The evaluation of clear corneal incision architecture using optical coherence tomography

Javier Orbegozo Gárate, MD1; Erika Vázquez Cruchaga, MD1; Iñaki Basterra Barrenetxea, OD1; Begoña Díez González, OD1; Germán González Martín, OD1

PURPOSE: To investigate the architecture of clear corneal incision post phacoemulsification cataract surgery using optical coherence tomography (OCT).

SETTING: Centro Oftalmológico Integral, Bilbao, Spain.

METHODS: This prospective observational study analyzed 60 clear corneal incisions (CCI) done in phacoemulsification with a 2.20 mm Intrepid HP disposable metal knife (Alcon). All wounds were evaluated 1 day, 7 days and 1 month after surgery by Cirrus OCT (Carl Zeiss Meditec, Inc.).

RESULTS: The first day the mean CCI length was 1.49 ± 0.19 mm (range 1.16 to 2.1 mm), the mean incision size was 2.24 ± 0.05 mm and the mean incision angle was 42.40 ± 4.87 degrees (range 30 to 55 degrees). In one month the mean CCI length decreased to 1.29 ± 0.15 mm and the mean incision angle decreased to 36.28 ± 4.54 degrees. The CCI architectural features were observed with the following frequencies: epithelial gaping (16.67%), endothelial gaping (53.33%), local detachment of Descemet’s membrane (88.33%), slightly deficient sealing of the endothelial side of the wound (21.67%) and tissue separation (5%). These values normalized in one month follow up.

CONCLUSION: Optical coherence tomography allowed excellent evaluation of corneal incisions after cataract surgery. Measurements of the incision using OCT are highly repeatable.

KEYWORDS: clear corneal incision, cataract, OCT, optical coherence tomography.

J Emmetropia 2011; 2: 201-205

Clear corneal incisions are the most popular type of incision used in modern-day phacoemulsification cataract surgery. CCI allows sutureless surgery, induces little astigmatism and provides fast visual rehabilitation. Over the past decade the incidence of endophthalmitis after cataract surgery has increased. There has been much debate on whether the increasing use of clear cornea incision has contributed to this. A recent study speculated that the integrity of CCI in the postoperative period may be a critical factor in predicting endophthalmitis. This possibility has led to in vivo studies of the stability and architecture of these incisions. Morphologic features of corneal incisions, such as the incision angle, square configuration and the enlargement of the small incision for IOLs implantation seem to be important factors in preventing transient gaping and poor edge apposition of the wound. Incision gaping may allow bacteria to penetrate the anterior chamber through inversion of the intraocular pressure gradient.

The imaging technique of optical coherence tomography (OCT) can be used to examine the internal architecture of CCI. The noncontact Cirrus OCT is quick and easy to use and safe for the patient. Recently, Torres et al. found that gaping of the endothelial edge and incomplete wound sealing in the early postoperative period tended to improve one month after surgery. The aim of our study, using the Cirrus OCT to examine CCI, was to evaluate the evolution of CCI 1 day, 7 days and 30 days after cataract surgery by measuring epithelial aperture, endothelial aperture, detachment of the Descemet, endothelial position lost, oedema, tissue separation, incision length, incision angle and incision planes.
PATIENTS AND METHODS

This prospective observational study comprised 60 eyes which had uneventful phacoemulsification cataract surgery with implantation of a posterior chamber IOL at the Centro Oftalmológico Integral (Bilbao) by the same surgeon Dr J.O. Exclusion criteria were patients with intraoperative complications and preoperative anterior segment disease. Nevertheless, the tenets of the Declaration of Helsinki were followed and all patients provided informed consent after receiving an explanation of the aims of recording AS-OCT data.

Surgical Technique

All the patients were operated with 2.20 microincision coaxial phacoemulsification.

All the surgeries were performed under topical anaesthesia of lidocaine hydrochloride 5% (Xylocaine). Incisions were always temporal. A 0.1 mm deep groove was made with a 15° disposable metal knife (Alcon) and the incision was made with a 2.20 mm Intrepid HP disposable metal knife (Alcon). Incision was constructed to create a 3-plane internal architecture. Initially, the blade was directed steeply into the corneal superficial stroma and then brought parallel to the corneal surface to create a tunnel. This was followed by a steepened entry into the anterior chamber.

Sodium hyaluronate 1.6% (Z-hyalin plus) was used as the ophthalmic viscosurgical product. The procedures were performed with an Infinity system (Alcon) and OZil technology.

The phacoemulsification procedures were performed using 30-degree Kelman ABS 0.9 mm tapered Miniflared (Alcon).

In all eyes an AcrySoft SA60AT (Alcon) was implanted in the capsular bag using a Monarch II injector system with a C cartridge. The wound stroma was hydrated with 0.5 ml of balanced salt solution at the end of the surgery and the IOP restored. Next, gentle pressure was applied to the posterior lip of the incision to test for wound leakage and ensure sealing.

Patient Examination

All the patients had a clinical slitlamp examination with a Seidel test and IOP. A first AS-OCT examination was performed one day after surgery using Cirrus HD OCT (Carl Zeiss) with Fourier Domain (Espectral) technology. It operates at 830 nm wavelength. This technology captured 26000 axial scan per second giving high-resolution images. We used cube option centred in the centre of the incision wound to obtain the measurements. The procedure was repeated 7 and 30 days after surgery. Ten architectural features were used to objectively describe the CCIs: size of the incision, incision angle (fig. 1), incision length (fig. 1), internal architectural planes, gaping of the wound at the epithelial and endothelial side (fig. 2), local detachment of Descemet’s membrane, misalignment of the roof and the floor of the incision at the endothelial side, loss of coaptation along the tunnel and incisional oedema (figs. 3-4).
RESULTS

Of the 60 patients (35 right, 25 left) enrolled in the study, none was excluded. The mean patient age was 77 years (range 90 to 65 years). No patient had clinically visible incision leakage or positive Seidel test. All corneas were clear and the mean incision size was $2.24 \pm 0.05$ mm.

One-day postoperative evaluation

The mean postoperative IOP was $16.08$ mm Hg ± 7.47 (SD) (range 8 to 40 mm Hg). The mean CCI length was $1.49 \pm 0.19$ mm (range 1.16 to 2.1 mm). Although a 3-plane profile was attempted in each case, 60% of CCIs had a visible 3-plane profile on OCT (fig. 5). 36.67% of CCIs had a 2-plane profile on OCT (fig. 6) and 3.33% CCIs had a single plane profile (fig. 7). This was invariably a result of inadequate depth of the first stage of the incision. The mean angle of incision was $42.40 \pm 4.87$ degrees (range 30 to 55 degrees).

Gaping of the wound appeared in 16.67% of the cases in the epithelium and in 53.33% of the cases in the endothelium. Local detachment of Descemet’s membrane occurred in 88.33%. The sealing of the endothelial side of the wound was slightly deficient, in 21.67% of the eyes we could see misalignment of the
roof and the floor of the incision at the endothelial side, but there was no relationship between the incision angle and the presence of endothelial gaping.

All incisions were surrounded by an area of corneal stromal oedema (figs. 3-4), but only 3 eyes suffered from tissue separation (fig. 8).

Seven-Day postoperative evaluation

On the one hand, the mean postoperative IOP normalized and was 12.32 mm Hg ± 3.23 (SD) (range 5 to 25 mm Hg). The mean CCI length was 1.46 ± 0.17 mm (table 1) and the mean angle of incision was 41.85 ± 4.94 degrees (table 1). These ones are not significantly different from the first day values.

On the other hand, the endothelium gaping reduced to 36.7%, the epithelium gaping showed also a trend towards recovery decreasing to 3 cases (5% of the eyes). Local detachment of Descemet’s membrane occurred in 83%, and the sealing of endothelial side of the wound was slightly deficient and in 11 % of the eyes. We detected stromal oedema in 91.67% of the eyes. Only 1 eye suffered from tissue separation.

One-month postoperative evaluation

The mean IOP continued normalizing, being 11.93 mm Hg ± 2.96 at this stage (range 6 to 19 mm Hg). The mean CCI length decreased to 1.29 ± 0.15 mm and the mean incision angle was 36.28 ± 4.54 degrees (table 1).

In this evaluation, the gaping of the wound in the epithelium disappeared and the gaping in the endothelium decreased to 2 cases (3%). Local detachment of Descemet’s membrane was present in 5% of the eyes and sealing of the endothelial side of the wound failed in 6.67%. Incisions surrounded by stromal oedema were 8.33% of all the cases and eyes affected by tissue separation disappeared.

DISCUSSION

In this study we used the AS-OCT to explore the corneal wound architecture after phacoemulsification. Torres et al.9 studied the corneal incision angle and observed wound sealing 1, 3 and 30 days after surgery. They found no correlation between the structural integrity of the wound and the incision angle. Taban et al.12 used OCT to observe wound gaping immediately after surgery. They found that larger angles of incision tended to seal better under conditions of lower IOP, whereas incisions with a low angle of approach tended to seal better with a higher IOP. In our experience, the smaller the angles of approach to the wound the more effective at creating a self-sealing wound. The angle of the incision in this study, 36 degrees, appeared to be shallow enough to create a self-sealing wound. The shallow angle gives the wound structural integrity, as the IOP would press the lower lip of the incision against the upper lip.

Torres et al.11 found internal gaping in their uniplanar incision in 25% of the cases at 24 hours and 10% at one month. In our experience we only had 3 cases of uniplanar incision and we did not find internal gaping in these cases.

All of our incisions were surrounded by an area of corneal stromal oedema, the oedema even continued at

<p>| Table 1. Anterior segment OCT measurement of incision angle and wound length |
|-------------------------------------------------|-------------|-------------|</p>
<table>
<thead>
<tr>
<th>Revision</th>
<th>Incision angle (degrees)</th>
<th>Range</th>
<th>Incision length (mm)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 day</td>
<td>42.40 ± 4.87</td>
<td>30 to 55</td>
<td>1.49 ± 0.19</td>
<td>1.17 to 2.10</td>
</tr>
<tr>
<td>7 days</td>
<td>41.85 ± 4.94</td>
<td>31 to 55</td>
<td>1.46 ± 0.17</td>
<td>1.13 to 2.00</td>
</tr>
<tr>
<td>30 days</td>
<td>36.28 ± 4.54</td>
<td>28 to 55</td>
<td>1.29 ± 0.16</td>
<td>1.00 to 1.70</td>
</tr>
</tbody>
</table>
7 day follow up, but at least it disappeared at 1 month. We related the variation of the length and the incision angle with the oedema (tables 2 and 3).

In conclusion, AS-OCT is a risk-free, fast and precise method to measure the dimension, shape and position of cataract surgical incisions. We think the use of the AS-OCT after surgery is recommendable to confirm the absence of gaping. This information may help in the development of a consistent technique to create self-sealing incisions and decrease the risk of endophthalmitis.

REFERENCES