

Watertight cataract incision closure using fibrin tissue adhesive

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PURPOSE: To determine whether a simple method for applying fibrin tissue adhesive to a clear corneal cataract incision can create a watertight seal.

SETTING: Laboratory investigation.

METHODS: Clear corneal cataract incisions were simulated in 8 eye-bank eyes. In 4 eyes, fibrin adhesive was applied to the incision in a simple manner; the other 4 eyes were controls with no adhesive. Each eye was tested under low pressure conditions to detect fluid ingress of India Ink on the eye's surface. The eyes were tested again with external compression to distort the incision to detect fluid egress.

RESULTS: In the eyes with fibrin adhesive, there was no egress of fluid with incision distortion and no ingress of India Ink. In the 4 eyes without adhesive, there was ingress and egress of fluid.

CONCLUSION: A simple method of applying fibrin adhesive to cataract incisions created a watertight seal.

J Cataract Refract Surg 2007; 33:1461–1463 © 2007 ASCRS and ESCRS

Entering the anterior chamber through a 2-step clear corneal incision is considered standard practice in modern small-incision cataract surgery. However, Pow et al.¹ have shown that postoperative bacterial endophthalmitis is more common in patients having these incisions than in those having the scleral tunnel technique. McDonnell et al.² postulate that clear corneal incisions initially self-seal because intraocular pressure (IOP) forces the internal lip of the incision to close (Figure 1, top). However, when the IOP drops

within a few hours, internal incision gape allows the incision to imbibe ocular surface fluid (Figure 1, bottom).

Fibrin tissue adhesive has shown promise in ocular applications including trabeculectomy,³ lamellar keratoplasty,⁴ and pterygium.⁵ In studies by Kim et al.⁶ and Henrick et al.,⁷ fibrin adhesive was effective in closing scleral tunnel cataract incisions. This study was designed to determine whether a simple method of applying fibrin tissue adhesive to a clear corneal cataract incision can create a watertight seal.

Accepted for publication March 15, 2007.

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Presented at the annual meeting of the American Academy of Ophthalmology, Las Vegas, Nevada, USA, October 2006.

Supported by a grant from Baxter BioScience, Deerfield, Illinois, USA.

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MATERIALS AND METHODS

Four fellow-eye pairs of eye-bank corneas were tested; 4 eyes received fibrin adhesive and 4 eyes did not. Each cornea was mounted on an artificial anterior chamber (ALTK System, Moria USA) (Figure 2), and fluid was infused from a 500 mL bottle of balanced salt solution (BSS) through intravenous tubing from a height of approximately 75 cm. Simulated intraocular pressure (IOP) was measured with a TonoPen XL (Medtronic, Inc.). A peripheral incision was made with a 2.85 mm slit knife (Surgical Specialties Corp.) beginning at the limbus and tunneling about 2.0 mm centrally, where it entered the artificial anterior chamber.

Simulated IOP was lowered to nearly zero by slowly lowering the BSS bottle to a point just above the height where the corneal surface showed the first subtle signs of collapse. In control eyes, no fibrin adhesive was placed in the corneal incisions.

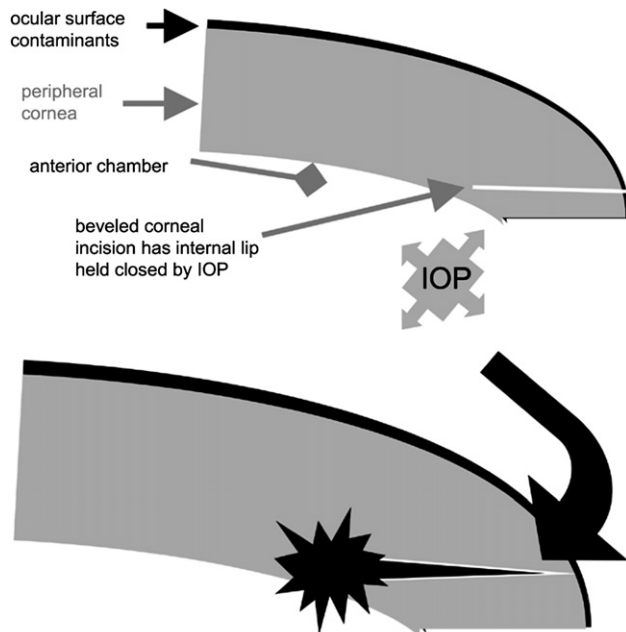


Figure 1. *Top:* Initially, a beveled corneal incision will self-seal because hydrostatic pressure in the eye forces the internal lip of the wound to close. *Bottom:* The IOP drops in the first few hours after surgery, and incision gape allows ocular surface contaminants to enter the anterior chamber.

Preparation and Application of Adhesive

For the adhesive eyes, Tisseel VH fibrin sealant (Baxter BioSurgery) was prepared according to the manufacturer's instructions. Instead of using the manufacturer-supplied syringes, 0.1 cc of each component (thrombin and fibrinogen) was drawn into a separate 1.0 cc syringe through an 18-gauge needle. The needle was then removed from each syringe. At the tip of the thrombin syringe, a small bead of thrombin was formed and this was applied to the bottom side of the metal slit knife to wet this surface of the blade. In a similar manner, a small bead of fibrinogen was applied to the opposite flat side of the same metal slit knife. Thus,



Figure 2. Experimental apparatus.

each flat side of the slit knife carried 1 component of the adhesive, but the 2 were separated and could not polymerize. This knife was then carefully inserted, without cutting tissue, into the temporal corneal incision to coat the anterior and posterior aspects of the incision with fibrinogen and thrombin, respectively (Figure 3). While the adhesive was applied, a small amount of BSS was visible coming from the artificial anterior chamber. Without manipulating the eye further, the adhesive was allowed to polymerize for 30 seconds.

In both control and adhesive corneas, each incision was tested for ingress of fluid under low IOP conditions. With the infusion bottle held at the level at which the adhesive was applied, a small amount (about 50 μ L) of India Ink (Parker Quink, Parker Pen Co.) was lightly painted onto the external incision opening using a soaked Weck cell sponge. Penetration of dark fluid into the incision canal, visible at the microscope within 1 minute of applying the ink, was considered a positive sign of ingress.

To test for egress of fluid under high IOP conditions, the BSS bottle height was raised to 75 cm. A dry Merocel sponge (K-sponge, Katena Products, Inc.) was used to apply gentle pressure to the anterior and posterior edges of the incision. Visible egress of fluid during 10 seconds of manipulation was considered a positive sign of egress.

RESULTS

Results are shown in Table 1. The mean IOP at a bottle height of 75 mm was 33 mm Hg \pm 3 (SD) (range 26 to 37 mm Hg). In the 4 control eyes without adhesive, ingress of India Ink into the clear corneal incisions was visible at low IOP. In the eyes with adhesive, no ingress of India Ink or egress of fluid was visible at low IOP. At 75 mm bottle height, all 4 control eyes showed egress of fluid when the anterior or posterior incision margin was lightly compressed with forceps. Similar compression of the incision margin in adhesive-sealed eyes led to no egress of fluid.

DISCUSSION

This study demonstrates that corneal incisions used for cataract surgery can be sealed with fibrin tissue adhesive and will resist ingress of ocular surface fluid during low pressure conditions or egress of fluid during external compression. There are several limitations

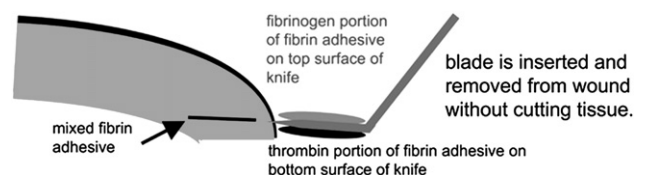


Figure 3. At the conclusion of surgery, fibrin adhesive is applied to the corneal wound by coating the top and bottom surfaces of a slit knife with each component of the adhesive. The knife is then inserted into the wound, without cutting tissue, to coat the anterior surface with fibrinogen and the posterior surface with thrombin. When the knife is withdrawn, the 2 components mix, sealing the wound.

Table 1. Results of IOP and fluid ingress/egress testing.

Donor and Eye	IOP (mm Hg)		Visible Ingress of India Ink?	Egress of Fluid?
	at 75 cm Bottle Height	Adhesive Applied?		
1, left	33	No	Yes	Yes
2, left	37	No	Yes	Yes
3, left	30	No	Yes	Yes
4, left	33	No	Yes	Yes
1, right	35	Yes	No	No
2, right	34	Yes	No	No
3, right	35	Yes	No	No
4, right	26	Yes	No	No

to the methodology used in this study. First, the corneal fluid dynamics in human eye-bank eyes might differ from those in a living patient. Second, testing for fluid leakage with external compression is not an easily standardized test and may not be an ideal simulation of the eyelid forces that exist after cataract surgery. However, this simple test is what most surgeons use to determine whether suture placement is necessary after cataract surgery. Presumably, passing the Merocel compression test implies adequacy of wound closure that would satisfy most surgeons. The test demonstrates better wound closure with fibrin adhesive than with no adhesive.

This study suggests that fibrin tissue adhesive may have a place in routine cataract surgery, but several barriers to its routine implementation exist. First, the toxicity of fibrin adhesive to intraocular structures has not been carefully studied and requires further investigation. Second, to be a useful surgical sealant, the duration of action of the fibrin adhesive would have to extend beyond the time that natural healing renders most eyes self-sealed. This generally occurs 1 to 2 days after surgery when epithelial surfaces fuse and the endothelial pump provides internal “suction” to render the incision resistant to all but significant external forces. Fibrin adhesive is known to provide about 7 days of adhesive strength—more than enough for cataract surgery.

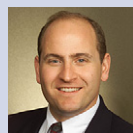
A better method of applying fibrin adhesive to a corneal cataract incision may exist. In the United States,

Tisseel adhesive is supplied with a Duploject double-syringe system (Baxter AG) that includes a double-barrel cannula for dispensing the 2 adhesive components to the surgical site. This cannula was not used in our study because it was thought the large size would distort the corneal incision, with egress of enough anterior chamber fluid to dilute the adhesive components and render them ineffective.

Paracentesis incisions are routinely created in cataract surgery and were not addressed in this study. Because of their small size, they are thought to be self-sealing and most surgeons do not suture them. However, it may be worthwhile to apply adhesive to the epithelial surface of these small incisions to provide total closure.

REFERENCES

1. Powe NR, Schein OD, Gieser SC, et al. Synthesis of the literature on visual acuity and complications following cataract extraction with intraocular lens implantation; the Cataract Patient Outcome Research Team. *Arch Ophthalmol* 1994; 112:239–252; erratum, 889
2. McDonnell PJ, Taban M, Sarayba M, et al. Dynamic morphology of clear corneal cataract incisions. *Ophthalmology* 2003; 110:2342–2348
3. Bahar I, Lusky M, Gatton D, et al. The use of fibrin adhesive in trabeculectomy: a pilot study [letter]. *Br J Ophthalmol* 2006; 90:1430
4. Kaufman HE, Insler MS, Ibrahim-Elzembely HA, Kaufman SC. Human fibrin tissue adhesive for sutureless lamellar keratoplasty and scleral patch adhesion; a pilot study. *Ophthalmology* 2003; 110:2168–2172
5. Koranyi G, Seregard S, Kopp ED. Cut and paste: a no suture, small incision approach to pterygium surgery. *Br J Ophthalmol* 2004; 88:911–914
6. Kim JC, Bassage SD, Kempfski MH, et al. Evaluation of tissue adhesives in closure of scleral tunnel incisions. *J Cataract Refract Surg* 1995; 21:320–325
7. Henrick A, Kalpakian B, Gaster RN, Vanley C. Organic tissue glue in the closure of cataract incisions in rabbit eyes. *J Cataract Refract Surg* 1991; 17:551–555



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