

Profile of clear corneal cataract incisions demonstrated by ocular coherence tomography

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PURPOSE: To examine the profile of clear corneal cataract incisions in the living eye using optical coherence tomography (OCT).

SETTING: Private practice, Eugene, Oregon, USA.

METHODS: The Zeiss Visante OCT anterior segment imaging system was used to study the profile of clear corneal cataract incisions, all in senior citizens. The OCT images of the operative eye were taken on the first postoperative day approximately 24 hours after surgery. The OCT images of clear corneal incisions were compared with an OCT image of a control eye, incisions without stromal hydration, and previous drawings of clear corneal incisions.

RESULTS: In the images, the clear corneal incisions had an arcuate configuration rather than a straight line configuration, as previously indicated. This architecture appears to add greater stability as a result of a tongue-and-groove-like fit of the floor to the roof of the incision as well as an incision that is longer than the chord length that had previously been measured. Other findings include that stromal swelling, which facilitates sealing of these incisions by the endothelial pump, lasted for at least 24 hours.

CONCLUSIONS: Results indicate an incision in the plane of the cornea with a chord length of at least 2.0 mm provides advantageous architecture for adequate self-sealing. Proper clear corneal incision construction resulted in an incision architecture that seemed to have increased stability and added safety, contributing to an absence of endophthalmitis for more than 10 years and 9000 cases in a single practice.

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The role of unsutured clear corneal incisions for cataract surgery and the apparent increased incidence of postoperative endophthalmitis in many reports are under intense scrutiny.^{1–6} Clear corneal incisions, which involve an incision in the plane of the cornea with a length equal to 2.0 mm, were first described in 1992 (I.H. Fine, MD, “Self-Sealing Corneal Tunnel Incision for Small-Incision Cataract Surgery,” *Ocular Surgery News*, May 1, 1992, pages 38–39), and we continue to construct them in essentially the same manner in our practice. In 1992, the incisions were as wide as 4.0 mm, but more recently the maximum width

is 3.5 mm if the incision is not sutured. [Figure 1](#) shows an artist’s view of what the profile of clear corneal incisions were thought to look like. [Figure 1, A](#), shows the single-plane incision and its apparent inherent lack of stability as 1 surface can easily slide over another. Charles Williamson, MD, modified the incision by making a shallow, perpendicular groove before incising the cornea into the anterior chamber ([Figure 1, B](#)). David Langerman, MD, deepened the perpendicular groove, believing that it led to greater stability ([Figure 1, C](#)). We abandoned these grooved incisions in favor of a paracentesis-style incision because of the difficulties associated with a persistent foreign-body sensation in the grooved incision and pooling of mucus and debris in the gaping groove. More important, the grooved incision disrupts the fluid barrier an intact epithelium creates, which allows vacuum sealing as a result of endothelial pumping.

The initial incision construction technique began with a blade applanated to the surface of the globe, with the point at the edge of the clear cornea; the blade advanced for 2.0 mm into the cornea before incising Descemet’s

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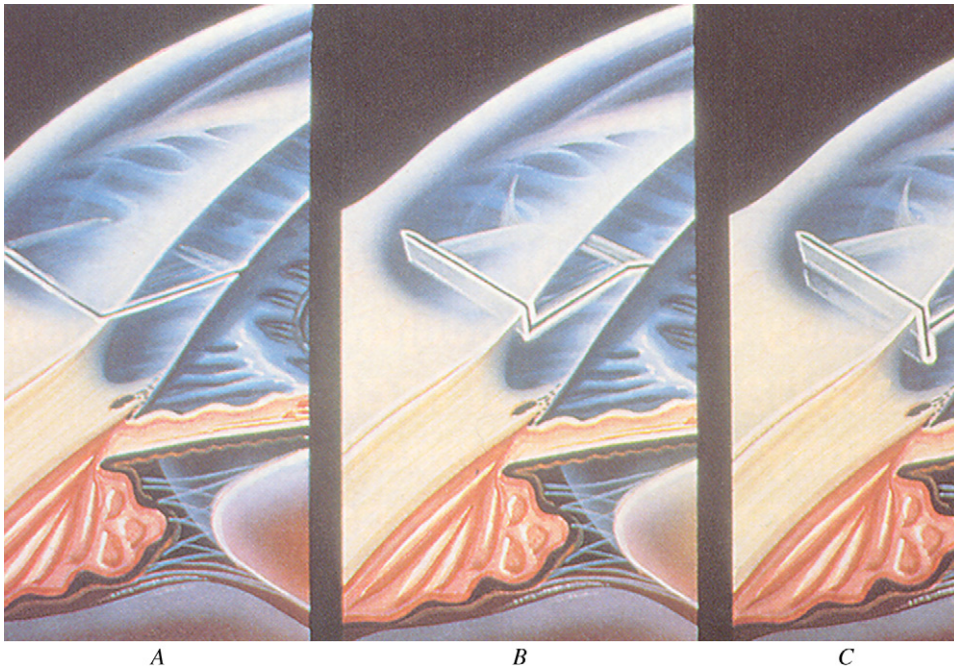


Figure 1. Artist's interpretation of cross-section view of clear corneal incisions circa 1992.

membrane (Figure 2). These early incisions were made with knives with straight sides; however, these were replaced by trapezoidal-shaped knives to allow enlargement of the incision without violating the architecture by cutting sideways. From the onset of the use of clear corneal incisions, stromal hydration of the incisions, which thickens the cornea, forcing the roof of the incision onto the floor of the incision and facilitating endothelial pumping to the upper reaches of the cornea, was strongly advocated. Testing the seal of the incision with a Seidel test using fluorescein was also strongly advocated.⁷ These practices have not

changed since 1992, except for the elimination of the depression of the posterior lip of the incision.

In this study, we examined the profile of clear corneal incisions using the Zeiss Visante optical coherence tomography (OCT) anterior segment imaging system. This technology has allowed the first view of the clear corneal incision in the living eye in the early postoperative period. All previous views were in autopsy eyes sectioned through the incision, which introduces artifacts. Figure 3 shows an example of the corneal periphery in a control eye that includes the anterior chamber angle. The regularity of the

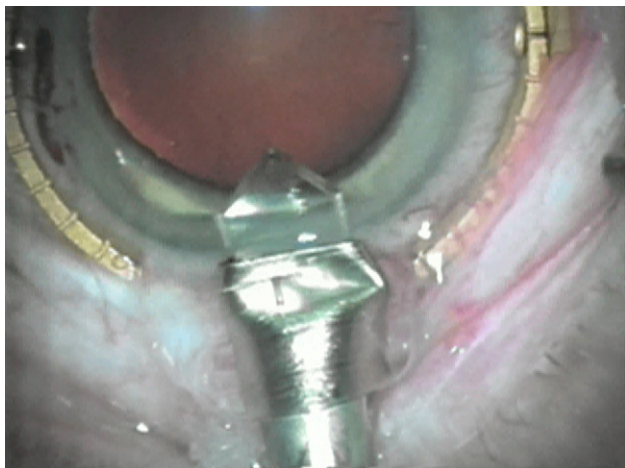


Figure 2. Clear corneal incision construction with the blade completely inserted.



Figure 3. Optical coherence tomography image of a control eye showing the corneal periphery including the anterior chamber angle.

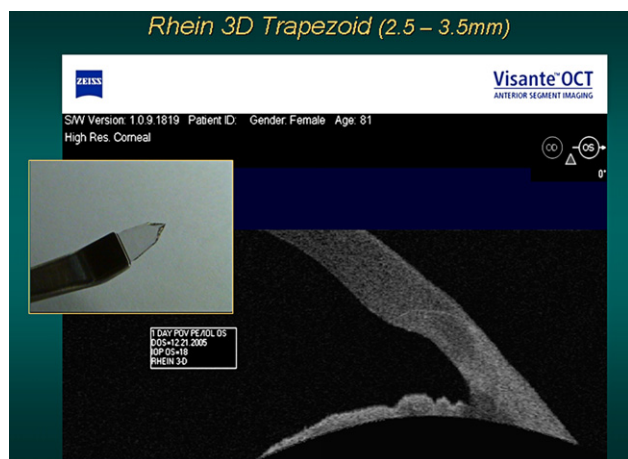


Figure 4. Optical coherence tomography image of a clear corneal incision made with the Rhein 3D trapezoidal 2.5 to 3.5 mm blade. Image of the blade is inset.



Figure 5. Optical coherence tomography image of a clear corneal incision made with the Rhein 3D trapezoidal 2.5 to 3.5 mm blade. Image of the blade is inset.

corneal epithelium blending into the conjunctiva and the clear corneal stroma blending into sclera can be clearly seen.

PATIENTS AND METHODS

All clear corneal incisions were made by the same surgeon (I.H.F.). The OCT images of each operative eye were taken on the first postoperative day within 24 hours of cataract surgery and are representative of multiple images from multiple patients. Incision width was defined as the measurement parallel to the limbus. Incision length was the distance, in a straight line, between the external incision and the entrance through Descemet's membrane. Several types of knives were used to create the clear corneal incisions during cataract surgery.

RESULTS

Figures 4 and 5, which were taken on the first day postoperatively, show a clear corneal incision that is actually curvilinear, not a straight line, as seen in the artist's depiction of clear corneal incisions (Figure 1). This arcuate incision was considerably longer than the chord length originally estimated for the length of the incision. The architecture of the incision allowed for a fit not unlike tongue-and-groove paneling, adding a measure of stability to these incisions and making it considerably less likely that 1 surface will slide over the other.

Figure 6 shows an incision that was made with a 300 μ m groove at the external edge of the incision before incision construction. The incision still had a curved or arcuate configuration, but the gapping of the external groove, noted on the first day postoperatively, was accompanied by a similar offset of the internal lips of the incision, which

appeared to be somewhat less stable than a paracentesis-style incision.

These images appeared to demonstrate the persistence of stromal swelling from stromal hydration on the first postoperative day, which many critics of clear corneal incisions believed disappeared within 1 to 2 hours. To confirm that the swelling was the result of stromal hydration rather than surgical trauma, OCT images were taken of cases in which there was no stromal hydration of the incision. Figure 7 is representative of an incision that did not receive stromal hydration and shows less thickening around the incision and some gapping of the internal lip of the incision.



Figure 6. Optical coherence tomography image of a clear corneal incision with a 300 μ m groove at the external edge of the incision. Image of the Rhein 3D blade is inset.

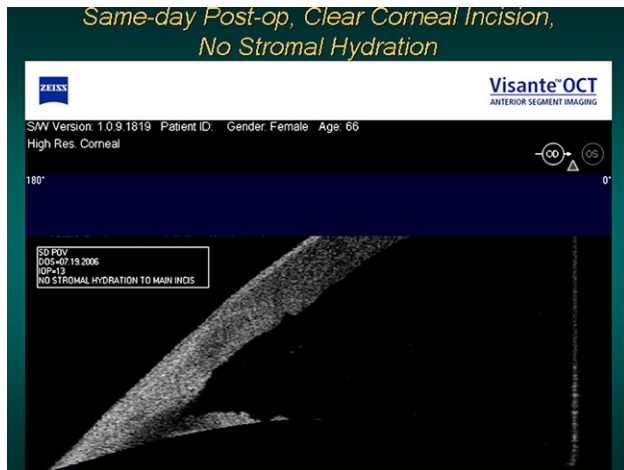


Figure 7. Optical coherence tomography image of a clear corneal incision that did not receive stromal hydration.

All clear corneal incisions had a similar arcuate architecture, even though they were constructed using a variety of blades. Figures 4 to 6 show clear corneal incisions made with the Rhein 3D trapezoidal blade (#05-5088, Rhein Medical). The BD Kojo slit blade (BD Medical-Ophthalmic Systems) is metal and is curved in the direction of the width of the incision. This created an arcuate incision paralleling the curvature of the peripheral cornea with a chord length whose width was considerably smaller than the arcuate incision in the dimension tangential to the limbus itself, which may add a greater degree of stability. Figure 8 shows the advantageous architecture of the incision constructed by the BD blade; again, the arc length was considerably longer than the chord length and was probably a hyper-square incision in that it was only 2.0 mm wide.

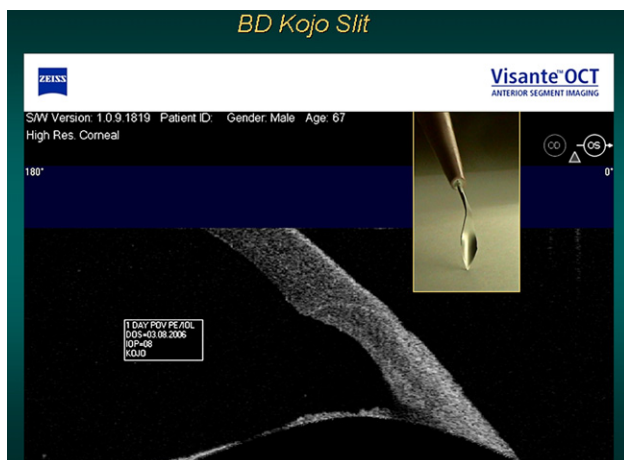


Figure 8. Optical coherence tomography image of a clear corneal incision made with the BD Kojo slit blade.

DISCUSSION

One of the surprising findings was that proper incision construction resulted in a longer incision than the chord length that was measured and in greater stability (like tongue in groove paneling) of the incision. Another surprising finding was that stromal swelling does last for at least 24 hours. These findings demonstrate some characteristics we believe have contributed to an added measure of safety with clear corneal incisions that, in conjunction with other prophylactic measures, can result in the absence of endophthalmitis.

Endophthalmitis prophylaxis involves many factors including proper preoperative antibiotic regimen; preparation of the surgical field including povidone-iodine (Betadine) and draping over the lashes and meibomian orifices; incision construction; surgical technique, including atraumatic surgery; power modulations to avoid heating the incision; not grasping the roof of the incision with a toothed forceps, which would abrade the epithelium and disrupt the fluid barrier for endothelial pumping; incision closure; testing for leakage; and postoperative antibiotics. At our practice, not a single case of infectious endophthalmitis has occurred in more than 9000 cases over a period exceeding 10 years.

Attention to all details of endophthalmitis prophylaxis is essential. However, incision construction leading to proper architecture is of primary importance among all variables that are part of endophthalmitis prophylaxis and not all clear corneal incisions are the same.

In conclusion, an incision in the plane of the cornea with a chord length of at least 2.0 mm appears to provide advantageous architecture for adequate self-sealing.

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