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LASIK Surgery for Treatment of Residual Errors of Refraction after Phaco Surgery

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Abstract

Cataract is a main cause of curable blindness, and phacoemulsification is the preferred technique for its management by most of ophthalmologists. Prober IOL calculation is mandatory to decrease the incidence of residual refractive errors after phaco operation. LASIK is a main line for treatment of these errors. The aim of this research is to evaluate the the LASIK surgery for correction of residual refraction errors post phaco surgery, as regards its efficacy, safety and accuracy. An interventional, prospective, and non-randomized research included twelve eyes in 12 patients. Their mean age was 59.75 years. They were subjected to phaco surgeries, were diagnosed as post-phaco-residual errors of refraction and were referred for LASIK correction of these errors. Full medical history taking form cases, full ophthalmological assessment, and Pentacam examination. LASIK surgery was performed under topical anesthesia, at least 6 weeks after phaco surgery. Follow-up was performed at one day, one week, and one-month post-LASIK. The average age was 59.75 years. The average time elapsed between phaco and Lasik surgeries was 8.66 weeks. Eight eyes were compound myopic astigmatism, two had simple myopic astigmatism, and two eyes had mixed astigmatism. Before LASIK surgeries, mean UCVA, mean BCVA, mean K1, mean k2, mean spherical equivalent and mean thinnest corneal location were 0.46, 0.92, 41.83 D, 43.13 D, -1.21 D and 557.9 microns. One month after LASIK surgery, mean UCVA, mean BCVA and mean spherical equivalent were 0.87, 0.94 and -0.15 D. The differences between pre- and post-LASIK UCVA and mean spherical equivalent were statistically significant, while between pre- and post-LASIK BCVA was statistically non-significant. At the end of the follow up time, all cases had spherical equivalent equal or less than $\pm$0.75 D, UCVA equal to 0.8 or better, and BCVA equal to 0.9 or better. Intra-operative LASIK complications were reported in the form of few small subconjunctival hematomata in 5 cases. Symptoms of post-LASIK dry eye were reported also in all cases (100%) and were persistent in 10 cases till the follow up visit one month postoperatively. Halos and glare were reported in 8 cases and persisted in 5 cases till the follow up visit at one month after LASIK surgery. For correction of residual refractive errors after phaco surgery, LASIK surgery is harmless, effective, accurate, and predictable. Interval of 6 weeks between phaco and LASIK surgeries is safe.

Keywords: LASIK, Phaco, Excimer laser, Errors of refraction, LASIK complications, IOL power calculation

1. Introduction

Globally, the most common cause of curable blindness is cataract Cougdon [1]. Reitblat [2] reported that cataract removal with intraocular lens (IOL) implantation is one of the most regularly done surgical procedures currently. They also revealed that most cataract cases treated with modern microsurgical techniques, sophisticated biometry tools, new IOL technology, and updated IOL power calculation methods to restore high-quality vision .

Much research has attempted to assess power of IOL calculation formulae as the greatest predictor of real postoperative refractive outcomes Soyoung [3].

Alió [4] reported that despite recent breakthroughs in cataract operation, on occasion residual refractive error induced unacceptable visual outcomes. For both the patient and the practitioner, a refractive surprise after cataract operation is a stressful and an unpleasant situation. For the repair of residual refractive error, many surgical approaches are offered including lens-based techniques (IOL exchange or piggyback IOLs) and corneal-based operation (laser refractive operation) .

Following cataract surgery, patients who have already obtained myopic correction via PRK or LASIK may experience an unfavorable hyperopic refractive result, which attributed to mistakes in assessing effective lens position and corneal power, that are two essential variables in calculation IOL power. In all corneal refractive operations, variable degrees of astigmatism (regular and/or irregular), also an alteration in the optical profile of the cornea are common findings Khor [5].

When aiming for emmetropia, cataract surgeons should think about how to address preexisting corneal astigmatism. Peripheral corneal relaxing incisions, the implantation of a toric IOL, and incisions on the steep axis are some of the methods used to minimize corneal astigmatism Behndig [6].

It's critical to understand the various approaches for resolving refractive surprise following cataract surgery. Following cataract operation, LASIK for residual mistake correction resulted in 92.85% of eyes attaining a final spherical equivalent (SE) within 0.50 D and 100% of eyes attaining a SE within 1.00 D Fernández [7].

LASIK refinement for the correction of residual refractive error after cataract surgery with multifocal IOL implantation or monofocal is harmless, effective, and delivers more accurate refractive outcomes in eyes previously implanted with monofocal IOLs Piñero [8].

Wavefront-guided therapy with iris registration have been reported to have better results than conventional LASIK Erdem [9].

For patients who want monovision after cataract surgery, using the laser has been described to be an effective and predictable technique Jin [10]. Despite these benefits, LASIK has some restrictions, including a short corneal stromal thickness, high refractive defects, and restricted access to the excimer laser for cataract surgeons.

After cataract extraction and IOL implantation, a viable, non-invasive, and accurate treatment for correcting ametropia is LASIK. Alternatives include lens-based operations (piggyback lens insertion or IOL exchange). Piggyback In circumstances of corneal abnormalities, extreme ametropia, or when an excimer laser platform is not available, IOLs have proven to be technically easier and more accurate than IOL exchange Schallhorn [11].

The purpose of this study was to evaluate the safety, efficacy, and precision of LASIK surgery for the correction of residual refractive defects following phaco surgery.

2. Patients and Methods

An intervention, prospective, and non-randomized study was held between October 2019 and March 2021 at I-Vision Hospital. It included 12 eyes in 12 cases (5 females (41.7%) and 7 males (58.3%)). Their age was 59.75 + 5.31 years (Range: 51 – 68 years). Right eye was reported in 4

cases (33.3%), while left eye was reported in 8 eyes (66.7%). They were subjected to phaco surgeries at different hospitals and were not satisfied by their visual outcome. They were detected with post-phaco-residual mistakes of refraction and were referred to the hospital for treatment. They were willing for LASIK operations .

All cases were subjected to taking their full medical history including autorefractometry, the date of phaco operation, best corrected visual acuity (BCVA), uncorrected visual acuity (UCVA), slit lamp check for the anterior segment. Besides, eliminate surgical complications of phaco surgery, applanation tonometry, Volk +90D fundus examination, and Pentacam examination to check keratometric readings, eliminate keratoconus, and evaluate the thinnest corneal thickness. According to the conversion tables BCVA &UCVA were transformed to the decimal visual acuity.

Inclusion criteria: Cooperative case, clear cornea, post-phaco residual mistakes of refraction, normal fundus examination, no other ocular pathology, normal intraocular pressure, and normal Pentacam examination with central corneal thickness and keratometric readings safe enough to obtain a residual stromal thickness greater than 300 microns after LASIK , and keratometric readings greater than 35.0 D in the flat meridian after-LASIK, the time elapsed post phaco surgery is more than 6 weeks and stable refraction.

Exclusion criteria: corneal scarring, abnormal fundus examination, glaucoma, other operative or post-operative complications of phaco surgery, decentered IOL, other ocular pathology, autoimmune or collagen diseases, uncooperative patient, abnormal Pentacam examination, least corneal thickness less than 500 microns, if the thinnest corneal thickness calculated after LASIK is less than 300 microns, or if the predicted post-LASIK flat meridian is less than 35 D, if the time elapsed after phaco surgery is less than 6 weeks and if the refraction was still unstable.

Pre-surgery, each patient was knowledgeable about the procedure's nature as well as any potential complications. Each patient signed an informed written consent form. An informed written consent was signed by each patient. Mean time elapsed between phaco and LASIK surgeries + SD was 8.66 + 2.11 Weeks (Range: 6 – 24 weeks).

After using povidone iodine to sterilize the periocular region, surgery was conducted, and a plastic drape was placed. Before surgery, benoxinate hydrochloride (0.4%) was administered to the conjunctival sac three times with a one-minute gap between each application for anesthesia. The globed was then exposed using a wire speculum.

In all cases microkeratome (Moria II microkeratome) was used to procedure a lamellar hinged superior flap (110 microns) .

After forming of the flap, the excimer-Laser WaveLight EX500 was used to concentrate the laser on the corneal stroma and the activated eye tracker was utilized to centre the laser on the pupil. The flap was boosted, and the ablation was focused in 6.5 mm treatment zone on the dry stromal bed. The flap was then relocated, and stable saline solution was used to irrigate the interface. A flow of air was then used to dry the cornea. Slit lamp assessment was done immediately after operatively to exclude flap wrinkles nd confirm proper flap reposition.

Following surgery, patients were prescribed topical 0.3 percent tobramycin/0.1 percent dexamethasone eye drops (4 times/day for 7 days), as well as topical (2 mg/ml) sodium hyaluronate eye drops (4 times/ day for 6 weeks).

Statistical calculations: Collected results were reviewed, coded, and placed into the statistical program. Quantitative non-parametric as median with inter-quartile

range (IQR), meanwhile parametric data was represented as mean, ranges and standard deviations. Percentiles was used to assess the distribution of some parameters. Qualitative variables were represented as number and percentages. In qualitative data Fisher exact and/or Chi-square test were used in comparing groups when the expected count in any cell found < 5. Independent t-test was used to compare between two independent groups with quantitative data and parametric distribution. The p-value was considered non-significant (P > 0.05), significant (P< 0.05), and highly significant (P < 0.01)).

3. Results

This study included 12 eyes in 12 patients [5 (41.7%) females and 7 (58.3%) males]. Their age was 59.75 ± 5.31years (Range: 51 – 68 years). Right eye was reported in 4 cases (33.3%), while left eye was reported in 8 cases (66.7%). They were subjected to phaco surgeries at different hospitals and were referred for LASIK correction of residual errors of refraction .

Mean time elapsed between phaco and Lasik surgeries ± SD was 8.66 ± 2.11 weeks (Range: 6 –24 Weeks).

Figure (1): Moria II Microkeratome.

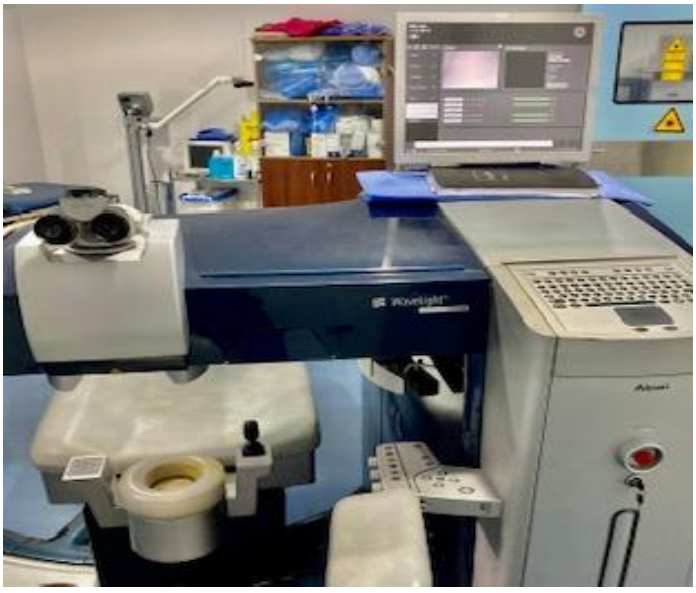

Figure (2): Excimer-Laser WaveLight EX500.

Table (1): Means of age of patients and the time elapsed between phaco and Lasik surgeries.

	Age (Year)	Time Elapsed Between Phaco and Lasik Surgeries (Weeks)
Mean ± SD	59.75 ± 5.31	8.66 ± 2.11
Range	(51 – 68)	(6 - 24)

Table (2): Sex of patients and laterality of affected eyes.

Sex		Laterality	
Males	7 (58.3%)	OD	4 (33.3%)
Females	5 (41.7%)	OS	8 (66.7%)

Table (3): Means of UCVA, spherical equivalent, BCVA, keratometric readings, thinnest corneal location and tissue ablation during LASIK surgeries

	UCVA	Spherical Equivalent (D)	BCVA	K1 (D)	K2 (D)	Thinnest Location (Microns)	Tissue Ablation (Microns)
Mean ± SD	0.46 ± 1.46	-1.21 + 0.23	0.92 ± 1.12	41.83 ± 0.73	43.13 ± 1.04	557.9 ± 23.8	29.16 ± 7.62
Range	(0.3 – 0.6)	(+1.75 - 2.25)	(0.7 – 1.2)	(40.39 – 43.72)	(41.08 – 45.10)	(526 - 601)	(18 – 39)

Table (4): Means, ranges and statistical relations between pre- and post-LASIK surgeries for UCVA, spherical equivalent and BCVA

		UCVA	Spherical Equivalent (D)	BCVA
Pre-LASIK	**Mean ± SD Range**	0.46 ± 1.46 (0.3 – 0.6)	-1.21 + 0.23 (+1.75 - -2.25)	0.92 ± 1.12 (0.7 – 1.2)
1 Day post-LASIK	**Mean ± SD Range, P-value**	0.86 ± 0.17 (0.6 – 1.2), P = 0.01 (Sig.)	-0.19 ± 0.06 (0.00 – 0.50), P = 0.03 (Sig.)	Not reported
1 Week post-LASIK	**Mean ± SD Range, P-value**	0.89 ± 0.16 (0.8 – 1.2), P = 0.02 (Sig.)	-0.14 ± 0.08 (0.00 – 0.50), P = 0.02 (Sig.)	0.96 ± 0.21 (0.9 – 1.2), P = 0.51 (non-Sig.)
1 Month post-LASIK	**Mean ± SD Range, P-value**	0.87 ± 0.18 (0.8 – 1.2), P = 0.01 (Sig.)	-0.15 ± 0.11 (0.00 – -0.75), P = 0.02 (Sig.)	0.94 ± 0.24 (0.9 – 1.2), P = 0.36 (non-Sig.)

Mean ± SD of UCVA before LASIK surgery was 0.46 ± 1.46 (Range: 0.3 – 0.6). Eight eyes (66.6%) were diagnosed as compound myopic astigmatism, two eyes (16.7%) had simple myopic astigmatism, and two eyes (16.7%) had mixed astigmatism. Mean ± SD of the spherical equivalent of all cases was -1.21 D ± 0.23 (Range: +1.75 – -2.25). Mean ± SD of the spherical equivalent of cases with post-phaco myopia or compound myopic astigmatism was -1.44 ± 0.18 D (Range: -0.75 – -2.25) .

Mean ± SD of BCVA before LASIK surgery was 0.92 ± 1.12 (Range: 0.7 – 1.2) . Mean K1 ± SD before LASIK was D 41.83 ± 0.73 (Range: 40.39 – 43.72 D). Mean K2 ± SD before LASIK was 43.13 ± 1.04 D (Range: 41.08 – 45.10 D). Mean Thinnest Corneal location before LASIK± SD was

557.9 ± 23.8 microns (Range: 526 – 601). Mean tissue ablation during LASIK surgeries was 29.16 ± 7.62 microns (Range: 18 – 39 microns).

At one day post LASIK surgery, UCVA as mean ± SD: 0.86 ± 0.17 (Range:0.6 – 1.2), and spherical equivalent was - 0.19 ± 0.06 (Range: 0.00 – 0.50).

One week post LASIK surgery, UCVA as mean ± SD was 0.89 ± 0.16 (Range: 0.8 – 1.2), spherical equivalent was - 0.14 ± 0.08 (Range: 0.00 – 0.50), and BCVA was 0.96 ±0.21 (Range: 0.9 – 1.2). One month after LASIK surgery, UCVA was 0.87 ± 0.18 (Range: 0.8 – 1.2), spherical equivalent was -0.15 ± 0.11 D (Range: 0.00 – -0.75 D), and BCVA was 0.94 ± 0.24 (Range: 0.9 – 1.2).

At 1 day, 1 week, and 1 month, there were significant changes between pre- and post-LASIK UCVA (P = 0.01, 0.02 and 0.01 respectively). Besides, significant changes between pre- and post-LASIK mean spherical equivalent (P = 0.03, 0.02 and 0.02 respectively) was found. While the differences between pre- and post-LASIK BCVA at 1 week and 1 month were statistically non-significant (P = 0.51 and 0.36). At the end of the follow up time, all cases had spherical equivalent equal to or less than ± 0.75 D, UCVA equal to 0.8 or better, and BCVA equal to 0.9 or better.

Few small subconjunctival hematomata were reported at the end of LASIK surgery in 5 cases (41.67%). Foreign body eye sensation was reported in all cases after LASIK surgery and complete resolution was reported in all cases at one month after LASIK surgeries. Other symptoms of post-LASIK dry eye were also reported in all cases (100%) and were persistent in 10 cases (83.33%) at the follow up visit of one month postoperatively. Halos and glare were reported in 8 cases (66.67%) and persisted in 5 cases (41.67%) till the follow up visit at one month after LASIK surgery. No other LASIK complications were reported in the study.

4. Discussion

As cataract is a main cause of curable blindness, cataract operation has become the most common intraocular procedure performed all around the world, most of ophthalmologists prefer phacoemulsification to other technique. Phacoemulsification includes the fragmentation of cataractous lens via ultrasonic probe, after that aspiration and irrigation of lens fragments Kaur [12].

With the introduction of a number of innovative IOL formulas, several studies made an effort to assess which IOL power calculation formula best predicts the definite after operative refractive results Soyoung [3].

Anticipations for the refractory results post cataract surgery are increasing. Surgical techniques, precise biometry, and new formulas for calculation intraocular lens power have improved the control for a better refractive outcome Fontes [13].

Melles [14] reported a multi-center retrospective research done on 18501 patients who were subjected to phaco surgeries. They reported that 81% and 98% of eyes were within ±0.50 D and ±1.00 D of predicted refraction, respectively.

Many intraocular lens (IOL) formulas have been used to assess the IOL for patients undergoing cataract surgery including Haigis, HofferQ, SRK/T, and Holladay1 Connell [15]. In an effort to enhance the precision of refractive outcome after cataract surgeries, frequent recent formulas have been brought together including Barrett Universal II, Holladay2, Kane, Olsen, and Hill-RBF Darcy [16].

Causes of post-cataract surgery refractive errors are numerous. El-Nafees [17] reported that eyes have axial lengths longer or shorter than the normal range typically experience a high rate of refractive error post cataract surgery. Kelly [18] reported other factors including, data entry error, poor patient cooperation, in addition to misplacement of the wrong lens into the wrong eye.

Patients with previous refractive surgery, may experience post-cataract surgery errors of refraction in the form of under-correction, thus yielding significant hyperopic error Speicher [19]. According to Odenthal [20] there are many causes for defects that may arise when calculate IOL power in cases with previous refractive surgery including an instrument defect when keratometric levels measure, as the anterior surface of the cornea flattens post kerato-refractive operation, corneal topography and conventional keratometry offer inappropriate corneal power values with a tendency to overestimate corneal power. Byeong [21] reported that the corneal refraction index is changed after refractive surgeries, leading to post-cataract surgery refractive errors**.**

There are many options for management of post-phaco residual refractive errors. Schallhorn [11] recommended the use of glasses as a first option, for patients who are accepting to use glasses. They also recommended contact lenses for cases of high astigmatism, anisometropia, or in patients habituated to wearing contact lenses. They added that any further operation conveys the hazard of loss of best corrected visual sharpness, infection, and complications associated with general anesthesia and these hazards are every so often more than in the initial cataract surgery.

According to Fernández [7], to do IOL exchange, the implanted IOL must be identified, and the second surgery should be performed on the same IOL platform. The exchange is technically simple to perform in early post-operative period. They reported that exchange is recommended if the refractive defects is greater than 1 D, because other procedures like corneal refractive surgery are more accurate in correcting smaller degrees of refractive error.

Stephenson [22] found that IOL repositioning, or rotation is the best alternative for patients with residual cylinder error after toric IOL placement. In cases where during surgery the IOL was placed in an improper position; rotation is indicated.

A piggyback IOL is ideal for cases having a hyperopic outcome, particularly if the IOL power is unknown Fernández [7]. They reported that it is additionally an option to IOL exchange if the procedure would be of high risk, like in cases of posterior capsule tears. The primary IOL must be fully in the capsular bag and the anterior chamber should be deep with an open angle to allow for necessary space for the secondary IOL. This technique is accompanied with higher risks of mechanical complications such as uveitis and glaucoma.

Stephenson [22] reported that LASIK surgery is a safe procedure to correct post-cataract surgery residual errors of refraction. It is recommended that LASIK be delayed 3 months post cataract surgery to permit incisional and refractive stability. Once manifest refraction is stable PRK may be pursued. It is ideally performed in errors less than 2 diopters particularly if associated with residual astigmatism, and the patient is free from LASIK contraindications.

In our study, 12 eyes in 12 patients were included, 7 males, and 5 females. Their mean age was 59.75 Patients were subjected to phaco surgeries and were presented with residual errors of refraction and were referred for LASIK correction. Mean time elapsed between phaco and Lasik surgeries was 8.66 weeks (Range: 6 - 24 Weeks). Stephenson [22] recommended that correction of residual errors by LASIK surgery is preferred to be done at least 3 months post phaco surgery to allow for incisional and refractive stability. In our study, we did LASIK surgery after stabilization of refractive error. We did not observe any drawbacks in performing LASIK at 6 weeks or more after the phaco surgery, which was enough period to get stability of the small phaco incisions.

In our study, statistically substantial differences were observed between mean

pre- and post-LASIK UCVA, mean spherical equivalent, while the difference between pre- and post-LASIK BCVA was statistically non-significant. By the end of the follow up period, all cases had spherical equivalent equal or less than ±0.75 D, UCVA 0.8 or better, and BCVA 0.9 or better. These results are in agreement with a study reported by Fernández [7]. They reported in their study that 92.85% of eyes achieved a final spherical equivalent (SE) within ± 0.50 D and 100% of eyes within ± 1.00 D after LASIK surgery for the correction of residual error after cataract surgery by LASIK.

In our study, few small subconjunctival hematomata were reported at the end of LASIK surgery in 5 cases (%). No other intraoperative complications were reported. Post-LASIK dry eye symptoms were reported in all cases (100%) and were persistent till the follow up visits one month postoperatively in 10 cases (83.33%). Halos and glare were reports in 8 cases (66.67%), which persisted till the follow up visit at one month after LASIK surgery in 5 cases (41.67%). Foreign body eye sensation was reported in all cases after LASIK surgery and complete resolution was reported in all cases at one month after LASIK surgeries. These results agree with Azar [23], who reported hazy vision, difficulty with night vision, glare, halos, light sensitivity, discomfort and small subconjunctival hematomata.

No serious complications were reported in our study, which is consistent with what had been found by Fernández [7], who reported that LASIK is a predictable, stable, effective and safe surgical procedure to correct myopia and myopic astigmatism.

5. Conclusion

LASIK surgery is effective, safe, accurate and with good predictability for correction of residual errors of refraction after phaco surgery. There is significant improvement of UCVA and the spherical equivalent refraction after LASIK correction in these cases. Interval of six weeks to be elapsed between phaco and LASIK surgeries is safe and enough.

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