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CHANGES IN CORNEAL BIOMECHANICS AFTER REFRACTIVE SURGERY USING CORVIS ST - A QUASI EXPERIMENTAL STUDY

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ABSRTACT

Objective: To assess the corneal biomechanical changes after refractive surgery using Corvis ST (Oculus Wetzlar, Germany) a dynamic scheimpflug analyzer.

Study Design: Quasi experimental study.

Place and Duration of Study: The study was conducted at Armed Forces Institute of Ophthalmology (AFIO), Rawalpindi, from Feb 2019 to Jul 2019.

Methodology: Following strict inclusion criteria 32 patients were recruited in the study. Total of 64 eyes of patients underwent refractive surgery. Laser in situ keratomileusis (LASIK) was performed on 44 eyes and Photorefractive keratectomy (PRK) was performed on 20 eyes. All measurements for assessment of corneal biomechanics generated by Corvis ST were taken before surgery, 1 week and one month after the procedure with scheimpflug based device (Corvis ST, oculus)

Results: In LASIK surgery after a week there was a change in pachymetry, A1 length, radius and IOP and at one-month pachymetry, deformation amplitude, A1 time, A1 length, A2 length, radius, Intraocular pressure (IOP) and peak distance came out statistically significant with a *p*-value of <0.05. In PRK group Pachymetry, A1 length and radius were statistically significant (*p*-value <0.05) after a month with no difference in parameters after one week.

Conclusion: Our study concluded that there were modifications in biomechanical parameters after LASIK and PRK, indicating changes in cornea after refractive procedures with PRK being less aggressive than Lasik.

Keywords: Corneal Biomechanics, Corvis St, LASIK, PRK.

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INTRODUCTION

Cornea has gained paramount importance within the past twenty years owing to initiation of refractive procedures[1]. The concern of post-operative kertoectasia after refractive surgery and treatment outcomes has highlighted the importance of corneal biomechanics[2]. Roberts stated that any surgery that causes changes in lamellae of cornea will generate biomechanical alterations[3], that will eventually cause an unpredictable change in shape of cornea.Thus biomechanical properties are influenced by refractive procedures[4,5].

Ocular response analyser (ORA, reichert. Inc Depew, NY) was the initial commercially available instrument for the assessment of corneal biomechanics that has facilitated in identification of glaucoma and refractive procedures outcome[6,7]. The first study published in journal of refractive surgery in January 2005 regarding results of ORA had showed variations in corneal biomechanics within keratoconus and post refractive procedures[8]. Recently a novel device for measurement of IOP and ocular biomechanics was launched that employs super speed camera to capture successive scheimpflug images during deformation of cornea using jet of air.

The procedures in the study were directed to correct myopia. Femtosecond laser in situ keratomileusis is a procedure in which femtosecond laser is used to create corneal flap followed by excimer laser ablation and flap replacement whereas photorefractive keratectomy is a photoablative procedure in which corneal ablation is done to acquire desired results.

In this study we assessed the modifications in ocular biomechanics measured by Corvis ST

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(Oculus Wetzlar, Germany) before and after performing Lasik and PRK in patients presenting at AFIO Our study is one of the first study being conducted in Pakistan to assess the response of refractive procedures on cornea in Pakistani population. Thus helping the refractive surgeons to prevent kertoectasia in susceptible corneas after these elective procedures.

METHODOLOGY

It was a quasi-experimental study conducted at Armed Forces Institute of Ophthalmology (AFIO) from 1 February till 31 July 2019. A non-probability- consecutive sampling technique was employed. The minimum sample size for the study was calculated to be 40, which was calculated by using sample size calculating equation, and putting value for prevalence of high myopia as 2.7%: $n= \frac{Z^2Pq}{e^2}$. The participants (underwent Lasik and PRK for myopia) were volunteers and they were chosen based on their availability and willingness to participate in the study. A local research ethical committee approval was taken reference number 211/ERC/AFIO. The purpose of study was explained and consent form was duly signed before enrolling patients.

Patients between the ages of 20-40 yrs were enrolled in the study with spherical equivalent of -1.00DS to -10.0 DS with no ocular disease like dry eyes, glaucoma, collagen diseases and no previous corneal procedures. Exclusion criteria include diabetics, irregular astigmatisms, keratoconus, ectasia assessed by deranged BAD-D, CBI and TBI.

Preoperative assessment consisted of unaided and best corrected visual acuity, cycloplegic refraction, corneal assessment by Oculyzer (wavelight), Topolyzer (wavelight), Corvis ST (Oculus Wetzlar, Germany) Pentacam (Oculus) followed by detailed slit lamp examination.

The corneal biomechanical parameters measured by Corvis ST (Oculus Wetzlar, Germany) were assessed preoperatively, at day 7 & day 30.

Data was entered and analyzed by using IBM SPSS (version 23.0) software. First of all normality of data was checked by using normality graphs and shapirowilk test. Quantitative normal data was described by using mean and standard deviation, while median and IQR was used for non-normal data. Percentage and frequencies were reported for qualitative data. Group comparisons are done by using Analysis of variance (one-way ANOVA) test. A *p*-value of less than 0.05 was considered to be statistically significant.

RESULTS

Total number of patients enrolled in the study were 32, hence total of 64 eyes were assessed pre and post refractive procedures. Of the 32 patients 11 (34%) were females and 21 (66%) male patients. LASIK was performed on 44 eyes (69%) whereas 20 (31%) eyes underwent PRK. Frequencies and percentages of procedures shown in graphical form in figure. At the time of examination, the overall mean age was 26.28 ± 5 years for study participants.

Various corneal biomechanical indices were found to be statistically significant in eyes that

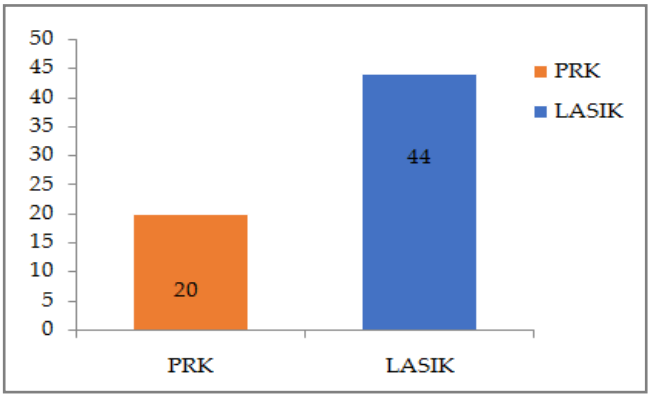

Figure: Frequency of procedures.

underwent LASIK, the means, Standard deviation and *p*-value for which are shown in table-I. After 1 week pachymetry, A1 length, radius and IOP were different compared to preoperative data and at day 30 pachymetry, deformation amplitude, A1 time, A1 length, A2 length, radius, IOP and peak distance were statistically significant (table-I).

PRK was performed on 20 eyes. Table-II showed the mean and standard deviation and *p*-

value of ocular biomechanics. Pachymetry, A1 length and radius differs after a month as shown in table-II.

pachymetry, which are as follows: Lasik procedure demonstrated correlation of change in IOP, maximum deformation amplitude, A1 time, A1 length, A1 velocity, A2 length, A2 velocity, peak

Table-I: Comparison of Cor Vis ST in LASIK Patients.

Dependent Variable	Mean ± SD (n=44)			*p*-value
	Pre Op	day 7	day 30	
Pachymetry	542.27 ± 25.58	461.29 ± 46.35	460.04 ± 48.29	<0.01
Deformation amplitude Max	1.05 ± 0.1	1.07 ± 0.12	1.12 ± 0.14	0.039
A1 Time (ms)	7.21 ± 0.34	7.05 ± 0.39	6.89 ± 0.40	0.01
A1 Length (mm)	2.23 ± 0.35	1.92 ± 0.33	0.16 ± 0.04	<0.01
A1 Velocity (m/s)	0.16 ± 0.04	0.155 ± 0.02	0.17 ± 0.03	0.3
A2 time (ms)	21.48 ± 0.25	21.34 ± 0.38	21.63 ± 0.36	0.01
A2 length (mm)	1.81 ± 0.37	1.50 ± 0.52	1.38 ± 0.56	<0.01
A2 Velocity(m/s)	0.29 ± 0.02	0.28 ± 0.03	0.27 ± 0.16	0.638
HC Time (ms)	15.95 ± 0.59	17.00 ± 15.70	15.78 ± 0.52	0.150
Radius (mm)	7.42 ± 0.6	8.15 ± 6.61	6.42 ± 0.69	<0.01
Peak Distance (mm)	5.05 ± 0.24	5.68 ± 5.12	5.34 ± 0.36	<0.01
IOP (mmHg)	15.32 ± 1.89	13.44 ± 3.02	12.89 ± 2.95	<0.01

Table-II: Inter group comparison of Cor Vis ST in LASIK patients.

Dependent Variable	Mean ± SD (n=44)		
	Pre op vs day 7	Pre op vs day 30	Day 7 vs day 30
Pachymetry	<0.01	<0.01	0.989
Deformation amplitude Max	0.832	0.04	0.147
A1 Time (ms)	0.119	<0.01	0.126
A1 Length (mm)	<0.01	<0.01	<0.01
A2 time (ms)	0.128	0.123	<0.01
A2 length (mm)	0.01	<0.01	0.541
Radius (mm)	<0.01	<0.01	0.312
Peak Distance (mm)	0.541	<0.01	0.008
IOP (mmHg)	0.001	0.606	<0.01

Table-III: Comparison of COr Vis ST in PRK patients.

Dependent Variable	Mean ± SD (n=20)			*p*-value
	Pre op	day 7	day 30	
Pachymetry	549.65 ± 30.88	486.10 ± 46.54	483.45 ± 47.03	<0.01
Deformation amplitude Max	1.00 ± 0.15	1.03 ± 0.16	1.02 ± 0.17	0.865
A1 Time (ms)	7.34 ± 0.49	7.11 ± 0.51	7.27 ± 0.72	0.457
A1 Length (mm)	2.35 ± 0.28	2.17 ± 0.32	2.11 ± 0.34	0.053
A1 Velocity (m/s)	0.166 ± 0.13	0.178 ± 0.12	0.13 ± 0.02	0.491
A2 time (ms)	21.17 ± 0.84	21.04 ± 0.97	21.22 ± 0.61	0.781
A2 length (mm)	2.68 ±4.18	1.66 ± 0.48	1.43 ± 0.41	0.232
A2 Velocity(m/s)	0.282 ± 0.05	0.29 ± 0.05	0.33 ± 0.12	0.112
HC Time (ms)	15.60 ± 0.50	15.517 ± 0.60	15.67 ± 0.59	0.675
Radius (mm)	7.456 ± 0.901	7.13 ± 0.87	6.67 ± 0.91	0.026
Peak Distance (mm)	7.456 ± 0.901	5.11 ± 0.42	4.96 ± 0.60	0.604
IOP (mmHg)	16.30± 3.45	15.02 ± 5.03	14.90 ± 5.47	0.588

Statistically significant correlation was seen between ocular biomechanical parameters and distance and radius with corneal thinning whereas in PRK changes in A2 length, IOP and

radius correlated with pachymetry as shown in table-III.

Table-IV: Inter group Comparison of Cor Vis ST in PRK Patients.

Dependent Variable	Mean ± SD (n=44)		
	Pre op vs day 7	Pre op vs day 30	Day 7 vs day 30
Pachymetry	<0.01	<0.01	0.843
Radius (mm)	0.254	0.007	0.110

Table-V: Correlation between changes in biomechanical parameters and corneal thinning after LASIK and PRK measured by CorVis ST

Biomechanical Parameters	LASIK		PRK	
	R	*p*-value	R	*p*-value
IOP (mmHg)	0.71	<0.01	0.34	<0.01
Def Amp Max (mm)	-0.49	<0.01	-0.27	0.35
A1 Time (ms)	0.58	<0.01	0.35	0.06
A1 Length (mm)	0.51	<0.01	0.16	0.21
A1 Velocity (m/s)	-0.39	<0.01	-0.26	0.47
A2 Time (ms)	-0.09	0.29	-0.03	0.83
A2 Length (mm)	0.56	<0.01	0.36	<0.01
A2 Velocity (m/s)	0.34	<0.01	0.35	0.15
HC Time (ms)	-0.08	0.83	-0.12	0.35
Peak distance (mm)	-0.63	<0.01	-0.14	0.28
Radius (mm)	0.64	<0.01	0.64	<0.01

DISCUSSION

Corneal biomechanics demonstrates the corneal response to externally applied forces and its intrinsicabilities. Different refractive procedures produce anatomical and optical alterations in cornea that alters the corneal biomechanics making them the tools to assess corneal integrity. The ophthalmologists are currently investigating after effects of all the refractive procedures to make them safe and optically satisfying. In the past Ocular Response Analyzer (ORA, reichert. Inc Depew, NY) and recently Corvis ST (Oculus Wetzlar, Germany) is used for corneal biomechanical evaluation that uses a jet of air to produce different parameters for corneal assessment. In our study we evaluated the parameters produced by Corvis ST (Oculus Wetzlar, Germany) before and after they underwent refractive surgery. The data was analyzed preop, at day 7 and day 30.

Kamiya[9] reported a change in corneal biomechanics both after Lasik and PRK with Lasik causing a marked reduction in corneal biomechanics as demonstrated by other studies[7-10]. Frings *et al*[4] Hassan *et al*[11] Osman *et al*[1] Shen *et al*[12] all demonstrated a change in corneal biomechanics after refractive surgery with more effects after Lasik. There are a significant alterations in corneal parameters after PRK, Lasik, Smile (small incision lenticule extraction), LASEK and EPILASIK[2,5,10,13-16]. They revealed a shortened A lengths with increased deflection amplitudes and reduction in radius of curvature and increased peak distance after Lasik surgery. These findings are consistent with our study that showed a statically increase in maximum deformation amplitude and peak distance while reduction in radius, A2 and A1 length. As measured by Corvis ST (Oculus Wetzlar, Germany) we also established that large no of parameters showed statically no significant difference in PRK group pre and post operatively. That is similar with study conducted by Hassan *et al*[11]. However, there is shortening of radius of curvature that is in concordance with the study of Chen *et al*[17].

A correlation was detected between the corneal thinning and ocular parameters that showed a positive correlation between A2 length and radius with corneal thinning in PRK group.

In case of Lasik correlations observed between IOP, deformation amplitude, A1 time, A2 length, A2 velocity and radius in parallel with study by Hassan *et al*[11].

Our limitation of study was a small sample size, the patients were followed for a brief period of one month, A long-term evaluation was not done. We didn't consider hyperopic group; only myopic patients were recruited in study. Future studies could be conducted to assess the response of corneal parameters over an extended period of time, Patients should be assessed at a specific time to rule out diurnal variation however Hon *et al*[18] specified no note worthy variations.

CONCLUSION

Parameters generated by Corvis ST (Oculus Wetzlar, Germany) were efficacious for explaining the deformation reaction between the pre refractive and post refractive cornea. PRK and Lasik do cause modifications in biomechanical parameters with PRK being less aggressive technique.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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