INTRAOCULAR PRESSURE CHANGE AFTER LASER IN SITU KERATOMILEUSIS (LASIK)

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To analyze the relationship between change in intraocular pressure (IOP) after laser in situ keratomileusis (LASIK), and preoperative central-corneal thickness (CCT), and central-corneal ablation depth (CCAD), a prospective study was conducted of 30 patients (60 eyes) with myopia or myopic astigmatism who underwent LASIK and who were followed up for a mean of 6 months. The parameters evaluated included IOP 1 week preoperatively and 3 months postoperatively, pre- and postoperative CCT, and CCAD; in addition, the anterior ocular segment and the fundus were examined, as was the apparent and cycloplegic refraction. There were 11 male patients and 19 female patients (mean age, 28.3 years) involved in the study. Mean IOP readings were 14.9 mmHg 1 week preoperatively, and 8.3 mmHg 3 months postoperatively; thus, the mean decrease in IOP after LASIK was 6.6 mmHg. Mean values for preoperative CCT, postoperative CCT, and CCAD were 537.2 ± 34.7 µm, 434.0 ± 32.5 µm, and 101.6 ± 23.90 µm, respectively. IOP correlated with CCT both pre- and postoperatively. The mean change in IOP after LASIK for myopia and myopic astigmatism was statistically significant, but did not correlate with CCAD or age. We postulate that CCAD is not a significant predictor of IOP after LASIK.

Key Words: intraocular pressure, laser in situ keratomileusis, LASIK

Laser in situ keratomileusis (LASIK) has become more popular in recent years. However, whether intraocular pressure (IOP) decreases after LASIK, and whether such a decrease might be proportional to central-corneal thickness (CCT) or the central-corneal ablation depth (CCAD), remains controversial [1,2]. In this study, we analyzed IOP with a computerized pneumatonometer and investigated the correlation with CCT, and CCAD, before and after LASIK.

MATERIALS AND METHODS

Subjects
Thirty patients (60 eyes) with myopia or myopic astigmatism underwent LASIK between January and June 2004. Patients had no deep cupping, a cup/disc ratio < 0.4, and mean preoperative IOP of 12–20 mmHg. All patients were over the age of 20, with no history of uveitis, glaucoma, ocular trauma, severe dry eye syndrome, or collagen disease, and without any systemic disease or drug allergy. The mean postoperative follow-up time was 6 months.

Ocular examination
Subjects underwent complete preoperative ocular examinations which included assessments of the following: the anterior segments and anterior vitreous using slit-lamp biomicroscopy; the posterior vitreous, disc, and macula,
Using slit-lamp biomicroscopy with a 90-diopter lens; the peripheral retina by indirect ophthalmoscopy; corneal thickness by pachymeter; and corneal-surface curvature by autokeratometer and topography. All eyes were normal regarding these assessments.

**IOP measurement**

IOP was measured using computerized pneumatonometer, with a mean value taken from two readings: one reading was made between 9:00 am and 11:00 am, and the other between 3:00 pm and 5:00 pm. Measurements were performed 1 week preoperatively and 3 months postoperatively. To measure IOP in each eye, IOP was measured consecutively three times with the pneumatonometer, without any time interval, and the mean value was used for statistical analysis. Measurements with variations greater than 2 mmHg between the highest and the lowest for any one eye were excluded. CCT was measured 10 times, close to the corneal center, with a pachymeter. CCT readings with variations greater than 10 µm between the highest and the lowest measurement for the same eye were excluded. For all other cases, the smallest CCT measurement was used in the analysis.

**Statistical analysis**

A paired t test was used to compare preoperative data with postoperative data. Regression analysis was used to verify correlations between IOP and CCT, both pre- and postoperatively, and between IOP change and CCAD. A p value of < 0.05 was considered statistically significant.

**RESULTS**

Of the 30 patients (60 eyes) in this study, 11 were male (36.7%) and 19 were female (63.3%); mean age was 28.3 ± 6.4 years. Mean IOP was 14.9 ± 2.9 mmHg 1 week preoperatively, and 8.3 ± 2.1 mmHg 3 months postoperatively (Table 1); thus, the mean IOP decrease after LASIK was 6.6 mmHg (p < 0.05). Mean values for preoperative CCT, postoperative CCT, and laser CCAD were 537.2 ± 34.7 µm, 434.0 ± 32.5 µm, and 101.64 ± 23.90 µm, respectively (Table 1). IOP correlated with CCT both before (correlation coefficient [r] = 0.334, p = 0.014) and after LASIK (r = 0.283, p = 0.042), whereas the mean decrease in IOP did not correlate with either laser CCAD or age (Table 2).

**DISCUSSION**

There are conflicting data in the literature about whether IOP changes after LASIK. Agudelo et al reported that IOP was not significantly correlated with thickness, or the amount of

<table>
<thead>
<tr>
<th>Table 1. Demographic data*</th>
<th>Male (n = 11)</th>
<th>Female (n = 19)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>28.2 ± 8.5</td>
<td>28.4 ± 5.1</td>
<td>28.3 ± 6.4</td>
</tr>
<tr>
<td>Pre-LASIK IOP (mmHg)</td>
<td>15.3 ± 2.2</td>
<td>14.6 ± 3.0</td>
<td>14.9 ± 2.9</td>
</tr>
<tr>
<td>Post-LASIK IOP (mmHg)</td>
<td>7.8 ± 1.4</td>
<td>8.4 ± 2.3</td>
<td>8.3 ± 2.1</td>
</tr>
<tr>
<td>Pre-LASIK CCT (µm)</td>
<td>547.3 ± 29.7</td>
<td>530.3 ± 32.8</td>
<td>537.2 ± 34.7</td>
</tr>
<tr>
<td>Post-LASIK CCT (µm)</td>
<td>445.5 ± 38.9</td>
<td>426.6 ± 29.3</td>
<td>434.0 ± 32.5</td>
</tr>
<tr>
<td>LCCAD (µm)</td>
<td>100.1 ± 24.5</td>
<td>102.3 ± 23.8</td>
<td>101.6 ± 23.9</td>
</tr>
</tbody>
</table>

*Data shown are mean ± standard deviation values. CCT = central-corneal thickness; IOP = intraocular pressure; LASIK = laser in situ keratomileusis; LCCAD = laser central-corneal ablation depth.

| Table 2. Correlations between intraocular pressure (IOP) and central-corneal thickness (CCT), laser central-corneal ablation depth (LCCAD), and age |
|----------------------------------|-----------------|-----------------|-----------------|
|                                  | Pre-LASIK IOP   | Post-LASIK IOP  | IOP decrease    |
| Pre-LASIK CCT                    | 0.014*          |                 |                 |
| Post-LASIK CCT                   |                 | 0.042*          |                 |
| LCCAD                            |                 |                 | 0.744           |
| Age                              | 0.945           | 0.185           | 0.434           |

* A statistically significant correlation; data shown are p values.
ablation, flattening or steepening, of the central cornea [1], whereas Vakili et al documented that LASIK had no statistically significant influence on IOP readings obtained with a Goldmann applanation tonometer, Tono-Pen®, or pneumatonometer [2]. Zadok et al reported that preoperative IOP showed a good correlation when values were obtained with a Goldmann applanation tonometer or pneumatonometer, but the postoperative decrease in IOP recorded with a Goldmann applanation tonometer was significantly greater than that recorded with a pneumatonometer (–3.8 ± 2.2 mmHg [–26.3 ± 15.2%] vs –2.3 ± 2.8 mmHg [–15.4 ± 10.7%]; p < 0.05) [3]. Regression analysis revealed no statistically significant correlation, with either device, between IOP and changes in corneal thickness or curvature [3]. Montes-Mico and Charman also described a decrease in IOP after refractive surgery, but found no correlation between IOP change and the correction attempted [4].

Arimoto et al documented that IOP was significantly reduced by LASIK, and that such IOP changes measured by pneumatonometer and Goldmann applanation tonometer correlated significantly with changes in CCT and corneal curvature, and with the corrected diopter value [5–7]. Recep et al reported a significant correlation between reduced IOP and altered CCT [8]. Further, Duch et al and Rashad and Bahnassy presented regression analyses showing significant correlations between changes in Goldmann applanation tonometer readings and changes in CCT [9,10]. However, Duch et al reported no significant correlation between CCT and pneumotonometer readings [9].

LASIK alters the structure, curvature, and thickness of the cornea. These changes depend not only on the corrected diopter value, but also on the treatment zone and excimer laser software; all three of these factors may influence the IOP reading. Agudelo et al suggested that decreased IOP after LASIK could be explained by reduced elastic forces in the ocular walls [1]. The elastic forces acting on a structure are quantified by Young’s elasticity modulus (stress divided by material strain) regardless of the structure’s thickness and length [1]. Different devices, such as the pneumatonometer, Goldmann applanation tonometer, and Tono-pen®, have been used for IOP measurement after LASIK. However, the Goldmann applanation tonometer tends to underestimate IOP in eyes with a flat corneal curvature and thin corneal thickness, and post-LASIK IOP values produced by a pneumatonometer rather than Goldmann applanation tonometer may be more accurate and reproducible [4]. In a recent study, a pneumatonometer seemed to give more reliable results when IOP was measured at the central cornea [4].

The method of IOP measurement may lead to variable results, and time of measurement is also important. Some clinicians measure IOP between 4:00 pm and 6:30 pm to avoid diurnal variation, whereas others use random times to obtain IOP measurements [1,2,5–7]. In our study, to avoid inter-individual differences in the diurnal variation of IOP, each patient had a mean IOP value taken from two readings, one made between 9:00 am and 11:00 am, and the other between 3:00 and 5:00 pm [8–10]. This study confirmed, by pneumatonometer, that IOP was reduced after LASIK, but that the decrease was not proportional to CCAD. In other words, CCAD was not a significant predictor of the post-LASIK IOP value. The decrease in IOP may not have been a real change, but rather a deviation in our ability to measure IOP because of reduced corneal thickness. Importantly, changes in IOP after LASIK must be carefully considered by clinicians, so that underestimation of IOP is avoided and optic-nerve damage does not progress unnoticed.

**REFERENCES**

雷射屈光角膜重塑術後之眼壓值變化

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本研究分析雷射原位角膜重塑術後眼壓值與中心角膜厚度及雷射切削深度之關聯。方法用前瞻性研究分析 30 位近視或遠視合併散光之受術者 (60 眼)。檢查包括術前一週之眼壓及術後三個月之眼壓，中心角膜厚度，雷射切削深度，裂隙燈及眼底檢查，睫狀肌麻痹術後之屈光。結果為 30 位受術者有 11 位男性及 19 位女性，平均年齡為 28.3 歲。術前 1 週平均眼壓為 14.9 mmHg，術後三個月平均眼壓為 8.3 mmHg，術後眼壓值平均降低 6.6 mmHg。術前平均中心角膜厚度為 537.2 μm，術後平均中心角膜厚度為 434.0 μm，平均角膜雷射切削深度為 101.6 μm。術前、術後眼壓值分別與術前、術後中心角膜厚度正相關。術前、術後眼壓測量值顯著下降，但眼壓值變化和角膜切削深度經迴歸分析並無正相關。我們認為故近視或遠視合併散光者經雷射原位角膜重塑術後，角膜切削深度並非術後眼壓測量值之預測因子。

關鍵詞：眼壓，雷射原位角膜重塑術，LASIK

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