Original Article

Comparison of Sub-Bowman Keratoplasty Laser *In situ* Keratomileusis Flap Properties between Microkeratome and Femtosecond Laser

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Abstract

Background: Since thin and high-quality flaps produce more satisfactory surgical outcomes, flaps created by mechanical microkeratomes are more economical as compared with femtosecond lasers, and no Iranian study has concentrated laser *in situ* keratomileusis (LASIK) flap peculiarities between Moria Sub-Bowman keratoplasty (SBK) microkeratomes and LDV femtoseconds, the present study compares and contrasts them. **Materials and Methods:** This cross-sectional study was done on all patients who underwent LASIK surgery 1-month before this study. Thirty eyes were divided into per group. Flaps in the first group and second group were created, respectively, using Moria SBK microkeratome and LDV femtosecond laser. The other stages of LASIK were done equally in both groups. One month after surgery, the thickness of flaps was measured by anterior segment optical coherence tomography in five regions of flaps. Corneal anterior density was calculated and recorded 1-month after surgery using pentacam and by employing optical densitometry in a distance in the limit range of 0–6 mm from cornea center. Densitometry measurements were obtained and expressed in standardized grayscale units (GSUs). **Results:** Postsurgery densitometry results reveal that anterior densities of cornea in limit range of 0–2 mm in groups of LDV femtosecond laser and Moria microkeratome are 21.35 ± 0.87 GSU and 22.85 ± 1.25 GSU, respectively. Accordingly, these two groups are significantly different in this regard ($P < 0.001$). Moreover, anterior densities of the cornea in the limit range of 2–6 mm in these groups are 19.66 ± 0.99 GSU and 20.73 ± 1.24 GSU, respectively. Accordingly, these two groups are significantly different in this regard ($P = 0.04$). There is a lower mean of flap thickness in the case of LDV femtosecond laser. **Conclusion:** Femtosecond laser method is greatly preferred as compared with Moria microkeratome because of greater homogeneity in flap thickness, smaller thickness, and lower density in optical zone.

Keywords: *Femtosecond, laser in situ keratomileusis, microkeratome*

Introduction

Laser *in situ* keratomileusis (LASIK) is a lamellar procedure using laser ablation.[1] LASIK is the most common refractive surgery because of its safety, efficacy, quick visual recovery, and minimal patient discomfort.[1] LASIK begins from a flap creation which is a very critical stage in this surgery and significantly affects surgical outcomes.[2] Regularity and reproductively of flap morphology play two significant roles. First, guarantee the safety of the procedure. Second, they influence the visual outcome.[3,4] Flaps were first created by traditional microkeratomes and the created flaps were thick without regularity, homogeneity, and accuracy.[3,4]

Surgeons cannot predict flap thickness only in accordance with microkeratome head label. The real flap thickness is affected by the type of microkeratome, the patient age, corneal thickness, keratometry before surgery, astigmatism before surgery, corneal diameter, and speed of microkeratome movement.[1] Flaps were gradually created by employing laser-based methods such as femtosecond. Femtosecond laser flaps can cause minor visual disorders due to their regularity, as compared with mechanical microkeratomes.[1]

Along with thin flap creation, a higher level of safety, insignificant pain, and rapid visual recovery in LASIK surgery, femtosecond lasers, utilized in procedures such as deep anterior lamellar keratoplasty and penetrating keratoplasty.[4,5]

Despite particular and acceptable advantages of femtosecond lasers, mechanical microkeratomes are still manufactured, and their construction technology is developed

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for creation thinner and more regular flaps relative to older generations of microkeratomes. New microkeratomes are cut from Sub-Bowman and create Sub-Bowman keratoplasty (SBK) method.

Both FS200 femtosecond laser and SBK microkeratomes can produce 100-microne flap. In Flaps created by SBK microkeratomes, the flap center thickness is directly interrelated with central corneal thickness.[6] Since thin and high-quality flaps produce more satisfactory surgical outcomes, and flaps created by mechanical microkeratomes are more economical as compared with femtosecond lasers, and no Iranian study has concentrated LASIK flap peculiarities between Moria one use-plus microkeratome and LDV femtoseconds (Ziemer Ophthalmic Systems), the present study compares and contrasts them.

Materials and Methods

This study is a cross-sectional research, which was carried out in Feiz Medical Education Institution and Parsian Ophthalmology Clinic (Isfahan, Iran) in 2014. The population consisted of all patients who underwent LASIK surgery 1-month before this study. The flaps of 15 patients (30 eyes) were created by LDV femtosecond laser and the flaps of 15 patients (30 eyes) were created by using Moria microkeratome. The target flap thickness was 110 μm in both. The patients were selected by considering following parameters: Consent of patients who underwent LASIK surgery 1-month before this study for participation in this research and their nonsufferance from corneal ecstasies. In addition, patients experiencing perforation of flaps or complete destruction of flaps during surgery, local infection during the study, and diffuse lamellar keratitis were omitted from this research.

The sample size was 30 eyes in each group of patients, which was calculated by using sample size equation for comparison of means and by considering 95%-level of confidence, 80% of test power, standard deviation (SD) of 1.1 in case of flap thickness, and the minimum significant difference between two methods, that is, 0.03.

After the proposal was approved by Medical Ethics Committee of The University, 60 eyes meeting above-said requirements were randomly divided into two groups (30 eyes per one group). Flaps in the first group and the second group were created respectively by Moria SBK microkeratome and LDV femtosecond laser. The other stages of LASIK were done similar in both groups.

One month after surgery, the thickness of flaps was measured by anterior segment optical coherence tomography (AS-OCT) in five regions of flaps, that is, one AS-OCT in flap center and the other four in vertical and horizontal axes with a distance of 2.5 mm from the center and flap homogeneity was evaluated. Additionally, corneal anterior density (120 μm) was calculated and recorded 1-month after surgery by pentacam and by employing optical densitometry in a distance of 2 mm and 6 mm from cornea center. Visual acuity and astigmatism were examined 1-month after the surgery. The collected data were analyzed by utilizing SPSS software version 22 (SPSS Inc, Chicago, IL, USA) and by performing Chi-square test, *t*-test, and Mann–Whitney test.

Results

This study evaluates two groups of patients (30 eyes per each group) who underwent surgery by LDV femtosecond laser and Moria microkeratome. The mean age of patients in groups of LDV femtosecond laser and Moria microkeratome was 33.87 ± 10.03 and 33.53 ± 10.7 years old, respectively, with no significant difference ($P > 0.05$). In the former group and the latter group, 5 patients (33.3%) and 6 patients (40%) were male and in the latter, 10 patients (66.7%) and 9 patients (60%) were female, respectively, which shown no significant difference ($P > 0.05$).

There was no significant difference in visual means without glasses before the surgery in these two groups with the values of 0.93 ± 0.5 and 1.01 ± 0.36 in terms of logMAR ($P > 0.05$). Best corrected visual acuity in the groups before the surgery was 9.87 ± 0.51 and 9.37 ± 1.07 in terms of logMAR, respectively. Its mean was significantly different from the visual level in case of glasses before the surgery ($P < 0.05$). Visual means without glasses after the surgery in these two groups were 0.045 ± 0.09 and 0.045 ± 0.13 in terms of logMAR which had no significant difference ($P > 0.05$). On the other hand, visual levels were significantly improved after the surgery in both groups ($P < 0.001$). Variance analysis and observation replication show similar visual improvement in both groups without any significant difference ($P > 0.05$). Table 1 shows visual levels of patients before and after the surgery.

Postsurgery densitometry results reveal that anterior densities of cornea in limit range of 0–2 mm in groups of LDV femtosecond laser and Moria microkeratome are 21.35 ± 0.87 GSU and 22.85 ± 1.25 GSU, respectively [Table 2]. Accordingly, these two groups are significantly different in this regard ($P < 0.001$). The output is expressed in GSUs. The GSU scale is calibrated by proprietary software, which defines a minimum light scatter of 0 (maximum transparency) and maximum light scatter of 100 (minimum transparency). Moreover, anterior densities of the cornea in the limit range of 2–6 mm in these groups are 19.66 ± 0.99 GSU and 20.73 ± 1.24 GSU, respectively. Accordingly, these two groups are significantly different in this regard ($P < 0.05$).

Table 3 shows flap thickness means in different regions in cases of LDV femtosecond laser And Moria microkeratome. As results of *t*-test suggest, created flap thickness in all regions is significantly different. There is a lower mean of flap thickness in the case of LDV femtosecond laser.

Homogeneity of flap thickness in different regions was examined by measuring means of flap thickness in the center and other parts [Table 4]. Consequently, mean differences of flap thickness between center and superior regions in groups of LDV femtosecond laser and Moria microkeratome are, respectively, −1.13 ± 4.6 μm and −0.82 ± 25.2 μm. Although there is not any significant difference between these two groups in this regard, a greater homogeneity is observed in LDV femtosecond laser group because of greater SD in Moria microkeratome group. A comparison of flap thickness between central and inferior regions reveals that LDV femtosecond laser group is more homogenous as the result of lower SDs. A comparison of flap thickness between temporal and nasal regions does not show any significant difference in homogeneity in two groups ($P > 0.05$).

Table 1: Not connected visual acuity before and after surgery (logMAR)

Time	Group		*P**
	Femtosecond laser	Moria microkeratome	
Before surgery	0.93±0.5	1.01±0.36	0.48
After surgery	0.045±0.09	0.045±0.13	0.98
*P***	<0.001	<0.001	0.49***

*Difference between the groups before and after the surgery in accordance with *t*-test, **Difference between the groups before and after the surgery in accordance with paired t-test, ***Visual changes after the surgery in accordance with variance analysis and observation replication

Table 2: Means GSU and SD of anterior densities of cornea in groups of LDV femtosecond laser and Moria microkeratome

Range	Groups		*P**
	Femtosecond laser	Moria microkeratome	
2-0 mm	0.87±35.21	1.25±22.85	<0.001
6-2 mm	0.99±19.66	1.24±20.73	0.04
Total	2.13±21.18	3.63±22.41	0.12

SD: Standard deviation, GSUs: Grayscale units

Table 3: Means and SD (μm) of flap thickness

Location	Group		*P*
	Femtosecond laser	Moria microkeratome	
Flap center	6.53±112	7.97±129	<0.001
Temporal	9.09±114.73	10.06±131.43	<0.001
Nasal	8.56±112.13	10.02±128.93	<0.001
Superior	7.49±113.13	26.27±129.82	0.001
Inferior	5.59±113.17	9.69±128.93	<0.001

SD: Standard deviation

Discussion

As flap homogeneity created by LASIK surgery can significantly improve visual quality and acuity and can significantly impact upon postsurgery outcomes and astigmatism and as LASIK surgery is primarily performed by LDV femtosecond laser and Moria microkeratome, this paper compared SBK LASIK flaps in cases of LDV femtosecond laser, and Moria microkeratome in terms of visual acuity, anterior density of cornea, and flap homogeneity. Two groups of patients (30 eyes per each group) who underwent surgery by LDV femtosecond laser and Moria microkeratome were examined. No significant difference was observed with regard to age and gender distribution as well as presurgery visual acuity between the groups, and there is not bias. Accordingly, the difference in postsurgery visual acuity, corneal density, and flap thickness is perhaps affected by the method of flap creation. Visual acuity was significantly improved after the surgery in both groups ($P < 0.001$). Postsurgery densitometry results reveal that anterior density of cornea in femtosecond laser group was lower than the other group in the limit range of 0–6 mm. Due to a significant difference in optical zone, lower density, and better optical quality are expected in the case of femtosecond laser.

A greater homogeneity was observed in LDV femtosecond laser group as compared with Moria microkeratome. In addition, in other researches a variety of parameters can affect the thickness of flaps created by microkeratome, and therefore, surgeons cannot predict flap thickness only in accordance with microkeratome head label. To put it differently, the real flap thickness is affected by microkeratome type, the patient age, corneal thickness, keratometry before surgery, astigmatism before surgery, cornea diameter, and speed of microkeratome movement.[1] On the other hand, femtosecond laser flaps can cause minor visual disorders due to their regularity, as compared with mechanical microkeratomes.[1]

Table 4: Means and SD (μm) of flap thickness in both groups

Location	Group			
	Femtosecond laser		Moria microkeratome	
	Mean difference	*P*	Mean difference	*P*
Flap center with superior	−1.3±4.6	0.19	−0.82±25.2	0.9
Flap center with inferior	−1.17±3.39	0.07	0.67±7.33	0.96
Flap center with temporal	−2.73±6.45	0.027	−2.43±4.72	0.008
Flap center with nasal	−0.13±5.59	0.9	0.07±4.73	0.94

SD: Standard deviation

Findings of Shah and Gritz, Mian and Shetein, and Durrie *et al*. demonstrate LASIK flaps created by femtosecond laser significantly are thin.[5,7,8] Mai *et al*. suggest that LASIK flaps created by FEMTO LDV laser can relatively and effectively do predictions, and flap diameter affects its thickness.[9] Zhang *et al*. points out that after analysis of flaps by AS-OCT, flaps created by FS200 are more uniformed and reproducible, relative to Moria microkeratome.[10,11] Zhou *et al*. make a comparison between LDV femtosecond laser and M2 Moria microkeratome. As they suggest, flap dimensions are more accurate and uniformed in LDV femtosecond lasers.[12] According to Zhai *et al*., flaps created by intarlase and Moria one use-plus SBK are more regular and hemogen as compared with the older version of microkeratomes, that is, 90 μm head.[13]

Conclusion

Therefore, as our results and other findings suggest, femtosecond laser method is greatly preferred as compared with Moria microkeratome because of greater homogeneity in flap thickness, a smaller thickness, and lower density in optical zone.

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Conflicts of interest

There are no conflicts of interest.

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