Effect of refractive surgery on binocular vision and ocular alignment in patients with manifest or intermittent strabismus

D Godts, R Trau, M-J Tassignon

Objective: To evaluate the effect of refractive surgery on binocular vision and ocular alignment in patients with manifest or intermittent strabismus, with or without vertical component.

Setting: University Hospital Antwerp, Edegem, Belgium.

Patients and methods: 13 patients (22 eyes) with strabismus underwent refractive surgery. Five of these patients presented with an esotropia and four of them with a small vertical deviation. Five patients had a manifest exotropia, of whom two presented with a small vertical deviation. Two patients had an intermittent exotropia with binocular vision, of whom one patient had a vertical deviation. One patient had a hypertropia with a dissociated vertical deviation.

Results: 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. Vertical deviation was found preoperatively in 8 of the 13 patients. This vertical deviation remained unchanged postoperatively, but improved in one patient with anisometropia.

Conclusion: Preoperative intermittent or manifest strabismus is not a contraindication for refractive surgery provided some specific recommendations are taken into account, such as an adequate preoperative orthoptic examination and aiming at emmetropia for both eyes.

Refractive surgery has become a common procedure for the correction of myopia, hyperopia, astigmatism and anisometropia. Depending on the amount and type of ametropia, different refractive procedures can be used. Diplopia and strabismus have been reported as complications after refractive surgery, cautioning the ophthalmologists to include an orthoptic examination in the preoperative evaluation and to define patients at risk. Recently, hyperopic accommodative strabismus and myopic exotropia in anisometropia have been proposed as a separate indication for refractive surgery.

Our study aimed to evaluate the effect or the benefit of refractive surgery on ocular alignment and binocular function in patients with preoperative intermittent or manifest strabismus.

MATERIALS AND METHODS

In 13 patients with strabismus, refractive surgery was performed on 22 eyes between January 2000 and May 2005. Of them, six patients were male and seven were female. The patient's age ranged between 24 and 68 years (mean 44.3 years). Patients seeking refractive surgery and having a medical history of strabismus with mild amblyopia, ametropia or anisometropia were consecutively included in this study. Amblyopic eyes with visual acuity <20/60 were excluded from the study.

For the purpose of refractive surgery, the ophthalmological examination included visual acuity, manifest and cycloplegic refraction, anterior and posterior segment evaluation, intraocular pressure, corneal topography, ultrasonic pachymetry, pupillometry and fundus cyclotorsion. The uncorrected visual acuity and best-corrected visual acuity (BCVA) were measured with the Logmar chart at a distance (4 m) and near (33 cm). Subjective manifest refraction was measured, obtaining the maximum plus correction or minimum minus correction, and objective refraction was measured with the Nidek autorefractometer. Cycloplegic refraction was determined 40 min after instillation of cyclopentolate 1%. Fundus cyclotorsion was measured with the scanning laser ophthalmoscope.

Five patients were myopic, four patients were hyperopic and four were anisometropic. Seven patients had a phakic anterior chamber lens implantation (Iris Claw/Artisan) for the correction of high myopia (patients 4, 5 and 13) or high hyperopia (patients 6, 7, 8 and 11). Three patients had diode thermokeratoplasty for the correction of low hyperopia (patients 9, 10 and 11) and the remaining three patients had laser in situ keratomileusis (LASIK; patient 3), laser epithelial keratomileusis (patient 2) and photoablation keratectomy (PRK; patient 1) for the correction of a low to moderate myopia.

Amblyopic eyes with vision <20/60 were the only eyes excluded in this series. One patient had a BCVA of 20/60 in his strabismic eye (patient 1) and four patients had a BCVA of 20/40 in their most ametropic or strabismic eye (patients 2, 8, 12 and 13). All other patients had a BCVA of ≥20/30 in both eyes.

Table 1 summarises the patient's age, sex, surgical procedure, preoperative refractive error, BCVA, ocular dominance and fundus cyclotorsion.

Unilateral macular excyclotorsion was found in three patients (patients 1, 12 and 13). Bilateral fundus excyclotorsion was found in another three patients (patients 4, 5 and 7).

A complete orthoptic examination was carried out before and 2 months after surgery. The ocular alignment was measured with the alternate prism cover test at 6 m and...
measuring peripheral fusion or suppression

28/F Iris Claw BE

57/M DTK LE

33/F Iris Claw BE

33/M LASIK BE

24/M PRK BE

53/F Iris Claw BE

24/M PRK BE

57/M DTK LE

43/M Iris Claw BE

39/F Iris Claw BE

28/F Iris Claw BE

7/F Iris Claw BE

68/F DTK BE

57/M DTK LE

49/M DTK RE

12/F Iris Claw BE

44/F Iris Claw RE

Table 1 Preoperative and postoperative examination

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age/sex</th>
<th>Surgery</th>
<th>Preoperative refractive error</th>
<th>Preoperative BCVA</th>
<th>Postoperative refractive error</th>
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<td>LE</td>
<td>RE</td>
<td>LE</td>
</tr>
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</tr>
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<td>5</td>
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<td>-7.50</td>
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<tr>
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<td>1.00</td>
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<td>1.00</td>
</tr>
<tr>
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<td>1.00</td>
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<td>1.00</td>
</tr>
<tr>
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<td>1.00</td>
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<tr>
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<td>-7.50</td>
<td>1.00</td>
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<tr>
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<td>44/F</td>
<td>Iris Claw RE</td>
<td>-1.00</td>
<td>1.25</td>
<td>-1.00</td>
<td>1.25</td>
</tr>
</tbody>
</table>

BCVA, best-corrected visual acuity; BE, both eyes; Dom, dominant; DTK, diode thermokeratoplasty; F, female; LASEK, laser epithelial keratomileusis; LASIK, laser in situ keratomileusis; LE, left eye; M, male; PRK, photorefractive keratectomy; RE, right eye.

Table 2 summarizes the orthoptic measurements.

As all patients were at high risk for postoperative diplopia as defined by Kowal, they were informed about that risk. Surgery was only performed after having obtained patients’ informed consent.

The intraocular refractive surgery was performed with M-JT and the corneal refractive surgery by RT. Corneal refractive procedures were performed under topical anaesthesia with oxybuprocaine 0.4%. The intraocular refractive surgery was performed under topical anaesthesia with a complementary intracamerular injection of lidocaine 1%.

The postoperative treatment of the patients implanted with an Iris Claw phakic IOL (intraocular lens) consisted of the topical instillation of Aculare and Tobraflex four times daily, tapered over 4 weeks. Patients who underwent LASIK, PRK or laser epithelial keratomileusis were fitted with a contact lens (focus night and day) immediately postoperatively and received Trafoks edo three times daily during the first 3–5 postoperative days. Successively, this treatment was replaced by Delcol four times daily and tapered over the following 3 months.

To avoid a switch of dominancy, the dominant eye was operated first in all nine patients in whom both eyes were treated. The dominant eye was operated first, and was targeted at emmetropia. The treatment of the non-dominant eye, targeted at emmetropia, was considered only if emmetropia was achieved in the dominant eye.

The time between the two surgeries ranged from 1 week (patients 1, 5, 6 and 8) to 4 weeks (patients 2, 3, 7 and 9). Patient 4 had a 1-year interval between both eyes because of unforeseen medical reasons.

The refractive follow-up ranged from 6 to 71 months (mean 33.9 months). Within this follow-up period, no patients had changes in binocular vision that justified an additional orthoptic examination.

RESULTS

The refractive error improved in all patients after one treatment. Some patients needed additional surgery to correct a residual astigmatism to obtain emmetropia. None of the patients lost any line of visual acuity. Patients 1, 5, 7 and 12 experienced an improved postoperative visual acuity. Table 1 shows the postoperative refractive error and BCVA.

Little change in ocular alignment was observed after surgery. The preoperative partial accommodative esotropia in patients 6, 7 and 8 remained unchanged postoperatively. In patient 6, the deviation even worsened slightly. In the patients with both myopia and esotropia, however, the

33 cm and in the synoptophore. Measurements were carried out with and without correction, after fixing a light and an accommodative target that was at a distance and near. The maximum deviation was recorded. Ocular motility was evaluated with the alternate cover test in the nine directions of gaze. Binocular vision was measured with the Gobin’s 15-deviation; 8 of them had a suppression depth of >17 as measured with the Bagolini red filter bar. Stereo acuity was measured with the Titmus scotoma. Fusion or suppression range was measured at a distance and near with the prism bar and in the synoptophore. Suppression depth was measured with the Bagolini red filter bar. Stereo acuity was measured with the Titmus and Lang test and retinal correspondence was evaluated in the synoptophore. All binocular vision tests were evaluated with optimal spectacle correction or contact lens correction before refractive surgery and without correction postoperatively.

Three patients with preoperative esotropia had hyperopia (patients 6, 7 and 8); one was myopic (patient 3) and one anisometropic (patient 11). All three patients with hyperopia had a partial accommodative esotropia, a V-pattern and a small vertical deviation. The patients with myopia had no vertical component. The patient with anisometropia had an esotropia, a V-pattern and a small vertical deviation.

Seven patients had an exodivergence preoperatively, of whom three had a small vertical deviation as well (patients 4, 5 and 13). Three patients with esotropia were myopic in both eyes (patients 2, 4 and 5), one was hyperopic in both eyes (patient 9) and three were anisometropic (patients 10, 12 and 13). In all patients, the exodivergence was more important at near than at distance. Patients 4, 5 and 9 had a V-pattern. Patients 4 and 5 presented additionally with an overaction of the inferior oblique muscle of the strabismic eye. The exodivergence of patient 9 was latent at a distance and intermittent at near. In patient 5, the exodivergence was intermittent at a distance and near. These two patients (patients 5 and 9) had fusion and stereopsis. Patient 12 had a manifest exodivergence at near, which was intermittent at distance. In this patient, fusion was poor at a distance and was absent at near fixation.

Patient 1 had a manifest vertical deviation with dissociated vertical deviation, no binocular vision, a V-pattern and overaction of the left inferior oblique muscle.

Suppression was found in all 11 patients with a manifest deviation; 8 of them had a suppression depth of >17 as measured with the Bagolini red filter bar.

All patients had normal retinal correspondence (NRC) when measured with the synoptophore.
deviation decreased. In the patient with anisometropia, no change was noticed. None of the patients with exotropia had an increase in their deviation postoperatively. The patient with low hypermetropia (patient 9) presenting with intermittent exotropia did not improve; in the two patients with high anisometropia (patients 12 and 13), deviation became intermittent to latent postoperatively, resulting in an improvement of binocular vision. Patient 12, who had minimal peripheral fusion at distance, developed postoperatively good peripheral and central fusion with stereopsis of 60°. Patient 13, who had no preoperative binocular vision, developed peripheral fusion postoperatively, with stereopsis of 400°. Vertical deviation improved in this patient as well. Patients 1, 4, 5, 6, 7, 8 and 11 with preoperative vertical deviation presented with minor changes in their vertical angle postoperatively. The ocular motility remained the same in all patients and no difference in excyclotorsion was noticed.

Table 2 summarises the postoperative orthoptic results.

No major intraoperative or postoperative complications were seen. Patients 4 and 12 presented with a transient intraocular pressure rise, which normalised a few days after treatment with antiglaucoma drugs. In patient 13, corneal epithelialisation was delayed, requiring a more intense postoperative care.

None of the eyes treated by refractive laser techniques presented with postoperative topographic decentration of the dilated corneal zone (patients 1, 2, 3, 9, 10 and 11).

**Table 2** Preoperative and postoperative orthoptic examination

<table>
<thead>
<tr>
<th>Patient no</th>
<th>Ocular alignment: distance</th>
<th>Ocular alignment: near</th>
<th>Binocular vision fusion</th>
<th>Binocular vision stereopsis</th>
<th>Ocular motility inferior oblique</th>
<th>Pattern</th>
<th>Ocular deviation: distance</th>
<th>Postoperative ocular alignment: distance</th>
<th>Postoperative ocular alignment: near</th>
<th>Postoperative ocular deviation: distance</th>
<th>Postoperative fusion</th>
<th>Postoperative stereopsis</th>
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<tr>
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<td>LE 0°HT</td>
<td>LE 0°HT</td>
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<td>No</td>
<td></td>
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</tr>
<tr>
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<td>w. 20°T</td>
<td>w. 20°T</td>
<td>d. no</td>
<td>No</td>
<td>Normal</td>
<td>Normal</td>
<td>18°XT</td>
<td>25°XT</td>
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<td>w. 20°T</td>
<td>w. 20°T</td>
<td>d. no</td>
<td>No</td>
<td>V</td>
<td>Overaction LE</td>
<td>20°XT</td>
<td>20°XT</td>
<td>d. no</td>
<td>No</td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>w. 20°T</td>
<td>w. 20°T</td>
<td>d. no</td>
<td>No</td>
<td>V</td>
<td>Overaction RE</td>
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<td>25°RE</td>
<td>d. no</td>
<td>No</td>
<td></td>
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<td>d. no</td>
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<td>V</td>
<td>Overaction RE</td>
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<td>20°XT</td>
<td>d. no</td>
<td>No</td>
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<tr>
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<td>w. 20°T</td>
<td>d. no</td>
<td>No</td>
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<td>Overaction RE</td>
<td>18°XT</td>
<td>18°XT</td>
<td>d. no</td>
<td>No</td>
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<td>8</td>
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<td>w. 20°T</td>
<td>d. no</td>
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<td>Overaction RE</td>
<td>18°XT</td>
<td>18°XT</td>
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<td>60°</td>
<td>V</td>
<td>Normal</td>
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<td>20°XT</td>
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<td>V</td>
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<td>Normal</td>
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cc, sum correction; d, distance; ET, exotropia; LE, left eye; LHT, left hypermetropia; n, near; RE, right eye; RHT, right hypermetropia; RH(T), intertemporal right hypermetropia; sc, side correction; V, V pattern; X, exophoria; XT, exotropia; XT(T), intemporal exotropia; †, prism disparity; º, degrees; ′, seconds of arc.

**DISCUSSION**

Refractive surgery did not markedly influence ocular alignment in our series. In 1997, Bilgihan et al. reported on one patient with preoperative accommodative esotropia who became orthophoric postoperatively. However, data about fusion or stereopsis did not appear in this paper. Galin et al. reported on one patient presenting with accommodative esotropia, which was successfully corrected with bilateral angle-supported phakic intraocular lenses. Hoyos et al. reported on LASIK treatment in nine patients with refractive accommodative esotropia. All patients were postoperatively orthophoric or remained micro-esotropic. Postoperative orthophoria was also described by Nemet et al. in six patients with total and partial accommodative esotropia. However, no data is given about the angle of deviation measured when fixing an accommodative target at near. Stidham et al. treated 24 patients (48 eyes) with LASIK for accommodative esotropia. Ten patients had a fully accommodative esotropia, of whom two became orthophoric postoperatively. Four patients had their esotropia converted to an esophoria and four patients showed no improvement at all. This contrasts with the results of Nucci et al., who found 100% orthophoria after PRK for mild to moderate hypermetropia in patients presenting with a purely accommodative esotropia. Stidham et al. found a reduction of the deviation in three of four patients with non-accommodative esotropia, of whom two were orthophoric after surgery. All these patients presented with a moderate to high hypermetropia and most of them remained slightly hypermetropic postoperatively. However, data about fusion, fine stereopsis or alignment when fixing an accommodative target are unavailable in these papers. Nemet et al. reported a complete resolution of exotropia after LASIK for myopic anisometropia. These results are predictable under preoperative contact lens simulation. Refractive surgery is a good option in case of a positive contact lens test or in patients with anisometropia who wore contact lenses but became intolerant to them.

Only one of the above-mentioned papers reported on refractive surgery in a patient with a combined vertical deviation. Of the 13 patients in our series, 7 (4, 5, 6, 7, 8, 11 and 13) had an Iris Claw phakic lens implantation and presented preoperatively with a vertical deviation in combination with a horizontal strabismus. Eight of the 13 patients presented with a V-pattern. One patient had a purely vertical deviation with dissociated vertical deviation, latent
nystagmus and excyclotorsion. In this patient, bilateral PRK was carried out with good centration of the ablation zone and good refractive results. None of the patients presented with a worsening of the vertical deviation after refractive surgery. We observed an improvement of the vertical deviation in one of the patients with high anisometropia whose strabismus became intermittent postoperatively (patient 13).

None of our patients presented with postoperative diplopia, dominance problems or binocular vision problems.

Our series comprises partial accommodative esotropia, non-accommodative esotropia, manifest and intermittent exotropia, and vertical deviation. All patients were treated by diverse refractive surgery techniques.

On the basis of the results obtained, we may conclude that preoperative intermittent or manifest strabismus is not a contraindication for refractive surgery provided some specific recommendations are taken into account, such as an adequate orthoptic examination, consecutive surgery of both eyes starting with the dominant eye, and aiming at emmetropia for the dominant eye and for the non-dominant eye. Monovision is prohibited in patients with strabismus presenting preoperatively with intermittent or manifest deviations.

Patients can be informed that no worsening in their ocular motility will occur after surgery. However, we still consider it advisable to inform the patients preoperatively about the possible risk of postoperative manifest decompensation, especially in patients presenting with an intermittent or latent deviation.

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REFERENCES