Best corrected visual acuity versus overcorrected visual acuity by LASIK in correction of Exotropia

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Abstract---The presence of myopia may be associated with a decreased demand for accommodation and hence lower convergence. This may predispose to an increased risk of developing exotropia. The study was conducted on myopic patients with extropia to compare the effect of myopic LASIK overcorrection versus myopic LASIK with optimum correction on the deviation degree of exotropia. This study was performed on 60 myopic patients with extropia. Patients were randomly allocated in two equal groups; group A operated by Lasik with optimum correction and group B operated by Lasik with overcorrection by -0.75. Patients were followed up one day, one week, one month and three months after surgery at each time for UCVA, manifest refraction, BSCVA, and degree of exophoria. There was a statistically significant decrease of the angle in patients underwent overcorrection (15.56±8.00) compared to patients underwent optimal correction (30.50±12.06) (P-value). This finding means that myopic refractive error overcorrection may help to improve control and alignment in intermittent exotropia. Myopic overcorrection in patients with intermittent exotropia was associated with significant improvement in the intermittent exotropia as compared with optimum correction.

Keywords---exotropia, lasi, lasik, myopia, visual acuity.
Introduction

Intermittent exotropia is the most prevalent kind of exodeviation and is often initially seen by parents in early infancy as a kid drifting out of one eye spontaneously, most often when the child is sleepy, sick, or daydreaming. Adult patients may manifest exodeviation after consuming alcoholic beverages or taking sedatives (Kaur et al., 2021). In addition to interplay between the convergence and divergence mechanisms, refractive errors may further modify the innervational pattern that influences the position of the eyes (Elkamshoushy et al., 2020). In a patient with uncorrected myopia, less than normal accommodative effort is required during near vision thus causing decreased accommodative convergence (Kaur et al., 2021). According to Donders, this constant under-stimulation of convergence may cause an exodeviation to develop (Pallikaris et al., 2015). Refractive surgery in patients with strabismus may carry a greater risk than in the normal population (Mehta et al., 2020). The risk of decompensation of strabismus and the development of diplopia are feared complications (Sharma et al., 2018). However, successful outcomes following refractive surgery in these patients have been reported (Godts et al., 2006). Diplopia and strabismus have been reported as complications after refractive surgery 1, cautioning the ophthalmologists to include an orthoptic examination in the preoperative evaluation and to define patients at risk (Ospina et al., 2018). Myopic exotropia in anisometropia have been proposed as a separate indication for refractive surgery (Garcia et al., 2019). The study was conducted on myopic patients with extropia to compare the effect of myopic LASIK overcorrection versus myopic LASIK with optimum correction on the deviation degree of exotropia.

Material and Methods

This is a randomized interventional study performed on 60 patients with exotropia and myopia. It was performed in a private hospital at Beni-suef Government during the period between April 2020 to March 2021 after the approval from the local research and ethical committee was obtained. Written informed consent was obtained from each patient prior to the surgical procedure and the patients were randomly allocated into two equal groups. In group A: myopic Lasik was done with optimum correction. In group B: myopic lasik was done with over correction. Male and female patient between 18 and 50 years old with intermittent exotropia and myopia > -1.00, were included in the current study. Exclusion criteria include patients refusal, patients with any other ocular disease, any contraindications to LASIK as sever dryness, small corneal thickness....etc., and patients with any other types of strabismus.

Preoperatively, we explained the study to the patients; a complete ophthalmic examination was performed including Uncorrected Visual Acuity (UCVA), Best Corrected Visual Acuity (BCVA), manifest and cycloplegic refraction. Slit lamp biomicroscopy, applanation tonometry, and pentacam were performed to all patients before the operation. Measure the degree of exophoria with Hirshburg and krimisky tests. Emmetropia is the goal in all patients in group (A) and over correction by -0.75 degree in group (B). Topical anesthesia was used. Flap alignment marks were placed on the cornea using a marker coated with
methylene blue. Suction ring was used in all cases. The ring was positioned on the cornea; suction was activated and intraocular pressure was verified. Microkeratome head was used to create corneal flap. The flap was reflected superiorly to expose the stromal bed. Allegretto 500Hz laser platform (Wave Light, Erlangen Germany) was used for laser ablation. Care was taken to ensure that the stromal bed will be Patients and Methods 61 dry before and during the ablation and that the undersurface of the flap was protected from the laser ablation. Using a balanced salt solution to irrigate the interface; then the flap was replaced. Immediately after surgery adequate flap position was adjusted using the slit lamp.

Follow up Postoperative, patients were followed up 1 day, 1 week, 1 month and 3 months after surgery at each times UCVA, manifest refraction, BSCVA, and degree of exophoria. Statistical analysis was performed using SPSS v. 25 (Statistical Package for Social science) for Windows (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.) Description of quantitative variables was presented in the form of mean± standard deviation (SD), description of qualitative variables was presented in the form of numbers (No.) and percent’s (%). Independent T-test (for parametric data) was used to detect the difference between both groups regarding scale variables (Man Whitney U test for non-parametric data). Chi-Square test (fisher exact) was used to detect the difference between both groups regarding the categorical variables. Comparison between pre and postoperative scale parameters was done by paired T test for parametric data (Wilcoxon signed rank test for non-parametric data). P-value was considered statistically significant when ≤0.05.

Results

The study included 17 males (28.33%) and 43 females (71.67%), with an average age of 24.9 ±4.1 years old, regarding type of deviation; 6 patients showed manifest exotropia and 54 patients have intermittent exotropia with no statistically significant difference between both groups regarding their age and gender. There was no statistically significant difference between patients underwent overcorrection and patients underwent optimal correction regarding their preoperative spherical equivalent, UCVA and BCVA. There was no statistically significant difference between patients underwent overcorrection and patients underwent optimal correction regarding their preoperative angle of deviation.

Table (1) showed that there was a statistically significant increase of the postoperative spherical equivalent OD (0.53±0.15) and OS (0.63±0.16) in patients underwent overcorrection versus OD (0.017±0.06) and OS (0.042±0.09) in patients underwent optimal correction (P-value<0.001). Regarding the postoperative spherical equivalent OD and OS categories the Plano was prevalent only in patients underwent optimal correction. there was no statistically significant difference between patients underwent overcorrection and patients underwent optimal correction regarding their postoperative mean UCVA OD (P-value>0.05) but, postoperative mean UCVA OS was significantly higher in patients underwent optimal correction (0.88±0.14) compared to patients underwent overcorrection (0.78±0.22) (P-value=0.033). There was no statistically
significant difference between patients underwent overcorrection and patients underwent optimal correction regarding their postoperative BCVA OD and OS (P-value>0.05).

Table (2) showed that there was a statistically significant decrease of the angle in patients underwent overcorrection (15.56±8.00) compared to patients underwent optimal correction (30.50±12.06) (P-value<0.001). Figure (1) showed that there was a borderline statistically significant difference of the postoperative type of deviation between patients underwent overcorrection and patients underwent optimal correction (P-value=0.05). Ortho deviation was showed in three cases among the overcorrection group, while no cases showed ortho deviation in the Optimal correction group. Table (3) showed that there was significant increase of spherical equivalent OD and OS after the overcorrection technique. The angle after the overcorrection significantly decreased from 34.44 ±8.91 to 15.56 ±8.00 after the over correction (P-value<0.001). Table (13) showed that there was significant increase of spherical equivalent OD and OS after the optimal correction technique. The angle after the optimal correction significantly decreased from 34.50±11.62 to 30.50±12.06 after the optimal correction (P-value<0.001). The decrease of the angle was more significant in the overcorrection group.

Table 1
Postoperative spherical equivalent OD and OS of both studied groups

<table>
<thead>
<tr>
<th></th>
<th>Over correction group no=30</th>
<th>Optimal correction group no=30</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spherical Equivalent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OD</td>
<td>+ 0.53 ±0.15</td>
<td>+ 0.017 ±0.06</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>OS</td>
<td>+ 0.63 ±0.16</td>
<td>+ 0.042 ±0.09</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>UCVA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OD</td>
<td>0.81 ±0.19</td>
<td>0.88 ±0.16</td>
<td>0.179</td>
</tr>
<tr>
<td>OS</td>
<td>0.78 ±0.22</td>
<td>0.88 ±0.14</td>
<td>0.033*</td>
</tr>
<tr>
<td>BCVA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OD</td>
<td>0.86 ±0.15</td>
<td>0.88 ±0.16</td>
<td>0.618</td>
</tr>
<tr>
<td>OS</td>
<td>0.81 ±0.20</td>
<td>0.88 ±0.14</td>
<td>0.097</td>
</tr>
</tbody>
</table>

*P-value is significant

Table 2
Postoperative angle of both studied groups

<table>
<thead>
<tr>
<th></th>
<th>Over correction group no=30</th>
<th>Optimal correction group no=30</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle (Mean ±SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Categories</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Δ10</td>
<td>4 (13.3)</td>
<td>2 (6.7)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Δ 15</td>
<td>6 (20)</td>
<td>4 (13.3)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Δ 20</td>
<td>5 (16.7)</td>
<td>3 (10)</td>
<td></td>
</tr>
</tbody>
</table>
Table 3
Comparison between preoperative and postoperative parameters among the overcorrected group

<table>
<thead>
<tr>
<th></th>
<th>Over correction group no=30</th>
<th>Optimal correction group no=30</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preoperative</td>
<td>Postoperative</td>
<td>Preoperative</td>
</tr>
<tr>
<td>S.E OD</td>
<td>-4.90 ±2.3</td>
<td>+ 0.02 ±0.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>S.E OS</td>
<td>-4.78 ±1.9</td>
<td>+ 0.04 ±0.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BCVA OD</td>
<td>0.88 ±0.2</td>
<td>0.88 ±0.2</td>
<td>NA</td>
</tr>
<tr>
<td>BCVA OS</td>
<td>0.88 ±0.2</td>
<td>0.88 ±0.2</td>
<td>NA</td>
</tr>
<tr>
<td>Angle</td>
<td>34.50 ±11.6</td>
<td>30.50 ±12.1</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

S.E: spherical equivalent, BCVA: Best Corrected Visual Acuity
NA: not applicable (not calculated as it is the same before and after)
*P-value is significant

Discussion

Refractive surgery has been reported to cause both improvement and decompensation in extraocular alignment, with rare manifestation of diplopia.
One of the most commonly refractive errors is myopia which is usually associated with exodeviations (Zaidi et al., 2018). This study was conducted to compare the effect of myopic LASIK overcorrection and optimum correction on deviation degree in myopic patients with exotropia. In our study all the studied participants in both groups before LASIK had intermittent exotropia and myopia, after LASIK, there was a statistically significant decrease of the angle in patients underwent overcorrection (15.56±8.00) compared to patients underwent optimal correction (30.50±12.06) (P-value<0.001). This finding means that myopic refractive error overcorrection may help to improve control and alignment in intermittent exotropia. Our findings were in line with previously published studies.

Overcorrecting minus lenses have been used in patients with exotropia to increase accommodative convergence, with sometimes temporary and sometimes sustained improvement of extraocular alignment and fusion (Bayramlar et al., 2017). Our findings could be explained as the secondary hyperopia caused increased accommodative convergence and improved alignment, as in overcorrecting minus lens therapy. There is evidence that myopic patients with exotropia or intermittent exotropia may actually gain the accommodative stimulus required to maintain better control of their strabismus tendencies once their myopia is corrected (Mehta et al., 2020). Nemet et al., reported complete resolution of exotropia following Laser in situ Keratomileusis (LASIK) for myopic anisometropia. These patients had positive contact lens simulation 6. In another study, ocular alignment and binocular function remained unchanged postoperatively in all except two patients with high anisometropia who experienced an improvement in binocular function. In these patients, the preoperative manifest deviation became intermittent or latent after surgery, allowing fusion and stereopsis (Godts et al., 2006). However, in those two studies the correction was optimal correction.

Conclusions and Limitations

There are at least two limitations to this study. Firstly, we examined a relatively young group of patients, second, we could not access a lot of published research on the effect of LASIK overcorrection in myopic patients with intermittent exotropia to compare the results obtained from the current study, but despite this, the results of this study may be a starting point for other larger studies to prove that LASIK overcorrection could improve the intermittent exotropia in myopic patients. From the current study we concluded that, myopic overcorrection in patients with intermittent exotropia was associated with significant improvement in the intermittent exotropia as compared with optimum correction. We consider it advisable to perform an adequate orthoptic examination before and after refractive surgery even in patients with low to moderate myopia. The basic guideline is to perform a comprehensive strabismus evaluation in all heterophoric patients undergoing refractive surgery. Strabismus surgery if required can follow refractive stabilization and appropriate preoperative counseling should address both issues.
Acknowledgments

Disclosure

The author reports no conflicts of interest in this work.

Ethical considerations

Ethical approval was obtained from the Research ethical Committee at Faculty of Medicine, Beni-Suef University (The FM – BSU).
Ethical approval number: FMBSUREC/03052020/Ahmed.

Abbreviations

UCVA: Uncorrected visual acuity
BSCVA: Best corrected visual acuity
LASIK: Laser in situ Keratomileusis
OD: Oculus dexter (right eye)
OS: oculus sinister (left eye)
PRK: Photorefractive Keratectomy.

References