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Management of Post Lasik Residual Myopic Astigmatism: Evaluation of Two Different Techniques

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Abstract

Background: This study to evaluate two different techniques which are femtosecond lasik and transepithelial photorefractive keratotomy in management of post lasik residual myopic astigmatism. In both techniques we calculate the central corneal thickness, preoperative refractive errors SER, preoperative UDVA, CDVA, and postoperative six months UDVA.

Aim of Study: The aim of lasik surery is emmetropia. Post lasik residual errors are necessitating redo surgery. In redo surgery many factors like corneal biomechanics, stromal bed thickness and the previous corneal flap should be considered. Different surgical techniques developed aiming at restoring emmetropia.

Patients and Methods: Patients are divided into two groups each group is 40 eyes. Each group was evaluated and examined for CCT, Preoperative UDVA & CDVA, postoperative UDVA, pentacam, and all preoperative investigations. The Visumax femtosecond and MEL 90 excimer lasers were used for all FS-LASIK procedures and the MEL 90 excimer laser used for the two step trans epithelial PRK. The follow-up period were six months for both groups.

Results: In both groups twenty seven patients were operated for forty eyes. In group one the main SER was –1.98 ±0.47D, the main UDVA was 0.34±0.13 Log MAR, the main preoperative CDVA was 0.01 ±0.03 Log MAR, the main preoperative CCT was 466.10 ± 12.08 micron, the main postoperative CCT was 309.40 ±9.63 micron. In group two the main SER was –1.77±0.67D, the main UDVA was 0.32±0.11 Log MAR, the main preoperative CDVA was 0.00 ±0.01 Log MAR, the main preoperative CCT was 402.97 ±20.15 micron and the main postoperative CCT was 379.27 ±26.26 micron.

Conclusion: Both groups achieved high percentages of the postoperative target refraction with high safety and efficacy. Wave front guided ablation improves the outcome of refraction and aberrations especially in TPRK.

Key Words: *Trans epithelial PRK – Femotsecond lasik – Myopia – CCT – Emmetropia.*

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Introduction

MYOPIA is the commonest refractive disorder. The prevalence of myopia is increasing, it is expected that myopia account for almost 50% of the world's population refractive errors by 2050 **[1]**. Lasik refractive surgery is a popular procedure for safe and effective myopic correction. The first refractive surgery was in 1988 by McDonald and coworkers **[2,3]**. Laser in situ keratomileusis (LASIK) has been the most frequently performed refractive surgeries, and the results of long-term follow-ups as long as 10 years have been reported **[4-6]**. One of the commonest reported problems of refractive surgery is myopic regression. With the recent advances of lasik machines, ablation algorithm, tissue saving, wave front guided ablation and different techniques used the problem become less than before but still exciting. Lasik redo surgery represents almost 20% of all lasik surgeries **[7]**. Actually one of the most important issue to be considered in redo surgery is residual stromal bed thickness and corneal biomechanics **[8,9]**. However different techniques of enhancement is existing which include, surface ablation, lifting of original flap and doing the enhancement but this method carry the risk of many flap complication and finally creating a new flap at different depth followed by the ablation **[10-13]**.

Patients and Methods

In this prospective case controlled clinical study 80 eyes of 54 patients divided into two groups based on corneal stromal thickness. In the 1 st group which is the femtosecond Lasik enhancement group the CCT was 450 micron and above while in the 2nd group which is two step surface ablation the CCT was less than 380 micron and the expected residual stroma thickness is 290 micron and above for both groups. SER ranged from –0.75 to –3.00.

Each group has 40 eyes of 27. The patients operated in the specialized eye hospital between 2017 and 2019. The study adhered to the tenets of the Declaration of Helsinki. An informed consent obtained from each patient after explaining the refractive errors of his or her eyes, the surgical steps, the postoperative recovery time, the postoperative medications, and the six months follow-up period. The inclusion criteria included patients with history of Lasik refractive surgery six months ago or more with residual myopic or myopic astigmatism and SER range from –0.75 to –3.00 D. All patients should complete 6 month follow-up after redo surgery. Emmetropia was the target of the study. Exclusion criteria included one eye patients, corneal dystrophy, forme fruste keratoconus, pellucid marginal degeneration, severe dry eye syndrome. Patients with cataract, diabetic retinopathy, maculopathy, eye lid disorders, glaucoma, and systemic diseases affecting the ocular tissue healing, all are excluded from the study. Full detailed examinations performed for all patients preoperatively and at postoperative, one day, one week, one month, three months, and six months. Examinations included the uncorrected and corrected distance visual acuity, manifest and cycloplegic refraction, slit-lamp examination (Haag-Streit, Köniz, Switzerland), slit-lamp biomicroscopy, fundus examination, corneal epithelium assessment by fluorescein staining, tear breakup time, Schirmer test, intraocular pressure measurement (noncontact tonometer; NT-530, NCT Nidek Co., Ltd., Aichi, Japan), central corneal thickness (CCT) using ultrasound pachymetry (UP-1000; Nidek), Corneal wavefront aberrations were measured using the Keratron Scout (Optikon 2000, Rome, Italy), and Scheimpflug-based corneal topography (Pentacam HR, Oculus, Wetzlar, Germany), Anterior segment OCT (ASOCT) used to measure accurately the thickness of the previous corneal flap and the actual stromal thickness. Visual acuity was measured at 6 meter with a Snellen chart and converted to the Log MAR scale for statistical analysis. The Carl Zeiss Refractive Suite, the Visumax femtosecond and MEL 90 excimer lasers (Carl Zeiss Meditec, Jena, Germany), were used for all FS- LASIK procedures and the MEL 90 excimer laser used for the two step trans epithelial PRK. The excimer laser ablations in both groups were performed using The MEL 90 excimer laser. This 193nm Gaussian beam excimer laser has 1024 Hz pupil and limbal tracker that compensates for cyclotorsion and a shot frequency of 500Hz. All surgeries were wavefront-guided. The treatment was centered on visual axis and Emmetropia was aimed for all eyes. Superior-hinged flap parameters were programmed for all eyes of group one. Treatment parameters were selected using CRST-Master software (Carl Zeiss Meditec AG), which combines refractive, wavefront, topography, and flap parameters through an interactive user interface. The ablation optical zone (OZ) diameter was selected based on the same mesopic pupil diameter obtained from the wavefront analyzer and the software automatically calculates a transition zone up to 2.2mm. The Visumax FSL system was used to create the LASIK flap in group one. The Femtosecond laser uses a wavelength of 1043nm, a repetition rate of 500 kHz, and a pulse duration of 220 to 580 femtosecond. One of 3 curved contact glass sizes for the FSL was selected depending on corneal diameter measured with topography system. One drop of topical anesthesia (proparacaine 0.50%) was applied to the eye twice with two minutes interval before starting surgery. Diluted povidone iodine was applied on the lashes and eyelids a closed loop lid speculum was placed. One drop of diluted povidone iodine is applied to conjunctival sac then wash of conjunctival sac with BSS followed by drying the sac using a micro sponge. All patients of group one had planned flap with the 500-kHz femtosecond laser. The flap parameters were as follows: 8.5mm flaps diameters, 120 um flap thickness, 90° side-cut angles, and 4.0mm hinge length set in a superior orientation. After the flap was lifted, ablations were performed using the MEL-90 excimer laser with a tissue-saving function (triple-A profile). After surgery, post-operative topical antibiotic moxifloxacin (vigamox) was applied 4 times a day for 7 days and a topical steroid prednisolone acetate (pred-forte) 4 times a day for one week and twice a day for the second week, and a preservative free lubricant Propylene glycol (systane ultra) was used for four times a day for 6 months.

For the second group (two step trans-epithelial PRK) the corneal epithelium was removed in non-mechanical way where the excimer laser used to remove the epithelium in the first step followed by stromal ablation in the second step. In this two-step surgery the actual depth of epithelium ablation was 55-65 micron based on previous measurements and previous studies **[14-17]**. Soft contact lens which is gas permeable and high-water content applied for four days. Postoperative medications include topical antibiotics moxifloxacin (vigamox) four times a day for one-week, preservative free lubricants Propylene glycol (systane ultra) four times a day for six months and steroids three times a day for one month and twice a day for other two months fluoromethalone (FML).

Statistical analysis:

Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 28 (IBM Corp., Armonk, NY, USA). The normality of all data samples was performed using the Shapiro Wilk test and proved to be deviated from normal distribution. Data was summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the non-parametric Mann-Whitney test. For comparison of serial measurements within each patient the non-parametric Friedman test and Wilcoxon signed rank test were used. For comparing categorical data, Chi square (χ^2) test was performed. Exact test was used instead when the expected frequency is less than 5. *p*-values less than 0.05 were considered as statistically significant.

Results

In group one the mean ages were 21.75 ±3.25. the distribution was 62.5% females and 37.5% males. The mean preoperative SER were –1.98 ± 0.47. Preoperative CDVA were 100% 20/20. The preoperative mean CCT were 466.10 ± 12.08 micron while the mean postoperative residual corneal stroma bed thickness was 309.40 ±9.63 micron. The mean flap thicknesses were 121.08 ±6.57 micron. The mean UCDVA were 0.01 ±0.03, 0.09± 0.07, –0.07±0.08 Log MAR for the 1 st, 3rd and 6th months postoperatively consequently. By the 6th month follow-up the residual SER errors were as follow 15% were –0.50, 50% were –0.25, 12.5% were –0.13 and 22.5% were 0.25 By six month postoperative follow-up, UDVA improve significantly 55% of patients gain one line and 15% gain two line compared to preoperative CDVA. No patient lost line of the preoperative CDVA.

In group two the mean age was 20.75 ±3.21. The gender distribution was 32.5% males and 67.5% females. The mean preoperative refraction was –1.77±0.67 D. The mean preoperative CDVA was 0.00±0.01 Log MAR. The postoperative UDVA were 0.11 ±0.08 for the 1 st month. –0.06±0.07 for the 3rd month and –0.03±0.05 LogMar for the 6th month. The mean preoperative CCT was 402.97 ±20.15 micron while the mean postoperative CCT was 379.27±26.26 micron. By the 6th month postoperative the residual SER errors were as follow 12.5% were –0.50, 25% were –0.25,20% were 0.25 and 42.5% were 0.50.

Table (1): Femtosecond lasik group 1 data.

	Femtosecond Lasik Group 1				
	Mean	SD	Median	Mini-mum	Maxi mum
Age	21.75	3.25	22.00	16.00	27.00
Preop refraction	–1.98	0.47	–2.00	–1.00	-2.75
Preop UDCVA	0.34	0.13	0.40	0.50	0.10
One month UCDVA	–0.01	0.03	0.00	0.00	-1.00
Three months UCDVA	–0.09	0.07	–0.10	0.00	-0.20
Six months UCDVA	–0.07	0.08	–0.10	0.00	-0.25
Preop CDVA	0.01	0.03	0.00	0.10	0.00
Preop CCT	466.10	12.08	465.50	440.00	497.00
Postop CCT	309.40	9.63	306.50	296.00	335.00
FS flap thickness	121.08	6.57	125.00	111.00	129.00

Table (2): Two step PRK group 2 data.

	Two Step PRK Group 2				
	Mean	SD	Median	Mini-mum	Maxi mum
Age	20.75	3.21	20.00	15.00	27.00
Preop refraction	–1.77	0.67	–1.75	–3.00	–0.75
Preop UDCVA	0.32	0.11	0.30	0.10	0.50
One week UDVA	0.27	0.11	0.30	0.10	0.50
One month UCDVA	0.11	0.08	0.10	0.30	0.00
Three months UCDVA	–0.06	0.07	–0.10	0.00	–0.20
Six months UCDVA	–0.03	0.05	0.00	0.00	–0.10
Preop CDVA	0.00	0.00	0.00	0.00	0.00
Preop CCT	402.97	20.15	400.50	323.00	437.00
Postop CCT	379.27	26.26	374.00	355.00	497.00

Table (3): Comparison of residual error two groups.

	Femtosecond Lasik Group 1		Two Step PRK Group 2		*p*-value
	Count	%	Count	%	
Sex:					
M	15	37.5	13	32.5	0.639
F	25	62.5	27	67.5	
Residual ERROR:					
–0.50	6	15.0	5	12.5	<0.001
–0.25	20	50.0	10	25.0	
–0.13	5	12.5	0	0.0	
0.25	9	22.5	8	20.0	
0.50	0	0.0	17	42.5	

Table (4): CCT in each group.

	Femtosecond Lasik Group 1					*p*-value
	Mean	SD	Median	Minimum	Maximum	
Preop CCT	466.10	12.08	465.50	440.00	497.00	<0.001
Postop CCT	309.40	9.63	306.50	296.00	335.00	
	Two Step PRK Group 2					
Preop CCT	402.97	20.15	400.50	323.00	437.00	<0.001
Postop CCT	379.27	26.26	374.00	355.00	497.00	

Discussion

Since long time Lasik refractive surgery became the commonest surgery for sight correction. Moreover, it is safe, effective, and highly predictable and has a rapid recovery time. However, one of the major drawbacks of lasik surgery is regression **[18,19]**. The myopic regression could be due to corneal epithelial hyperplasia, corneal steepening, and changes in corneal biomechanics. It is noticed that the myopic regression increased with the increase in preoperative refractive error **[20]**. Emmetropia could be achieved by different techniques. Using lasik either by flap lifting and doing the laser enhancement which is unsafe due to possibility of either epithelial down growth or other flap related complications or doing another flap away from the original one followed by laser enhancement **[21-23]**. Photo refractive keratotomy is other safe choice and it works successfully especially with patients of low residual stromal bed. Although the technique is older and painful but still has a good result for treating residual post lasik errors. Moreover, that flapless enhancement surgery does not affect the corneal biomechanics which is already affected in the primary refractive surgery **[24]**. Mechanical epithelial scraping carries the risk of primary lasik flap displacement, long procedure time and non uniform surface for ablation. However, excimer laser can remove the epithelial layers and doing surface ablations in two steps known as two step Trans epithelial PRK. Trans-PRK is safe surgery less painful than alcohol assisted PRK. Moreover, rapid recovery with smooth uniform healing **[25,26]**.

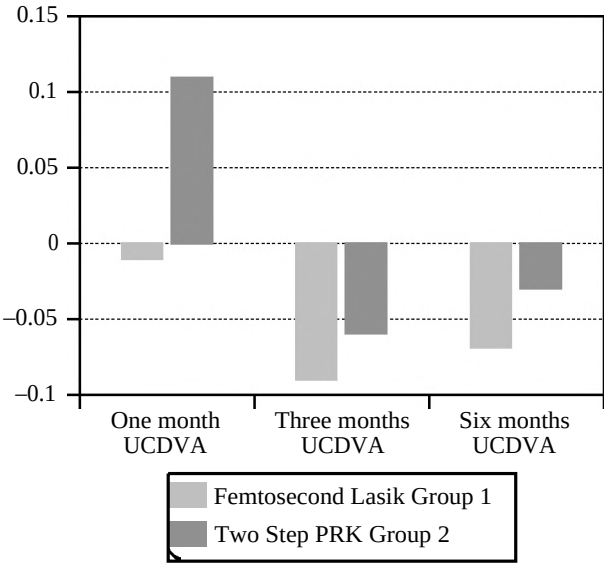

Fig. (1): Comparison between the log MAR UCDVA of the two groups.

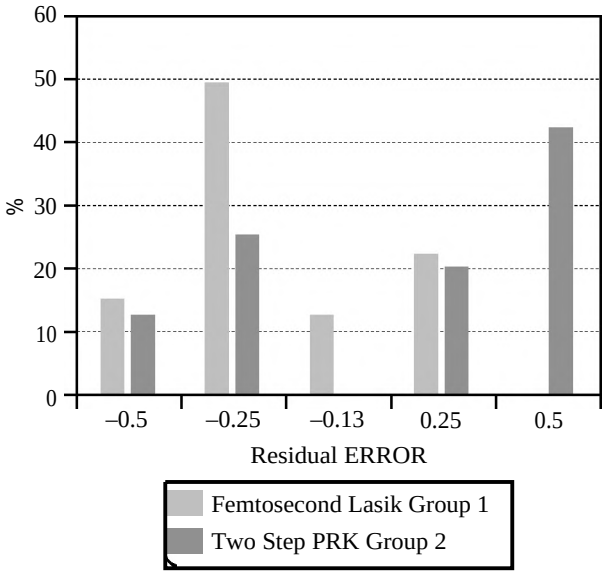

Fig. (2): The percentage of residual errors of the two groups by the six month.

However, there is a controversy about the ablation depth of the corneal epithelium. The ablation profile is calculated based on the central epithelial thickness of a normal cornea which is 55 to 65um at 4mm from the center of the cornea **[17]**. Which is the base for epithelial ablation algorithm in T-PRK laser machine. However, that isn't totally accurate as in patients with low epithelial thickness there is a tendency for over correction as part of energy used for epithelial ablation is used for stromal ablation and the opposite in patients with high epithelial thickness. Moreover, the distribution of epithelial thickness isn't symmetrical all over the cornea **[27,28]**. Customized ablation improved the results of all patients regarding refractive errors and aberrations **[29]**. Most patients of femtosecond lasik group achieved the best UDVA by the first month and remain stable at the postoperative follow up tell the six months. While all patients of PRK showed delayed results as they reach the best UDVA by the third month and remain stable tell the six months. 55% of FS-Lasik patients gain one more lines of their preoperative BCVA and 15% gain two lines, while 35% of TPRK group gain one or two lines of their preoperative BCVA. The postoperative refractive error was significantly higher in the T-PRK group compared to FS-Lasik group. By the six month 15% of patients were –0.50 while 85% of patients were between ±0.25 in femtosecond lasik group. While in T-PRK group 12.5% were –0.50, 37.5% were ±0.25 and 42.5% were 0.50. There is a tendency toward over correction in T-PRK group. The over correction may be related to corneal dehydration during surgery. The longer time of surgery could be a reason to increases

dehydration of the corneal stroma **[30]**. There is a significant difference between attempted and achieved SE in the T-PRK group with tendency to overcorrection. The safety index was above one in both groups with higher safety index in the FS-Lasik than TPRK group. The efficacy and UDVA were improved significantly in each group. Both the safety and efficacy were better compared to that of other studies **[31,32]**.

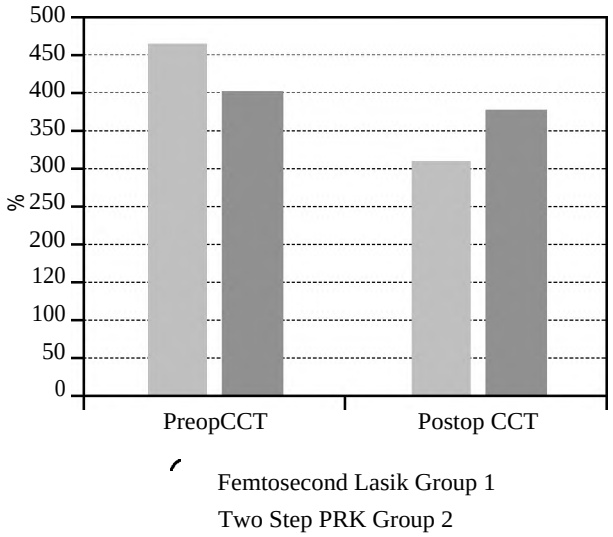

Fig. (3): Comparison of preoperative and postoperative CCT.

The risk of ectasia and marked affection of corneal hysteresis especially with low stromal bed thickness direct the refractive surgeons to another way for treatment of post laser residual ammetropia **[33]**. The new look of the old PRK which is trans-epithelial PRK has many advantages like flapless surgery, laser manipulation of corneal epithelium with corresponding no touch of primary lasik flap, and it works with low residual stromal bed thickness.

Conclusion both femtosecond lasik and TPRK techniques are highly effective and safe in treating post lasik residual ammetropia based on residual stromal bed thickness. Preoperative assessment of residual stromal bed thickness and primary flap thickness using different machines especially ASOCT is important. Wavefront guided ablation improves the outcome of refraction and aberrations.

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علاج ضعف الأبصار بعد عمليات الليزك باستخدام طريقتين مختلفتين

فى هذه الدراسة الإكلينيكية تم تقييم مرى قصر النظر بعد عمليات الليزك إلى مجموعتين وتم إجراء فحوصات ما قبل الجراحة وتم استخدام تقنية الفمتو سكند ليزك لعلاج المجموعة الأولى وكذلك تم استخدام تقنية تصحيح الابصار الضوئى خلال الخلايا السطحية للقرنية على مرحلتين وتم تقييم النتائج خلال ستة أشهر من المتابعة وتم تقييم نسبة تحسن الابصار وإلتآم الجرح وسمك القرنية وتبين أن كلتا الطريقتين مناسبة لتصحيح الإبصار وأمنة ويمكن الاعتماد عليها.