

Conductive Keratoplasty: A Surgical Management Option for Presbyopia

CK improves near vision, without disrupting distance vision or depth perception.

BY TATIANA L. NAOUMIDI, MD, PhD

Conductive keratoplasty (CK) is known to improve near vision in presbyopic patients, with little or no compromise of binocular distance vision or depth perception. This procedure also maintains preoperative levels of contrast sensitivity, and it boasts excellent safety—even with LASIK flap creation.

Even though there are clear benefits associated with CK, some surgeons are still hesitant to use this procedure for presbyopia correction. First, patients must show a history of monovision lens wear or undergo a successful preoperative monovision trial. Second, the correction is only limited to fewer than 2.25 D, and the surgeon must overcome a learning curve that includes avoidance of inducing cylinder. (See *Minimizing Induced Cylinder: Five Pointers*.) Last, the US Food and Drug Administration (FDA) has currently labeled CK as a temporary presbyopia correction.

The history of keratoplasty dates back to 1898, when L.J. Lans¹ defined the principles of keratotomy. As this ideal evolved, Gasset and Kaufman² performed the first thermal keratoplasty in 1975, followed by the development of hyperopic thermal keratoplasty³ in 1981, and the first thermal keratoplasty with a Nd:YAG laser for the correction of hyperopia⁴ in 1990.

RADIO FREQUENCY ENERGY

CK is a relatively easy procedure that delivers controlled-release radio frequency energy (350 KHz) to the stroma at 500 μm , via a 90- μm keratoplast tip. This causes an increase in the corneal stroma temperature, due to electric impedance in the flow of energy through the three-dimensional grating of collagen fibrils. Once the collagen fibrils reach 65° C (ie, the optimal temperature for permanent collagen shrinking), denaturation occurs. Collagen shrinkage occurs in a cylindrical diameter of approximately 100 μm and a depth of 500 μm .

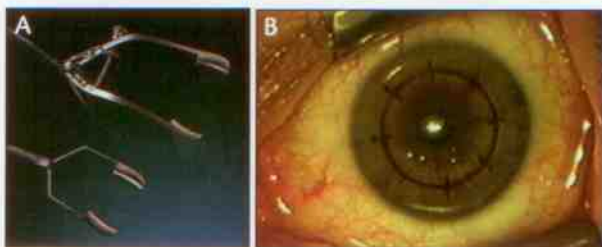


Figure 1. The speculum (A) is positioned, and the corneal surface is marked (B), to create a template for CK treatment.

If 65° C is not reached during CK, then the corneal stroma will rehydrate and regain its original configuration. Conversely, if the temperature reaches 75° C to 80° C, then necrosis of the corneal stroma will occur, and poor healing response and scar formation will occur. Either outcome (ie, under- or overheating) will certainly result in a refractive regression.

A good candidate for CK should: (1) have presbyopia, (2) be older than 45 years, (3) need reading spectacles, (4) have bad bilateral near UCVA and good bilateral distance UCVA, (5) have fewer than 0.75 D cylinder in both eyes, and (6) have 0.75 D or fewer of sphere in both eyes. Patients should

MINIMIZING INDUCED CYLINDER: FIVE POINTERS

- Mark the corneal surface precisely.
- Do not use heavy staining in the cornea, and be sure to avoid excessive coloring.
- Use the markers to carefully apply each spot to the cornea.
- When applying spots, always stay perpendicular to the cornea.
- Do not insert the probe into the same spot more than one time.

CK FOR ASTIGMATISM AT THE TIME OF CATARACT SURGERY

BY ELIZABETH A. DAVIS, MD, FACS

We know that nearly one-third of patients undergoing cataract surgery have more than 1.00 D of astigmatism. And, given that most surgeons actually worsen or induce astigmatism unless they perform on-axis incisions, about half of cataract patients have more than 1.00 D of astigmatism postoperatively—a degree of astigmatism that is incompatible with 20/20 vision. Just 1.00 D of residual astigmatism will reduce visual acuity to 20/30, while 1.50 D of residual astigmatism will reduce it to 20/50.

Conductive keratoplasty (CK) at the time of cataract surgery is a simple and effective solution for an era in which our refractive goal after cataract surgery, especially with new technology presbyopia-correcting IOLs, should be 0.50 D or fewer of cylinder.

I perform CK for astigmatism (CK-A) in cases with 1.25 D of astigmatism or greater, but 3.00 D or fewer of cylinder. In an ongoing study, my colleague and partner, Richard L. Lindstrom, MD, and I have treated nine eyes. The median age of patients is 63 years. Results are presented in Table 1. There have been no complications, no induction of astigmatism, and no loss of BCVA. Follow-up is ongoing.

TECHNIQUE PEARLS

CK-A should be performed prior to making any incisions for the cataract surgery. I apply topical proparacaine and a povidone-iodine swab to the eyelids and place the lid speculum. Next, I mark the cornea under the operating microscope, using an RK marker to mark the flat axis (Figure 1) and a CK marker to denote the 6-, 7-, and 8-mm optical zones (Figure 2). Using moderate to light pressure of

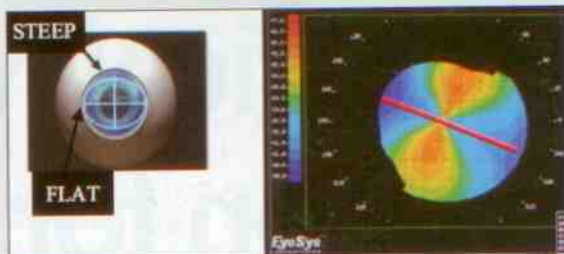


Figure 1. The cornea is marked under the operating microscope.

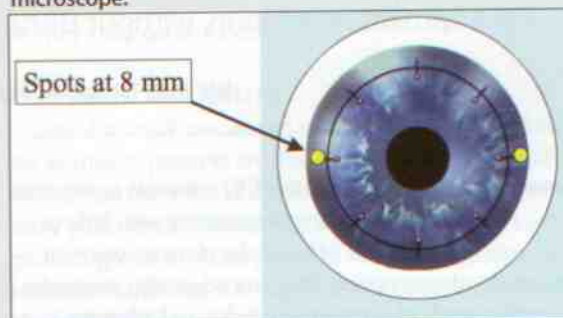


Figure 2. A CK marker denotes the optical zones.

the CK probe, I place two spots straddling the flat meridian (minus cylinder axis) at the 8-mm optical zone.

The CK-A procedure takes approximately 3 minutes. Afterward, the speculum is removed, and the patient is prepped and draped with standard sterile technique. I reglove and proceed with cataract surgery.

CK is a safe procedure that does not weaken the cornea or cause dry eye. It is titrateable, meaning that the surgeon can begin conservatively and add more spots later, depending on the outcome. Approximately 90% of cataract surgery astigmatism treatments and enhancements may probably be done with CK alone. If additional effect is needed, astigmatic keratotomy or excimer laser correction may be performed. In my opinion, CK-A is an ideal solution for the refractive cataract surgeon who wants to offer patients greater spectacle independence. ■

Elizabeth A. Davis, MD, FACS, is a partner at Minnesota Eye Consultants in Bloomington, Minnesota, and she is Adjunct Assistant Clinical Professor of Ophthalmology at the University of Minnesota, in Minneapolis. She states that she holds no financial interest in the products or companies mentioned. Dr. Davis may be reached at +1 952 885 2474; eadavis@mneye.com.

TABLE 1: CK-A AT THE TIME OF CATARACT SURGERY

	Preop	2 Weeks Postop	1 Month Postop
UCVA	N/A	20/30	20/30
BCVA	20/50	20/20	20/20
Spherical equivalent	-1.71 D (range, -7.00 D to 2.50 D)	-0.29 D	-0.50 D
Mean cylinder (preop) and reduction in cylinder (postop)	Manifest 1.41 D (range, 0.75 D to 2.50 D)	Manifest 0.75 D reduction	Manifest 0.75 D reduction
	Keratometric 1.56 D (range, 1.25 D to 2.13 D)	Keratometric 1.02 D reduction	Keratometric 0.78 D reduction
	Topographic 1.84 D (range, 1.12 D to 3.00 D)	Topographic 0.87 D reduction	Topographic 1.12 D reduction



Figure 2. CK is applied to the predetermined spots.



Figure 3. Two spots should constitute rings with 6-, 7-, and 8-mm diameters.

also have a clear central cornea, undistorted central mires in topography, no latent hyperopia, and a greater than 550- μ m peripheral pachymetry at a 6-mm optical zone. Outlined below are the basic steps of CK:

- Apply a topical anaesthesia to the eye.
 - Position the speculum. Mark the corneal surface to create a template for the CK treatment application (Figure 1).
 - Apply the CK spots to the marks on the cornea (Figure 2).
- Apply this series of spots in a circular pattern to create a band of circumferential tightening within the stroma. This will secondarily steepen the paracentral optically active cornea.

The spots should constitute rings with 6-, 7-, and 8-mm diameters if necessary (Figure 3). The number of the spots is defined by the nomogram.

CK is a relatively easy procedure that delivers controlled-release radio frequency energy to the stroma at 500 μ m, via a 90- μ m keratoplast tip.

FDA STUDY

McDonald et al⁵ presented results from the US FDA study on CK. The investigators set out to treat presbyopia (ie, 0.75 D to 3.00 D, fewer than 0.75 D cylinder) in 150 patients (188 eyes). They also corrected hyperopia in the dominant eye, and overcorrected the nondominant eye to produce myopia. The NearVision CK (Refractec, Irvine, California) was used to place 16 spots in eyes with 1.00 D to 1.625 D or 24 spots in eyes with 1.75 D to 2.25 D. Although the range of correction was 0.75 D to 3.00 D, the mean intended correction was 2.03 \pm 0.63 D.

At 1 month and 6 months postoperative, only 1% of eyes (n=145 and 146, respectively) lost more than two lines of distance BCVA. At 12 months, no eyes (n=77) lost more than two line of distance BCVA. Furthermore, no eyes at 1, 6, and 12 months had a distance BCVA worse than 20/40 or

an increase in cylinder above 2.00 D. With respect to near BSCVA, 86% of patients experienced no change at 12 months and no eyes experienced a decrease of vision more than two lines. Fourteen percent of patients experienced an increase of one line at 12 months, however, no eyes experienced an increase of two or more lines.

The investigators concluded that the quality of vision at 12 months postoperative improved, whereas 98% of patients noted an improved quality of vision. Additionally, 84% of patients were satisfied with the results of their CK, and 100% maintained fair to excellent depth perception. The rate of adverse events was also low, with only 1% of patients experiencing a decreased BSCVA of more than 10 letters not due to irregular astigmatism.

MY EXPERIENCE

I have also used CK in my practice, with excellent results. In a 60-year-old female, I placed eight spots at 7 mm in the dominant eye and 16 spots at 7 mm and 8 mm in the nondominant eye. Her preoperative UCVA was J12 in the dominant eye and J16 in the nondominant, and 12 months post-CK, UCVA was J4 and J1, respectively. I added 2.75 D to both eyes.

In a 49-year-old male who experienced a regression of presbyopia 6 months postlaser sclerotomy, I placed 32 spots. His preoperative UCVA was J5, and after adding 1.50 D, he was J1.

I have found that CK is a beneficial technique for the correction of presbyopia. Results from the FDA trial, as well as my personal results, are promising. I have found that CK improves my patient's near vision, and they are still able to have good distance vision and depth perception. This procedure has excellent safety, and I will continue to use CK in my practice. ■

Tatiana L. Naoumidi, MD, PhD, is a Clinical Researcher in the Vardinoyannion Eye Institute of Crete, University of Crete, in Greece. Dr. Naoumidi states that she has no financial interest in the companies or products mentioned. She may be reached at Tatiana@Naoumidi.com; info@EyeInstituteCrete.com.

1. Lars LJ. Experimentelle Untersuchungen über Entstehung von Astigmatismus durch nicht-perforierende Corneawunden. *Graefes Arch Ophthalmol*. 1898; 45: 117-152.
2. Gasset AR, Kaufman HE. Thermokeratoplasty in the treatment of keratoconus. *Am J Ophthalmol*. 1975;79:226-232.
3. Fyodorov SN, Ivashina AI, Aleksandrova OG, Bessarabov AN. Surgical correction of compound hypermetropic and mixed astigmatism by sectoral thermal keratoagulation. *Implants in Ophthalmology*. 1990; 2: 43-48.
4. Seiler T, Matallana M, Bende T. Laser thermokeratoplasty by means of a pulsed holmium:YAG laser for hyperopic correction. *Refract Corneal Surg*. 1990;6:335-339.
5. McDonald MB, Durrie D, Asbell P, et al. Treatment of Presbyopia With Conductive Keratoplasty(R): Six-Month Results of the 1-Year United States FDA Clinical Trial. *Cornea*. 2004;23(7):661-668.