Treatment of corneal astigmatism with the new small-incision lenticule extraction (SMILE) laser technique: Is treatment of high degree astigmatism equally accurate, stable and safe as treatment of low degree astigmatism?

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Eye Surgery for Astigmatism: Small-incision lenticule extraction (SMILE) for treatment of low and high degrees of astigmatism

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Introduction
Astigmatism is when the corneal surface is non-spherical, whereby its refractive power varies in different meridians. SMILE is a new refractive procedure, where a stromal lenticule is cut by a laser and manually extracted. SMILE is proven efficient and safe for correction of myopia and low degrees of astigmatism (less than 3 diopters D). However, the literature is still sparse, especially for high degrees of astigmatism (3 D or more).

Objective
The aim of this study was to compare results up 3 months after SMILE treatment for low and high degrees of astigmatism concerning accuracy, visual acuity, safety and efficacy.

Method
Retrospective study of all eyes treated with SMILE for myopia with low or high degrees of astigmatism from 2011 to 2013. All treatments were performed at the Department of Ophthalmology, Odense University Hospital, Denmark. Inclusion criteria: Best spectacle-corrected visual acuity (BSCVA) of 20/25 or better on Snellen chart before surgery, and no other ocular condition than myopia with astigmatism. Exclusion criteria: Eyes having undergone re-treatment and eyes with no astigmatism before surgery. Clinical examinations were performed pre-operatively and at 1 day, 1 week and 3 months post-operatively.

Results
In total, 494 eyes with low astigmatism and 76 eyes with high astigmatism were included and analyzed.

Accuracy: After 3 months, 82% of eyes with low astigmatism and 59% of eyes with high astigmatism (P=0.14) were within ±0.5 D of attempted post-operative astigmatism, whilst 97% of eyes with low astigmatism and 95% of eyes with high astigmatism (P=1.00) were within ±1.0 D. Also, 79% of eyes with low astigmatism and 76% of eyes with high astigmatism (P=0.79) were within ±0.5 D of attempted post-operative spherical equivalent (SE) refraction.

Visual acuity and safety: The percentage of eyes with BSCVA of 20/20 or better was unchanged after both procedures. In total, 2% (n=9) of eyes treated for low astigmatism and no eyes treated for high astigmatism (P=0.61) had gained 2 or more lines of BSCVA after 3 months. However, 1% (n=6) of eyes treated for low astigmatism and 5% (n=4) of eyes treated for high astigmatism (P<0.05) had lost 2 or more lines of BSCVA after 3 months.

Conclusion
Our results indicated that SMILE was efficient in treatment of all degrees of astigmatism, but treatment of low degrees of astigmatism is more safe and produce better refractive outcomes than treatment of high degrees of astigmatism up to 3 months after surgery.

ACKNOWLEDGEMENT
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FINANCIAL DISCLOSURES
For all authors, None.

Figure 1: Pentacam tomography before and after surgery
Top: High-degree astigmatism
Bottom: Low-degree astigmatism

Figure 2: Percentage of eyes attaining specified levels of astigmatism 3 months after surgery.

Figure 3: Efficacy. Cumulative percentage of eyes attaining specified cumulative levels of uncorrected distance visual acuity (UDVA) after 3 months and compared to BSCVA before surgery. Only eyes with 0 D as target refraction were included (n=43).

<table>
<thead>
<tr>
<th>BASELINE</th>
<th>Low</th>
<th>High</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astigmatism (D)</td>
<td>-1.1 (2.8 to 0.3)</td>
<td>-3.5 (5.8 to 3.0)</td>
<td>&lt;0.05*</td>
</tr>
<tr>
<td>SE (D)</td>
<td>-7.3 (14.8 to -1.3)</td>
<td>-4.4 (14.8 to -1.6)</td>
<td>&lt;0.05*</td>
</tr>
<tr>
<td>SE attempted (D)</td>
<td>-0.6 (8.8 to 0.0)</td>
<td>-0.7 (8.8 to 0.0)</td>
<td>0.98</td>
</tr>
<tr>
<td>BSCVA (logMAR)</td>
<td>-0.04 (0.18 to 0.0)</td>
<td>-0.02 (0.18 to 0.0)</td>
<td>&lt;0.05*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3 MONTHS</th>
<th>Low</th>
<th>High</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astigmatism (D)</td>
<td>-0.4 (2.0 to 0.0)</td>
<td>-0.8 (2.0 to 0.0)</td>
<td>&lt;0.05*</td>
</tr>
<tr>
<td>Astigmatism (D)</td>
<td>-0.3 (1.3 to 0.5)</td>
<td>-0.5 (1.5 to 0.5)</td>
<td>&lt;0.05*</td>
</tr>
<tr>
<td>SE (D)</td>
<td>0.1 (3.0 to 3.5)</td>
<td>0.3 (1.0 to 1.1)</td>
<td>&lt;0.05*</td>
</tr>
<tr>
<td>BSCVA change (logMAR)</td>
<td>0.00 (0.22 to 0.0)</td>
<td>0.01 (0.22 to 0.11)</td>
<td>0.24</td>
</tr>
</tbody>
</table>

| Tabel 1: Baseline characteristics and outcomes 3 months after surgery. All values are average standard deviation (range) |
|----------|-----|------|---|
| Astigmatism (D) | Astigmatism (Cylindrical) |
| Astigmatism (D) | Achieved | attempted |
| SE (D) | Achieved | attempted |
| BSCVA change | Before surgery | Achieved |

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