Intraocular Pressure Changes after Laser-Assisted In-Situ Keratomileusis versus Photorefractive Keratectomy in Myopic Eyes

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Abstract: ***<u>Objective</u>: The aim was to compare intraocular pressure (IOP) changes after laser-assisted in-situkeratomileusis (LASIK) versus photorefractive keratectomy (PRK) in myopic eyes. <u>Background</u>: IOP measurement is necessary for diagnosing glaucoma. LASIK and PRK are used for correction of myopia. IOP is underestimated after LASIK and PRK. It is very important to evaluate IOP changes after LASIK and PRK especially in myopic patients, as myopia is a risk factor for primary open-angle glaucoma. <u>Patients and methods</u>: A total of 50 patients diagnosed clinically to have myopia were selected. Their ages ranged from 18 to 48 years. A total of 50 eyes were operated using LASIK and 50 eyes were operated using PRK . Patients were subjected to corneal topography by pentacam and IOP measurement by Goldmannapplanation tonometer (GAT), preoperatively and postoperatively at the end of the first week, the first month, and the third month. <u>Results</u>: The mean IOP in LASIK and PRK groups, which was preoperatively 15.86 ± 1.99 and 15.62 ± 2.12 mmHg, respectively, decreased postoperatively to 12.98 ± 1.83 and 12.98 ± 2.03 mmHg, respectively. There is a statistically nonsignificant difference between LASIK and PRK, postoperatively (P = 0.164), whereas there was a statistically highly significant difference between preoperative and postoperative IOP in both LASIK and PRK groups (P = 0.000). <u>Conclusion</u>: IOP is underestimated after laser correction. IOP decrease can be dramatic in highly myopic corrections. Preoperative IOP is the single strongest predictor of postoperative IOP change, with eyes with higher preoperative IOP having greater IOP decrease. LASIK correction will lower IOP by ~1 mmHg because of the effect of the lamellar flap.***

Keywords: Goldmannapplanation tonometer, intraocular pressure, laser-assisted in-situ keratomileusis, myopia, photorefractive keratectomy

1. Introduction

Laser vision correction (LVC), including laser-assisted in-situ keratomileusis (LASIK) and photorefractive keratectomy (PRK), uses an excimer laser to flatten or steepen the central cornea and change the refractive error of the eye. Tissue removed during this photoablative process can alter the biomechanical properties of the cornea. Most current methods for measuring intraocular pressure (IOP) make assumptions about corneal biomechanical parameters that can be altered after LVC [1,2]. Previous studies have examined the relationship between IOP and LVC. Some studies have looked solely at an individual type of LVC, including myopic LASIK [3], and myopic PRK [4]. Other authors have compared the influence of different types of LVC on postoperative IOP, including studies on myopic LASIK and PRK, myopic LASIK [5], and myopic PRK with myopic LASIK [6]. Overall, these studies have found a postoperative decrease in measured IOP by applanation. The largest study on this subject to date by Chang and Stulting[7], with 4240 patients, provided illumination on the effect of the lamellar flap on IOP change, but was limited to myopic LASIK and did not account for central corneal thickness (CCT), which has been shown to have a substantial effect on IOP measurement. The rest of these reports, although useful, have been hampered by small sample sizes and were limited in their ability to fully analyze factors related to the IOP change, such as the baseline patient characteristics, surgical parameters, and type of surgery [8].

Aim

The aim was to compare IOP changes after LASIK versus PRK in myopic patients.

Patients and methods

A prospective comparative clinically controlled study was performed within the period of 6 months from March 2020 to August 2020, which included100 eyes of 50 patients diagnosed clinically to have myopia. There were 15 males (30 eyes) and 35 females (70 eyes), who were operated in both eyes, and their age ranged from 18 to 48 years, with mean ± SD of 29.08 ± 7.71 years.

Inclusion criteria

Patients to be included must be free from any ocular disease except error of refraction, understand instructions, and provide informed consent.

Exclusion criteria

Patients who had cataract or glaucoma, patients with retinal diseases as diabetic macular edema, patients with previous vitrectomy or intraocular surgery, patients who had previous intraocular drug injection, patients aged not less than 16 years old, pregnant women, uncooperative patients, and those with inability to give informed consent were excluded from the study.

Ethical issues

An official permission was obtained from the manager of outpatient clinic for helping in conduction of our work and obtaining verbal consent from each respondent before the interview.

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Full history

Personal history including name, age, sex, residence, and occupation; history of previous medical illness; history of previous ocular illness; present illness (error); patient's first complaint; and onset of the disease, duration, and its progression were recorded.

2. Methods

Patients were classified into two equal groups: group 1 constitutes 50 eyes operated using LASIK surgery and group 2 constitutes 50 patients operated using PRK surgery. Both groups were treated by the same laser machine. Patients were examined preoperatively by visual acuity, manifest and cycloplegic refractive error by auto keratorefractometer, biomicroscopy by slit lamp, corneal topography by pentacam, and IOP measurement by Goldmannapplanation tonometer. Patients were followed up by the same methods at the end of the first week, the first month, and the third month postoperatively.

3. Statistical Analysis

Data were collected in a master sheet, coded, entered, and analyzed. χ 2 -Test is used for comparison with correlation between more than two proportions. Data were presented as mean ± SD for quantitative variables and number and percentage for qualitative variables. The threshold of significance was fixed as 5% level Student's t-test and the P value: P value of greater than 0.05 indicates nonsignificant results, P value of less than 0.05 indicates significant results, P value of less than 0.01 indicates highly significant results, and P value of less than 0.001 indicates very highly significant results. Final results were collected and tabulated and then comparison with correlation with each other was performed.

4. Results

The mean CCT in both LASIK and PRK groups, which was 560.85 and 512.3 μm preoperatively, respectively, became 503.16 and 422.34 μm postoperatively, respectively. There is a statistically nonsignificant difference between both groups preoperatively (P = 0.09), whereas comparing preoperative with postoperative values, there was a statistically highly significant difference in LASIK group(P = 0.003) and in PRK group (P = 0.008; Table 1). The mean reduction in CCT in LASIK and PRK groups was 57.66 ± 41.185 and 87.84 ± 41.096 μm, respectively. There is a statistically highly significant difference (P = 0.00421) between both groups(Table 2).

The mean IOP in the LASIK group, which was 15.72 ± 1.97 mmHg in the right eyes and 16.0 ± 2.02 mmHg in the left eyes, preoperatively, became 12.8 ± 1.94 mmHg in the right eyes and 13.16 ± 1.72 mmHg in the left eyes 3 months postoperatively. There is a statistically highly significant difference (P = 0.000) between preoperative and 3-month postoperative IOP in both eyes (Table 3). The mean IOP in the PRK group, which was 15.48 ± 2.16 mmHg in the right eyes and 15.76 ± 2.09 mmHg in the left eyes, preoperatively, became 12.96 ± 2.11 mmHg in the right eyes and 13.0 ± 1.96 mmHg in the left eyes 3 months postoperatively. There is a statistically highly significant difference (P = 0.000) between preoperative and 3-month postoperative IOP in both eyes (Table 4). The mean IOP in LASIK and PRK groups was preoperatively 15.86 ± 1.99 and 15.62 ± 2.12 mmHg, respectively, and 3 months postoperatively 12.98 ± 1.83 and 12.98 ± 2.03 mmHg, respectively. There is a statistically nonsignificant difference between LASIK and PRK preoperatively (P = 0.142) and there is a statistically nonsignificant difference between LASIK and PRK postoperatively (P = 0.164), whereas there was a statistically highly significant difference between preoperative and 3-month postoperative IOP in both LASIK and PRK groups (P = 0.000; Table 5). There is a statistically highly significant negative correlation between the change of CCT and change in IOP in both LASIK and PRK groups (P = 0.000; Table 6).

Table 1: Corneal thickening of studied groups

CCT (Micro metre)	LASIK		PRK		TOTAL	
	RE	LE	RE	LE	RE	LE
Pre op	560.84	560.86	514.08	510.52	537.46	535.6
Post op	501.64	504.68	423.56	421.12	462.6	462.9
t- Test	0.7216	0.6977	0.4644	0.4635	0.5788	0.5687
P	0.00034	0.00016	0.02	0.0172	0.0052	0.0015

Pre op	560.85	512.3	536.53
Post op	370.36	422.34	396.35
Z test	1.946	1.362	
P	0.003*	0.008*	

CCT, central corneal thickness; LASIK, laser-assisted in situ keratomileusis; PRK, photorefractive keratectomy. *statistically significant

Table 2: Reduction in central corneal thickness of the studied groups

Reduction in CCT	LASIK		PRK		TOTAL	
	RE	LE	RE	LE	RE	LE
Range	14-168	11-162	21-203	32-150	14-203	11-162
Mean +/- SD	59.2+/-44.08	56.12+/-38.29	88.08+/-43.926	87.6+/-38.265	73.64+/-45.93	71.86+/-41.09
Total(Mean+/-SD)	57.66+/-41.185*		87.44+/-41.096*		72.75+/- 43.51	
Significance*Chi square= 13.623 , P = 0.00421						

CCT, central corneal thickness; LASIK, laser-assisted in situ keratomileusis; PRK, photorefractive keratectomy. *statistically significant.

Table 3: Intraocular pressure changes during the study period among the laser-assisted in-situ keratomileusis group

IOP(mm Hg)	Right eye		Left eye	
	Range	Mean+/- SD	Range	Mean+/- SD
Preop*	12-19	15.72+/-1.97	12-19	16.0+/-2.02
1stwk Post op	10-17	13.24+/-1.83	11-16	13.72+/- 1.57
1st month Postop	10-16	13.16+/-1.72	10-17	13.24+/-2.09
3 rd month Post op*	10-16	12.8 +/-1.94	10-16	13.16+/-1.72
Mann-whitney*		18.828		19.392
P*		0.000		0.000

IOP, intraocular pressure; LASIK, laser-assisted in situ keratomileusis.*statistically significant.

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Table 4: Intraocular pressure changes during the study period among the photorefractive keratectomy group

IOP(mm Hg)	Right eye		Left eye	
	Range	Mean+/- SD	Range	Mean+/-SD
Pre op*	12-20	15.48+/-2.16	11-19	15.76+/-2.09
1st wk post op	11-18	13.48+/-1.78	9-17	13.48+/-1.71
1st month post op	10-19	13.0+/-2.22	9-17	13.2+/-1.98
3rd month post op*	10-18	12.96+/-2.11	9-17	13.0+/-1.96

Mann-Whitney* 15.922 15.667
P* 0.000 0.000

Table 5: Comparison between intraocular pressure changes of both laser-assisted in-situ keratomileusis and photorefractive keratectomy groups during the study period

IOP(mm Hg)	Groups		Significance	
	LASIK	PRK	Chi square Test	P
Pre op*	15.86+/-1.99	15.62+/-2.12	0.0295	0.142
1stwk post op	13.48+/-1.7	13.48+/-1.75	0.000	0.213
1st month post op	13.2+/-1.91	13.1+/-2.1	0.002	0.093
3rd month post op*	12.98+/-1.83	12.98+/-2.03	0.000	0.164

Mann-Whitney* 15.922 15.065
P* 0.000 0.000

IOP, intraocular pressure; LASIK, laser assisted in situ keratomileusis; PRK, photorefractive keratectomy. *statistically significant.

Table 6: Comparison between central corneal thickness changes and intraocular pressure changes of both laser-assisted in-situ keratomileusis and photorefractive keratectomy groups during the study period

CCT (Micrometre)	CCT (Micrometre)	IOP (mm Hg)	Significance	
			Chi square Test	P
LASIK	57.66+/-41.2	2.88+/-0.99	0.795	0.000
PRK	87.84+/-41.1	2.64+/-0.12	0.903	0.000

CCT, central corneal thickness; IOP, intraocular pressure; LASIK, laser-assisted in situ keratomileusis; PRK, photorefractive keratectomy

5. Discussion

Since 2000, a large number of patients have undergone LASIK for the correction of myopia. Following LASIK, it is very important to evaluate IOP, especially in myopic patients, as myopia is a known risk factor for primary open-angle glaucoma [9] and IOP is underestimated after LASIK owing to a decrease in corneal thickness and flap creation [10]; therefore, simple IOP measurement after LASIK cannot be used for glaucoma screening or the management of patients with glaucoma [11]. IOP after refractive surgery is underestimated not only using GAT but also using other devices, such as a pneumotonometer, TonoPen, dynamic contour tonometer (DCT), or noncontact tonometer [12]. Both DCT and ocular response analyzer measurements of IOP are less affected by corneal properties, particularly CCT when compared with GAT [13]. DCT and ocular response analyzer provide both more accurate and more valuable estimates of IOP after refractive surgery compared with standard tonometric techniques, including GAT [14]. Some studies investigated the association between preoperative and postoperative IOP measurements using various instruments and reported a wide range of results. On the contrary, a few population-based studies have reported formulas used to estimate true IOP based on various preoperative and postoperative parameters [15]. In a study by BahadirKilavuzoglu et al. [11], the decrease in IOP after LASIK was significant and was correlated with IOP preoperative, CCT, and spherical equivalent of the attempted correction (SE-ac), as reported earlier [16]. This study attempted to find a difference between the decrease of IOP after LASIK ablation and PRK in correction of myopia, in which 100 eyes of 50 patients diagnosed clinically to have myopia were selected. There were 15 male (30 eyes) and 35 female (70 eyes) patients operated in both eyes, and their ages ranged from 18 to 48 years with mean ± SD of 29.08 ± 7.71 years.

They were classified into two equal groups: group 1 constituted 50 eyes operated using LASIK surgery and group 2 constituted 50 patients operated using PRK surgery. Regarding the mean CCT in LASIK and PRK groups, there was a statistically nonsignificant difference between both groups preoperatively (P = 0.09), whereas comparing preoperative with postoperative values in the same group, there was a statistically highly significant difference in LASIK group (P = 0.003) and in PRK group (P = 0.008). There was a statistically highly significant difference (P = 0.00421) between both groups regarding the mean reduction in CCT. Regarding the preoperative parameters, there was a significant difference between the preoperative CCT between LASIK and PRK-MMC groups.This finding was quite expected because of the nonrandomized design of the study and considering that surface ablation is more commonly considered for patients with thinner corneas [17]. In the study, there was a statistically highly significant difference (P = 0.000) between preoperative and 3-month postoperative IOP in LASIK group, and there was a statistically highly significant difference (P = 0.000) between preoperative and 3-month postoperative IOP in PRK group. Regarding the mean IOP, there was a statistically nonsignificant difference between LASIK and PRK groups preoperatively (P = 0.142) and there was a statistically nonsignificant difference between both groups postoperatively (P = 0.164), whereas there was a statistically highly significant difference between preoperative and 3 months postoperative IOP in both LASIK and PRK groups (P = 0.000). The study also showed that there is highly significant negative correlation between the change in CCT and the change in IOP in both LASIK and PRK groups (P = 0.000). After the operation, in both groups (LASIK and PRK), the measured IOP decreased significantly after high myopic ablations. The decrease in the measured IOP was greater in the LASIK group, which is in agreement with the evidence that the LASIK flap does not contribute to the load-bearing characteristics of the post-LASIK cornea resulting in a more artificial low applanation tonometry reading after LASIK compared with PRK [7]. Readings obtained by the Perkins and air tonometers, measuring the IOP in the center of the cornea and therefore in the ablation zone, were significantly lower after the refractive surgery when compared with the presurgery values. However, the transpalpebral tonometer, which takes the IOP in the superior zone of the cornea, showed the same values before and after surgery. It seems that the cause for this IOP decrease may be the central corneal thinning resulting from the surgery together with the biomechanical change of the

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cornea after the flap creation [18]. Similarly, Shemesh et al. [19] found that patients undergoing LASIK treatment showed lower IOP after refractive surgery when measured with GAT but not when measured with DCT, which is apparently independent of CCT. Moreover, Shousha et al. [20] concluded that IOP lowered after LASIK treatment when measured with both GAT and noncontact tonometer. There are significant differences in the way IOP changes after myopic treatments with PRK and LASIK. Simple differences in the ablation profile for myopic corrections between LASIK and PRK could affect corneal biomechanics and thus account for this difference as in the measured IOP after refractive surgery. The myopic ablation profile removes tissue from the corneal stroma that is thickest in the center and thin on the edges, thereby flattening the cornea and reducing its refractive power. The amount of tissue removed in both profiles is related to the intended refractive correction [8]. MeasuredIOPaftermyopicLASIKandmyopicPRKhas been shown to decrease using a wide array of tonometry devices [1,21].The IOP reduction after myopic LASIK has been estimated to range from 0.027 mmHg/mm of ablated tissue to 0.041 mmHg/mm of ablated tissue and has been estimated at 0.021 mmHg/mm ablated tissue after myopic PRK. Chang and Stulting[7] analyzed 8113 eyes undergoing myopic LASIK with IOP measurements by the Tono-Pen and found a decrease of 0.12 mmHg per diopter of refractive correction. A study by Schallhorn et al. [8] found a reduction in IOP after myopic procedures that was strongly linked to the amount of myopia corrected, 0.40 mmHg (95% confidence interval: 0.39–0.41) per diopter of myopic correction for both PRK and LASIK. For a conventional ablation profile, this equates to 0.32 mmHg per 10 mm of tissue removal, which is similar to the correlation between CCT and measured IOP that we and others have found in unoperated eyes [22]. This is similar to what has been described for both myopic LASIK and myopic PRK, confirming the previous estimates. Preoperative IOP was the single strongest predictor of postoperative IOP change, with eyes with a higher preoperative IOP having a greater IOP decrease. Some of this phenomenon may be due to regression to the mean, that is, higher than normal values tend to be closer to normal when measured a second time, although this was mitigated in part by averaging the available preoperative values for patients with more than 1 measurement. It also may be because of innate differences in the elastic properties of the cornea between eyes with lower preoperative IOP and higher preoperative IOP [8]. Preoperative CCT was independently related to the amount of IOP decrease after LVC. This is an interesting finding. Thicker CCTs experienced less change in IOP from preoperative to postoperative than thinner CCTs, and this was true across all groups. This would suggest that thicker corneas are more resilient to ablation and experience less biomechanical alterations after ablation than thinner corneas [8]. Two previous studies have attempted to quantify the effect of the cutting of a lamellar flap on measured IOP reduction after LASIK. By using a regression analysis, Chang and Stulting[7] estimated that the cutting of the lamellar flap independently reduces measured IOP by an average of 1.36 mmHg. Another study estimated the lamellar flap reduced measured IOP by 1.61.8 mmHg [23]. Schallhorn et al. [8] estimated that the lamellar flap lowers IOP by 0.94 mmHg (95% confidence interval: 0.89) for myopic procedures. This is slightly lower than both previous estimates, but the larger number of variables analyzed, the different tonometer, or the larger sample size may explain the difference. Although it is theoretically possible that the use of different microkeratomes might affect postoperative IOP, this was unclear in the study. Because most patients undergoing refractive surgery are young and have healthy eyes, the need to consider IOP in the context of their ocular health is most likely many years away from the time that they underwent refractive surgery, and the availability of preoperative data may be scarce. Therefore, the utility of IOP correction in clinical practice using this model may be limited by the scarcity of preoperative data.

6. Conclusion

Overall, measured IOP is underestimated after laser correction. IOP decrease can be dramatic in highly myopic corrections. Preoperative IOP was the single strongest predictor of postoperative IOP change, with eyes with a higher preoperative IOP having a greater IOP decrease. Any LASIK correction will lower IOP by ~1 mmHg because of the effect of the lamellar flap.

7. Financial support and sponsorship

Nil

8. Conflicts of interest

There are no conflicts of interest.

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