Wound Construction

Square limbal incisions offer the highest margin of safety.

BY PAUL H. ERNEST, MD

A surgeon's goal with any wound is to stabilize it mechanically until fibroblasts can seal it histologically. In ophthalmology, a secondary aim is for this process to occur without any adverse effect on the refractive state of the eye.

Despite pharmaceutical and technological advances and the use of smaller incisions, the incidence of endophthalmitis after cataract surgery rose from 1:1000 in 1992 to 1:400.[1] I believe that change is due to ophthalmologists' increasing use of clear corneal incisions. Determining the safest cataract incision should be based on science and can be discussed in terms of two categories, geometry and location.

GEOMETRY

I studied science engineering in college before deciding as a senior to pursue a career in medicine. My early training has strongly influenced my work in ophthalmology.

I became interested in wound construction in 1990. In laboratory studies, my colleagues and I inflated cadaver eyes with fluid and used pressure gauges to determine how different cataract incisions withstood increases in IOP. We found that only wounds with an internal corneal lip did not rupture or leak.[2] When critics questioned the relevance of our findings for external pressure, I conducted further research in which square incisions with a 1.5-mm corneal component proved to be the most mechanically and refractively stable (Figure 1). They resisted external pressures as great as 525 psi,[3] and additional vector analysis demonstrated that square incisions induced only 0.25 D of cylinder.[4]

LOCATION

Surgeons create cataract incisions either in the avascular clear cornea or in the limbus and sclera. Interestingly, many ophthalmologists who say they use clear corneal incisions really make them in the anterior limbus. Cutting through any of the terminal vascular arcade of the conjunctiva means that the incision is in the anterior limbus. If it is made in front of those vessels, no bleeding occurs, and the location is truly the clear cornea.

In feline studies, my colleagues and I found that incisions made in vascular (ie, limbal) tissue heal within 7 days, whereas those created in avascular (ie, corneal) tissue heal

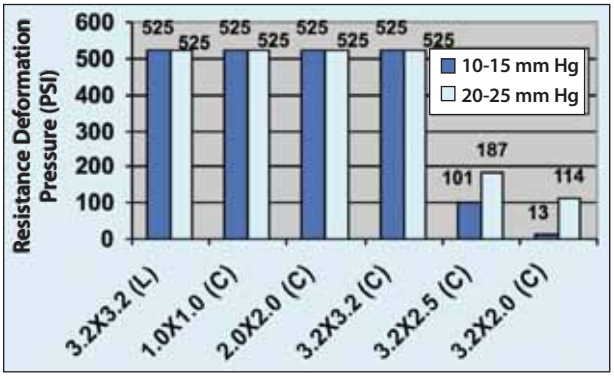

Figure 1. The author's research demonstrated that geometrically square incisions offered the most resistance to deformational pressure independent of their location. Rectangular incisions provided significantly lower resistance to deformational pressure and depended on the IOP.[2,3] (Note: The incisions' dimensions are given in millimeters.)

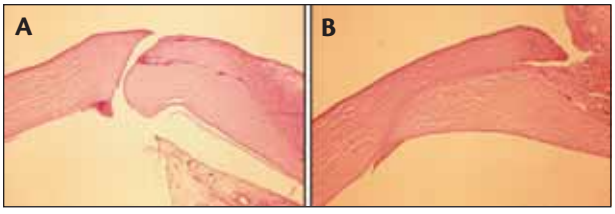

Figure 2. Seven days postoperatively, there is no sign of fibroblastic activity at the site of this corneal incision (A). In contrast, fibroblasts have completely sealed this limbal incision 7 days after surgery (B).[5]

in 30 to 60 days[5] (Figure 2). Incisions in the vascular limbus prompt a fibroblastic response. In the avascular cornea, keratocytes must undergo metaplasia and turn into fibroblasts in order to seal the wound.

In studies, my colleagues and I evaluated cataract incisions' resistance to deformational pressure in cadaver and feline eyes (Figure 3). The amount of pressure required to open the clear corneal incision was the same in the feline eye at 4 days postoperatively as in the cadaver eye. These results demonstrate that no fibroblastic activity was taking place at that time in the cat's eye, and they show that the theory of the endothelial pump is not valid, because obviously no endothelial pumping occurs in a cadaver. In contrast, a comparison of limbal incisions in cadaver and feline eyes demonstrated a resistance to deformational pressure by postoperative day 4 that was complete by postoperative day 7 in the animal model.[6,7]

Starting the cataract incision in the limbus (Figure 4) also offers a refractive advantage. The more posterior the incision is, the less flattening of the cornea occurs initially during the first several days postoperatively.[8]

Finally, for fibroblastic sealing to take place, the ocular tissue must return to its original configuration after stretching during surgery. Unlike the cornea, the limbus and sclera contain elastin, so incisions there can accommodate instrumentation without becoming distorted.

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The downside of limbal incisions is that, if the surgeon moves too posteriorly or drags some posterior conjunctiva into the incision, the shoulder of the keratome may create a buttonhole in the conjunctiva. Conjunctival ballooning could result. This complication, however, requires a subtle learning curve to avoid. Moreover, fluid egress is less with today's tighter phaco tips. Finally, should this complication occur, the surgeon can halt the procedure and perform what I call a *miniperitomy* for approximately 3 mm, and the ballooning will cease. Cauterizing the conjunctival incision is unnecessary; it will seal on its own by the next day.

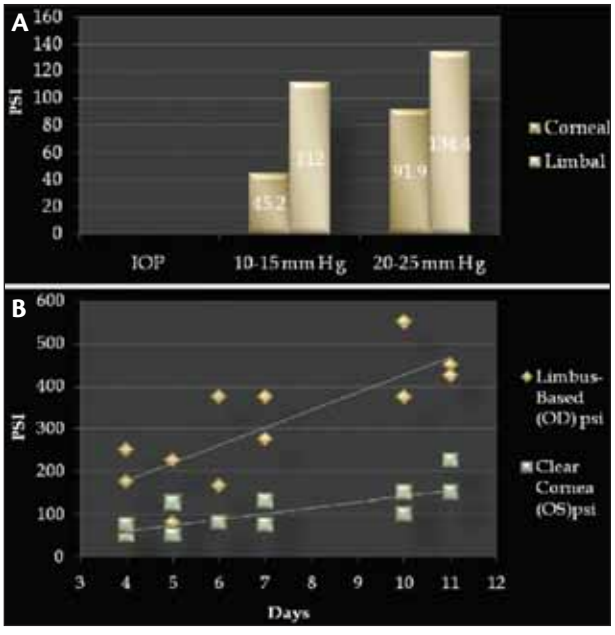

Figure 3. The same 3.00 X 1.75-mm corneal and limbal incisions in cadaver (A) and feline (B) eyes. In a side-by-side comparison, the clear corneal incision's resistance to deformational pressure was the same in the cadaver eye as on postoperative day 4 in the feline eye. These results implied that the endothelial pump did not stabilize the wound and that fibroblasts were not present to seal the incision. In contrast, on postoperative day 4, the limbal incision made in the feline eye offered more than two times greater resistance to deformational pressure than the same incision in a cadaver eye due to fibroblastic activity.[4,6,7]

CONCLUSION

The attraction of clear corneal incisions is that they are easier to create than limbal incisions (ie, no conjunctival issues) and the eye is clear on postoperative day 1. When they were introduced at the ASCRS annual meeting in 1992, clear corneal incisions were a minimum of 4.0 mm in

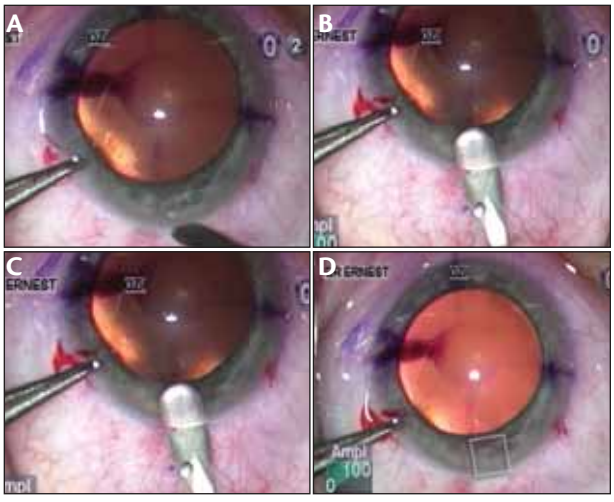

Figure 4. With the tip of a crescent blade, Dr. Ernest makes a 2.2-mm wide, partial-thickness incision through the limbus (A). A 2.2-mm tunnel incision is dissected into the cornea with an upward bias (B). A 2.2-mm keratome blade enters the anterior chamber through Descemet's membrane (C). The outline of the square limbal incision is highlighted (D).

width with a caudal length of 1.5 mm. Since then, they have become progressively narrower. I suspect that the rate of endophthalmitis was worse in the early stages of this type of incision than it is today

Whether or not my subjective impression is true, bacteria are introduced into the eye either during surgery or afterward. The fact that some ophthalmologists have performed 3,000 or 11,000 cataract procedures without one case of endophthalmitis is not scientific proof that clear corneal incisions are safe. I myself cannot remember when I last encountered this infection, but I believe it was before 1998, almost 30,000 cases ago.

No scientific evidence has been published to show that clear corneal incisions offer a higher margin of safety than limbal incisions. The contrary is true. Choosing the cataract incision that seals faster minimizes the time during which bacteria can enter the eye postoperatively. This is why I favor a square limbal incision. ■

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