes, spherical aberrations, and dryness of the eyes in Moria-Plus SBK microkeratome, M2 microkeratome, and femto-LASIK at one and three months after surgery. Thirty consecutive eyes from 15 individuals receiving LASIK for myopia (with or without astigmatism) were analyzed. There were three categories of patients: Femto-LASIK Group (5 patients, 10 eyes): Patients who underwent microkeratome surgery with an SBK 90 are considered part of the SBK group (10 eyes, 5 patients). Patients in the MORIA group (10 eyes across 5 individuals) had their corneas reshaped using an M2 90 MORIA microkeratome. The female-to-male ratio was 4:6 for the femto-LASIK group and 5:5 for the SBK group. And 3:7 for the MORIA group, the age extended from 22–33 years with a mean value of 27.60–3.95 years for the femto-LASIK group, from 21–41 years with a mean value of 30.20–6.29 years for the SBK group, and from 25–41 years with a mean value of 32.50–6.10 years for the MORIA group. No significance was obtained in the spherical error in the preoperative, one-month, and three-month parameters between the three groups, but by analyzing the spherical error in each group, there was a statistically significant decrease in mean spherical error over the periods through in each group, which was more significant in the Morea group than the SBK group and the Femto-LASIK group. Cylinder error between groups was statistically insignificant in the preoperative, one-month, and three-month parameters between the three groups, but by analysis of cylinder error, there was a statistically significant decrease in mean cylinder error over the periods through in each group, which was more significant in the Morea group than the femto-LASIK and the SBK groups.

After one month, the SBK group had considerably better uncorrected distance visual acuity than the femto-LASIK and MOREA groups. At three months, there was no longer a statistically significant difference between the three groups' uncorrected distance visual acuity, and there was no such difference between the two groups. All of these findings were in accordance with other previous studies [6-11].

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References

1. Binder PS. Analysis of ectasia after laser in situ keratomileusis: risk factors. J Cataract Refract Surg. 2007;33(9):1530-1538. doi: 10.1016/j.jcrs.2007.04.043.
2. Pallikaris IG, Kymionis GD, Astyrakakis NI. Corneal ectasia induced by laser in situ keratomileusis. J Cataract Refract Surg. 2001;27(11):1796-1802. doi: 10.1016/s0886-3350(01)01090-2.
3. Soong HK, Malta JB. Femtosecond lasers in ophthalmology. Am J Ophthalmol. 2009;147(2):189-197.e2. doi: 10.1016/j.ajo.2008.08.026.
4. Azar DT, Ghanem RC, de la Cruz J, Hallak JA, Kojima T, Al-Tobaigy FM, Jain S. Thin-flap (sub-Bowman keratomileusis) versus thick-flap laser in situ keratomileusis for moderate to high myopia: case-control analysis. J Cataract

Refract Surg. 2008;34(12):2073-2078. doi: 10.1016/j.jcrs.2008.08.019.
5. Karabela Y, Muftuoglu O, Kaya F. Corneal flap thickness with the Moria M2 single-use head 90 microkeratome in 72 consecutive LASIK procedures. Clin Ophthalmol. 2017;11:487-492. doi: 10.2147/OPTH.S129830.
6. Binder PS, Lindstrom RL, Stulting RD, Donnenfeld E, Wu H, McDonnell P, Rabinowitz Y. Keratoconus and corneal ectasia after LASIK. J Cataract Refract Surg. 2005;31(11):2035-2038. doi: 10.1016/j.jcrs.2005.12.002.
7. Tomlinson A, Bron AJ, Korb DR, Amano S, Paugh JR, Pearce EI, Yee R, Yokoi N, Arita R, Dogru M. The international workshop on meibomian gland dysfunction: report of the diagnosis subcommittee. Invest Ophthalmol Vis Sci. 2011;52(4):2006-2049. doi: 10.1167/iovs.10-6997f.
8. Salomão MQ, Wilson SE. Femtosecond laser in laser in situ keratomileusis. J Cataract Refract Surg. 2010;36(6):1024-1032. doi: 10.1016/j.jcrs.2010.03.025.
9. Althomali TA. Comparison of microkeratome assisted sub-Bowman keratomileusis with photorefractive keratectomy. Saudi J Ophthalmol. 2017;31(1):19-24. doi: 10.1016/j.sjopt.2017.01.004.
10. Kanclerz P, Khoramnia R. Flap Thickness and the Risk of Complications in Mechanical Microkeratome and Femtosecond Laser In Situ Keratomileusis: A Literature Review and Statistical Analysis. Diagnostics (Basel). 2021;11(9):1588. doi: 10.3390/diagnostics11091588.
11. Santhiago MR, Kara-Junior N, Waring GO 4th. Microkeratome versus femtosecond flaps: accuracy and complications. Curr Opin Ophthalmol. 2014;25(4):270-274. doi: 10.1097/ICU.0000000000000070.