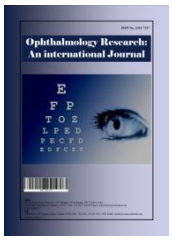

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Correction of Pre-Existing Astigmatism with Phacoemulsification Using Spherical Intraocular Lens and Wave front Guided Surface Ablation: A Retrospective Case Series

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Case Study

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ABSTRACT

Objective: To evaluate safety and efficacy of using spherical intraocular lens followed by wavefront guided surface ablation in correction of preexisting regular corneal astigmatism.
Methods: This retrospective case series study included 20 eyes of 16 patients having visually significant cataracts and co-existing regular corneal astigmatism. The patients underwent phacoemulsification with spherical intraocular lens and wavefront guided PRK three months later.
Results: There was a statistically significant difference for Uncorrected Visual Acuity UCVA, Best Corrected Visual Acuity BCVA, Manifest Refraction Spherical Equivalent MRSE, and refractive astigmatism postoperatively regarding all these parameters ($P<0.05$).
Conclusion: Astigmatism correction during or even after cataract surgery is a safe and effective method to improve visual outcomes. Longer period of follow up are required to evaluate stability of this technique and possibility of regression.

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Keywords: Astigmatism; phacoemulsification; spherical intraocular lens; wave front guided surface ablation.

1. INTRODUCTION

Phacoemulsification has rapidly become one of the most widely performed surgeries in the world. However, preexisting regular corneal astigmatism often result in some degree of residual refractive error [1]. It is reported that around 70% of the general population with cataract has at least 1diopter (D) of astigmatism, and around 33% of cases undergoing cataract surgery can be treated of preexisting astigmatism [2]. These findings imply that, while planning a surgery, we should care about both the spherical and the astigmatic components to get post-operative outcomes close to emmetropia as far as possible. Moreover, the most critical factor in dealing with the astigmatism is to check the exact source, axis and magnitude of the astigmatism and to make the decision about the appropriate technique for each patient [3].

In the past, the aim of cataract surgery was just restorative to remove a cloudy lens usually with the help of glasses post-operatively [4]. A modern era of cataract surgery aims to obtain the most preferable refractive outcomes for the cases and decrease any need for other corrections [4]. Phacoemulsification could eliminate the lenticular astigmatism part. For the elimination of the corneal part, the surgeon should assess the meridian and amount of corneal astigmatism [5]. Another issue is the surgically induced astigmatism (SIA) that can be produced by cataract incisions. SIA should not be neglected, especially in case of low pre-existing astigmatism. That is why it can now be considered as “refractive cataract surgery” [5]. Refractive cataract surgery has been designed for a more aggressive aim; to enable cataract cases to regain better vision and to eliminate or reduce the need for more corrections greatly, including the reading glasses following surgery [5]. Therefore, we aimed to evaluate using of spherical intraocular lens followed by wavefront guided surface ablation.

2. PATIENTS AND METHODS

This retrospective case series clinical study included 20 eyes of 16 patients who attended outpatient ophthalmology clinics in our University hospitals during 2017 and 2018 with visually significant cataracts indicated for phacoemulsification and co-existing regular astigmatism. We included patients diagnosed with visually significant cataracts and regular astigmatism between 1 to 4 D and completed follow-up. Exclusion criteria were the presence of any concurrent eye conditions that can affect the outcome of visual acuity as corneal scar, irregular astigmatism, glaucoma, chronic intraocular inflammations, lens sublaxation, posterior segment abnormalities, and previous refractive procedures. The patients had phacoemulsification with spherical intraocular lens and wavefront guided PRK three months later.

Data included history taking for age, sex, any systemic or topical medications, and history of any previous ophthalmic disease or surgery. In addition, we collected the data of uncorrected visual acuity (UCVA) and best-corrected visual acuity (BCVA) using Snellen Chart, then visual acuity was converted to Log MAR for statistical analysis, manifest Refraction if possible according to density of cataract, intraocular pressure (IOP) measurement using Goldman applanation tonometer and sterile fluorescein strips, anterior segment slit lamp examination, tear film to exclude dry eye syndrome, cornea to exclude scars and any other clinically detectable abnormalities, and lens to grade opacification and exclude sublaxation. Moreover, fundus examination, biometry to calculate IOL power using Zeiss IOL Master 500 Device was done.

The patients were prepared for the technique using topical antibiotics (Moxifloxacin hydrochloride 0.5%, Vigamox, Alcon, USA) 4 times daily 3 days before operation, topical Non-Steroidal anti-inflammatory drugs NSAID and pupillary dilators (Mydrapid 1%, Alexandria, Egypt). The slit lamp was used to mark the principal meridians (0,180 and 270 axes) using a hand held ink marker in all patients. The technique was carried out under aseptic conditions in the operating room with an operating microscope. Local anesthesia in the form of topical and peribulbar blocks as lidocaine solution was used. Topical application of 10% povidone-iodine (Betadine, Nile/Mundi) for periocular area, lids and eyelashes was done before any procedure. The patient was draped completely and an eyelid speculum was used. Drops of 5% povidone-iodine (Betadine, Nile/Mundi) were instilled into the conjunctival sac for 2 to 3 minutes and then washed by sterile

normal saline. The site of main wound was marked on the steep axis defined by preoperative biometry depending on the previous main meridians marked on the slit lamp preoperatively using a holed Mendez ring marker. Procedure started with making a side port entry and injecting viscoelastic in the anterior chamber. It was made in clear cornea with 20 G MVR blade. The side port should measure about 1 mm and run parallel to iris plane. After supporting the globe by placing a toothed forceps outside limbus opposite to the site of making side port and Anterior Chamber (AC) was entered with MVR blade. On the steepest previously marked axis, the main wound was done using 2.4 mm keratome that was pushed into the depth of the wound and angled forward into the layers of the cornea for about 1.5mm. Direction of keratome was forward and upward following the curve of cornea. Then the direction of keratome was changed downward to cut the Descemet's membrane and penetrate into the A.C. Standard phacoemulsification was performed. The same foldable hydrophilic acrylic Intraocular Lens (IOL) (Ocuflex,India) was implanted inside the bag. Meticulous removal of any viscoelastic materials and hydration of the main incision and side port by using balanced saline solution (BSS). The surgeons who performed operations and the authors of this study were the same.

Postoperative treatment included topical antibiotic eyedrops (Moxifloxacin hydrochloride 0.5%, Vigamox, Alcon, USA) five times daily and topical corticosteroids eyedrops (Prednisoline acetate, Econopred plus 1%, Alcon, USA) every two hours for the first day then tapered over one month. The patients were examined for follow up at one day then three days, one week, one month and three months after the operation.

Our patients were prepared for wavefront guided surface ablation by topical antibiotic (Vigamox) was applied 2 days before the procedure and topical anesthesia (Benox) was added frequently at the start then periocular area was sterilized by topical application of 10% povidone-iodine (Betadine, Nile/Mundi) for periocular area, lids and eyelashes before any procedure. Then, draped completely and an eyelid speculum was used to stabilize the eyelids. Mechanical removal of central 9 mm of epithelium using a hockey knife guided by 9 mm ring print was performed. Activation of pupil and iris registered tracking system was done. After centration was done, Excimer laser photoablation using (Star S4 IR Excimer laser, Amo internationals, USA). Mitomycin C (MMC) 0.05% was applied for 20-30 seconds. Copious irrigation used for at least 30 cmm of Balanced saline solution (BSS). A bandage soft contact lens was applied at the end of procedure Postoperative topical antibiotic eyedrops (Moxifloxacin hydrochloride 0.5%, Vigamox, Alcon, USA) five times daily, topical corticosteroids eyedrops (Prednisoline acetate, Econopred plus 1%, Alcon, USA) every two hours for the first day then tapered over one month, topical cycloplegia three times for five days to decrease postoperative pain and any preservative free lubricants for six weeks. The patients were examined for follow up till three months after the operation.

Statistical description and analysis of the present study was conducted using the mean, standard deviation, and range for descriptive statistics, T-test, Mann-Whitney test and Wilcoxon Signed Ranks test for inferential statistics by SPSS V.18 Software (SPSS Inc., Chicago, IL).

3. RESULTS

In this study, it was found that the range of age was from 42 to 60 years with a mean value of 50.60±5.10 years. As regard the sex, our study included 16 patients (9 females and 7 males). Regarding laterality, our study included (10 right and 10 left) According to this study, it was found that the range of biometry cylinder was 1.55 to 3.64 D with a mean value of 2.74±0.61 D.

Post operatively, there was a statistically significant difference for UCVA, BCVA, MRSE, and refractive astigmatism ($P<0.05$, Table 1).

There was a significant improvement in UCVA by log MAR as it improved from 1±0.42 (0.52:2) preoperatively to 0.114±0.056 (0.046:0.22) postoperatively ($p <0.001$). Also there was a significant improvement in BCVA by log MAR as it improved from 0.43±0.15 (0.22:0.7) preoperatively to 0.06±0.04 (0:0.16) postoperatively ($p <0.001$). There was a significant reduction in MRSE as it changed from -2.8±3.5 (-8:6) preoperatively to -0.18±0.35 (-1:0.25) postoperatively (0.008). There was a marked significant reduction in refractive astigmatism as it changed from 3±0.8 (1.75:4.5) preoperatively to 0.4±0.15 (0.25:0.75) postoperatively ($p <0.001$). Vector analysis is shown in (Table 2). For Absolute angle of error, there was a significant improvement.

Table 1. Shows the preoperative and postoperative changes in our study

Parameters	Preoperative	Postoperative	P-value
UCVA	1±0.42(0.52:2)	0.114±0.056(0.046:0.22)	<0.0001*
BCVA	0.43±0.15(0.22:0.7)	0.06±0.04(0:0.16)	<0.0001*
MRSE	-2.8±3.5(-8:6)	-0.18±0.35(-1:0.25)	0.008*
Refractive Astigmatism	3±0.8(1.75:4.5)	0.4±0.15(0.25:0.75)	<0.00001*

NB: P-value was calculated using Wilcoxon Signed Ranks Test
Significant P –value (*) should be <0.05

Table 2. Vector analysis of our study using alpins data analysis

Parameter		
Target induced Astigmatism (TIA)		3.03 ± 0.79D (1.75:4.5)
	Mean vector	1.21 axis 179
Surgical induced Astigmatism (SIA)		2.9±0.88 D (1.5:4.6)
	Mean vector	0.84 axis 0
Difference Vector (DV)		0.4±0.15 (0.25:0.75)
	Mean vector	0.37 axis 177
Magnitude of Error (ME)	+ =overcorrection - = undercorrection	-0.13±0.34 D (-0.73:0.48)
Correction Index (CI)	1 means ideal	0.95 D (0.67:1.23)
Angle of error (AE) by degrees		0.5 ±2.6 (-2.7:7.20)
Absolute AE by degrees		1.86 ±1.78 (0:7.20)
Torque Effect(TE)		0.02 ± 0.24 (-0.3:0.5)
Flattening Effect(FE)		2.89 ± 0.83 (1.5:4.59)
Index Of Success(IOS)		0.13± 0.07 (0.07:0.33)
Percentage of success		85.9% (66.7:92.8%)

As regard complications: no recorded cases of wound leakage, IOL decentration and endophthalmitis. There were 3 eyes that developed corneal edema that was reversible with medical treatment, only one eye developed postoperative AC reactions immediately postoperative that was reversible with medical treatments and 5 eyes that developed dry eye and needed long lasting lubricants.

4. DISCUSSION

There are multiple techniques to deal with the pre-existing astigmatism intraoperatively including the creation of a clear corneal phacoemulsification incision on the astigmatism steep axis, opposite clear corneal incisions (OCCIs), limbal relaxing incisions (LRIs), single or paired peripheral corneal relaxing incisions (CRIs) and correction with toric intraocular lenses or postoperatively by using Excimer laser vision correction [1]. In our study, we concentrated on customized photorefractive keratectomy (PRK) post phacoemulsification (two steps surgery). Ritu Nagpal et al. reported that 96.6% (29/30) of PRK eyes had residual refractive cylinder < 0.5 D. None of the patients had residual cylinder >

0.75 D. The spherical equivalent value was < 0.5 D in 93.3% (28/30) of PRK eyes [6]. Also UDVA ≥ 20/20 (6/6) was seen in 60% (18/30) of PRK eyes [6]. In our study, we found that 95% (19/20) of PRK eyes had residual refractive cylinder < 0.5 D. The spherical equivalent value was < 0.5 D 85% (17/20) of PRK eyes. Also UDVA ≥ 20/20 (6/6) was seen in 60% (12/20) of PRK eyes.

In customized photorefractive keratectomy, Excimer laser is used to correct residual errors guided by wavefront aberrations analysis done before the procedure Excimer procedures may be predictable in correcting refractive errors of lower amplitude showed in most patients. By using wavefront guided ablation, high order aberrations as well as possibility of decentration were eliminated. Sáles et al provided a review of the available literature for different approaches to deal with the post-cataract refractive errors such as, arcuate keratotomy, corneal excimer laser procedures (LASIK or PRK) and intraocular approaches, such as piggyback IOLs, IOL exchange, and light-adjustable IOLs. He showed that laser vision correction resulted in more effective and predictable outcomes compared to intraocular surgery in addition to avoiding potential risks for intraocular surgery [7]. Fernández-Buenaga et al. reported a retrospective study including patients with an unacceptable final refractive error following phacoemulsification. The study compared intraocular approach with IOL exchange and piggyback lens and LASIK. Although all of the three procedures appeared to be effective, the LASIK reported the best outcome regarding efficacy and predictability [8].

Jin et al compared both LASIK and lens-based surgery for correcting residual refractive error following cataract surgery on 28 eyes and showed that both procedures can be considered as effective, safe, and predictable procedures [9]. Alio et al. reported that laser vision correction may give more effective predictable outcomes compared to intraocular surgery. On a theoretical basis, piggyback IOLs and IOL exchange may be superior compared to surface treatments, but even with standardization and consideration as safe, the intraocular procedures result in potential risks for severe complications such as capsular rupture and endophthalmitis. Consequently, the excimer laser ablation is more desirable to avoid such dramatic complications with good refractive in addition to clinical outcome [10]. Aragona et al reported that PRK can be regarded as a safe and effective procedure to correct residual refractive errors following cataract providing the cases with their attempted visual acuity. Furthermore, it showed to be stable in the long term, resulting in more effective and predictable outcome compared to intraocular surgery [11]. In our study, there was improvement in UCVA, BCVA, MRSE, and reduction of refractive astigmatism as mean astigmatism changed from 3 ± 0.8D (1.75:4.5) preoperatively to 0.4 ± 0.15 D (0.25:0.75) postoperatively. Disadvantages of this method include postoperative pain, the possibility of haze formation and dry eye syndrome.

In our study, there were 3 eyes that developed corneal edema that was reversible with medical treatment, only one eye developed postoperative AC reactions immediately postoperative that was reversible with medical treatments and 5 eyes that developed dry eye and needed long lasting lubricants. In our study, there were no recorded cases of haze formation and endophthalmitis.

Bioptics means using excimer laser ablation after phacoemulsification (Two stages procedure) Bioptics is a useful and more predictable procedure in management of mild to moderate preexisting or even residual astigmatism.

PRK is safer than LASIK that induces more severe and persistent damage to corneal sensation, corneal barrier function, and tear film stability than PRK.

Wavefront-guided PRK with iris registration can be used to compensate for eye rotation, cyclotorsion, and pupillary centroid shift to improve outcomes.

Bioptics carries the risks of two procedures. The risks of IOL surgery as endophthalmitis as well as those of corneal refractive surgery, which include infection, irregular astigmatism, dry eye, and keratectasia as well as subjective complaints of halos, glare, and ghost images.

5. CONCLUSION

Correction of preexisting astigmatism during cataract surgery should be in mind in every case to improve visual outcome. Corneal topography should be done routinely preoperatively to exclude any occult corneal abnormalities and define the exact power and meridian of corneal astigmatism and correlate them with other refractive data. Longer period of follow up are required to evaluate stability of this technique and possibility of regression.

CONSENT

Informed consent for operations was obtained after discussing extensively with each patient about the benefits, risks, possible side effects of the procedure.

ETHICAL APPROVAL

All procedures performed in studies involving human participants were in accordance with the ethical standards of Tanta Faculty of Medicine ethics committee and with the 1964 Helsinki declaration and its later amendments. The ethical approval was obtained from the ethics committee of Tanta Faculty of Medicine, Tanta, Egypt.

AVAILABILITY OF DATA AND MATERIAL

The data used to support the findings of this study are available from the corresponding author upon request.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Abdelghany AA, Alio JL. Surgical options for correction of refractive error following cataract surgery. Eye and Vision. 2014; 1(1):1-7.
2. Xu L, Zheng D. Investigation of corneal astigmatism in phacoemulsification surgery candidates with cataract. [Zhonghua yan ke za zhi] Chinese Journal of Ophthalmology. 2010;46(12):1090-1094.
3. Amesbury EC, Miller KM. Correction of astigmatism at the time of cataract surgery. Current Opinion in Ophthalmology. 2009;20(1):19-24.
4. Rucker CW. Cataract: A historical perspective. Invest Ophthalmol. 1965;4: 377-383.
5. Nichamin LD. Treating astigmatism at the time of cataract surgery. Current opinIon in Ophthalmology. 2003;14(1):35-38.
6. Nagpal R, Sharma N, Vasavada V, et al. Toric intraocular lens versus monofocal intraocular lens implantation and photorefractive keratectomy: A randomized controlled trial. American Journal of Ophthalmology. 2015;160(3):479-486. e472.
7. Sáles CS, Manche EE. Managing residual refractive error after cataract surgery. Journal of Cataract & Refractive Surgery. 2015;41(6):1289-1299.
8. Fernández-Buenaga R, Alió JL, Perez Ardoy AL, Quesada AL, Cortés LP, Barraquer RI. Resolving refractive error after cataract surgery: IOL exchange, piggyback lens, or LASIK. Journal of Refractive Surgery. 2013;29(10):676-683.
9. Jin GJ, Merkley KH, Crandall AS, Jones YJ. Laser in situ keratomileusis versus lens-based surgery for correcting residual refractive error after cataract surgery. Journal of Cataract & Refractive Surgery. 2008;34(4):562-569.
10. Alio JL, Abdelghany AA, Fernández-Buenaga R. Management of residual refractive error after cataract surgery. Current Opinion in Ophthalmology. 2014;25(4):291-297.
11. Roszkowska AM, Urso M, Signorino GA, Spadea L, Aragona P. Photorefractive keratectomy after cataract surgery in uncommon cases: Long-term results. International Journal of Ophthalmology. 2018;11(4):612.

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