

Advent of conductive keratoplasty

CK is a fairly new non-laser refractive surgery technique that does not involve a lamellar cut or removal of corneal tissue. After a quiet entry onto the UK market, its success in the US has led many companies to rethink the potential patient benefits. **Gareth Paterson** reports

TYPICALLY, BETWEEN the ages of 40 and 45, patients approach optometrists with tales of woe regarding their inability to focus on near objects. The usual role of the optometrist is to guide their patient towards new spectacles or contact lenses. But as surgical techniques mature, other options can be discussed.

Many presbyopes have already benefited from corrective refractive surgery such as Lasik, Lasek and PRK, which can accurately correct hyperopia, myopia, and astigmatism. With this sudden freedom from distance corrective appliances, patients are now looking to correct their near vision symptoms. The fundamental differences between ametropia at distance and presbyopia mean that any surgery to alleviate near vision symptoms must take a different approach.

Heat-based refractive surgeries have been attempted in various forms during the last 100 years. Fyodorov – inventor of radial keratotomy – recently attempted to utilise heat-based corneal shrinkage to change corneal curvature. But there are problems with these ‘hot wire’ surgeries,

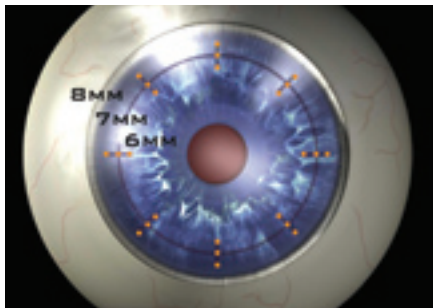


FIGURE 2. Positioning of the three treatment rings

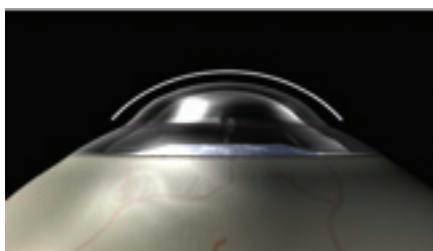
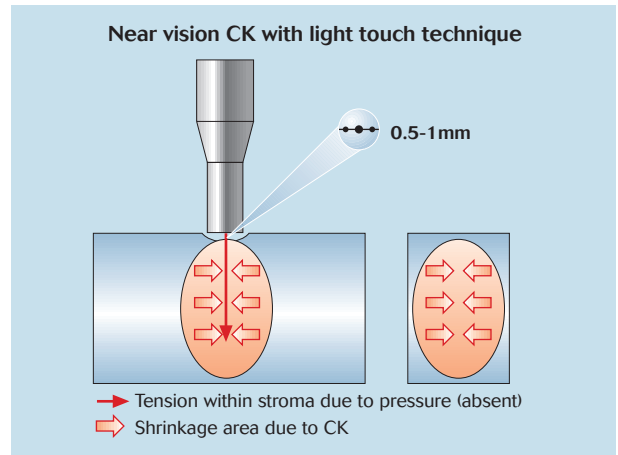


FIGURE 3. Changes in corneal shape after treatment

FIGURE 1. Rf action as it heats surrounding collagen



as although the nichrome wire reaches temperatures as high as 600°C, when applied to the cornea it cools instantly. This results in an irregular distribution of the heat energy, meaning results are unpredictable. Conductive keratoplasty (CK) uses radio frequency (Rf) energy to generate heat at specific sites within the cornea. Studies have found the treatment to be more predictable and stable than previous surgeries.

CK is most often used to steepen the central cornea in patients with hyperopia or to treat the symptoms of presbyopia in emmetropic or mildly hyperopic presbyopes. Other applications include the treatment of unsatisfactory refractions resulting from Lasik surgery and fine-tuning the refraction after cataract and intraocular lens (IOL) surgery. Modifications in the surgical method, called the ‘light touch’ technique, have further improved predictability and reduced side effects.

FDA studies and the worldwide surgical record of more than 175,000 procedures have shown the CK treatment to be safe and effective.

MECHANISM OF ACTION

The CK procedure, performed using the ViewPoint CK system from Refractive, Irvine, California, is based on the delivery of a precise amount of Rf energy (350Hz) through a finely-tipped stainless steel probe – diameter 90µm – inserted into the peripheral cornea at pre-marked spots along a 360° ring of 6,7 or 8mm diameter (Figure 2).

The probe extends 450µm into the cornea and no further, as an insulated Teflon-coated governor prevents a deeper treatment (Figure 1). Heat is not applied directly to the surface of the cornea, but is generated within the tissue due to the resistance of the stromal fibres. The tissue is raised to around 65°C, which causes the

collagen fibres to shrink without totally denaturing the protein. The tip acts as a heat sink carrying heat away, rather than a source that applies heat to the tissue. This is unlike laser thermal keratoplasty (LTK) and ‘hotwire’ techniques that heat downward from the corneal surface, heating the outermost fibres more than those deeper in the cornea.

Localised shrinkage of the collagen induces a contraction between treated areas flattening the mid-periphery, decreasing chord length and consequentially inducing steepening of the central cornea (Figure 3). When used for the treatment of astigmatism, CK is applied to one or more spots in a selected meridian to steepen that treated meridian. The process is self-limiting as the increasing denaturation of collagen reduces the efficacy of the Rf field and a reduction in temperature follows. The refractive effect of CK is determined by the number of spots treated, the number of rings treated and the diameter of that treatment ring. If all points were treated on all three rings, for maximum effect, the change of prescription would be +3.50D.

The procedure takes around one minute per ring of treatment, or about three to five minutes per eye. The cornea is marked initially with a target to identify the treatment spots. The surgeon gently applies the probe to the eye surface at the selected locations using the ‘light touch technique’. The treatment could vary from eight to 32 spots, depending on the prescription. Throughout the treatment the patient may be aware of some visual distortion but should not feel any pain or discomfort.

The surgeon will then instil antibiotic and anti-inflammatory drops and a bandage contact lens, which improves post surgical comfort, and can be removed the next day. After the procedure, treatment spots initially show whitening caused by localised oedema and thermal insult, but

EXPECTATIONS AND TOLERANCE

Probably the most important factor for patient selection is that patients must be able to tolerate the imbalance in the vision between the eyes, and must hold realistic expectations of what can be achieved.

Near vision CK helps patients to read the mobile phone numbers and newspapers but it may not help patients who perform sustained periods of close and detailed work. They may have to continue wearing reading glasses after the treatment. As with most elective surgery, patient satisfaction is often predictable from how well they are counselled on realistic outcomes.

RESULTS AND COMPLICATIONS

CK was developed initially as a treatment for mild hyperopia and approved by the FDA in 2002 after initial trials and subsequent studies showed a predictability and reliability in this role.

Results received from studies into its use as a treatment to help those with presbyopia have indicated that around 84 per cent of patients said they were either satisfied or very satisfied with the visual results and 98 per cent of individuals were able to see J5/N8 again indicating a high success rate.

The graphical representation of the improvement to patients' near vision shown in Figure 5 indicates the possible gains for our presbyopes. New roles for CK are being investigated as it may represent a less invasive method to control residual astigmatism after Lasik, PRK or cataract extraction. Early indications are encouraging.

Adverse events following any surgical procedure are inevitable, although certain procedures pose more risk in frequency and severity of potential complications, and patients must be aware of these. CK is known to have a lower incidence and severity of complications because, unlike procedures requiring corneal incisions such as excimer laser technology, CK is minimally invasive.

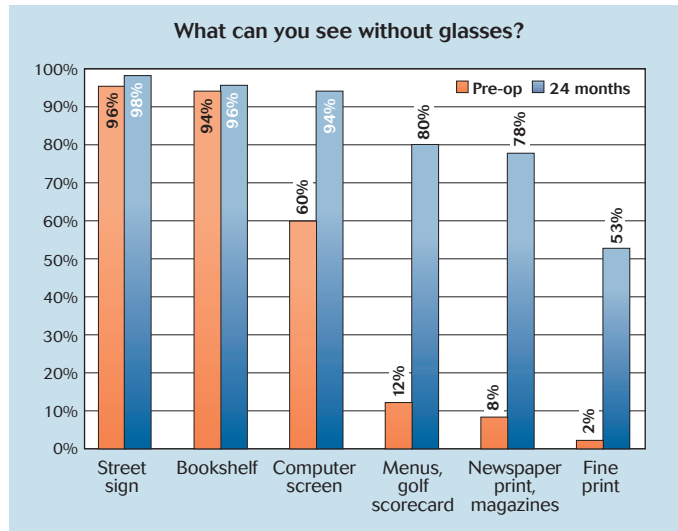


FIGURE 5. Graph showing pre- and postoperative visual results for CK patients

As with any surgical procedure, proper patient selection, a thorough ocular examination, together with careful discussion of the procedure's benefits, risks, and limitations are vital.

IMMEDIATELY AFTER TREATMENT

Within the first few hours after the procedure the patient may feel a variety of symptoms including sensitivity to light, watering, mild redness and foreign body sensation that will resolve with the use of postoperative antibiotic, anti-inflammatory and lubricating drops.

Patients should wear sunglasses after the procedure if necessary. Distance vision will be blurred for a day or two but improves quickly over the course of the first week (Figure 6). The variation of corneal power of the cornea means that although distance acuity improves the acquired near vision is not lost.

RE-TREATMENTS FOR OVER- AND UNDER-CORRECTION

Due to an individual's prescription level and unique corneal healing process, a second treatment or enhancement may be needed within the first year.

Re-treatments are usually performed for induced astigmatism, under correction

or over correction. These complications occur at a frequency of 5 to 8 per cent of cases, and are most commonly observed in patients under the age of 45.

Under correction is more common than over correction and can be treated with additional placement of CK spots. In studies performed immediately after the initial approval of CK the major reported side effect was of induced astigmatism. However, the use of the light touch technique in recent years has reduced this dramatically.

PATIENT CO-MANAGEMENT

The quick healing and low incidence of side effects after CK allow many patients to be managed at the practice of their local optometrist, rather than having to make repeated trips to the treatment clinic.

The role of the optometrist within the aftercare process promotes the idea that the optometrist is more than a spectacle provider. This helps to maintain the relationship that is so often lost when a patient has refractive surgery. Appointments the day after treatment, at two weeks, eight weeks to three months, six months and 12 months provide the patient with an adequate post-surgical care scheme.

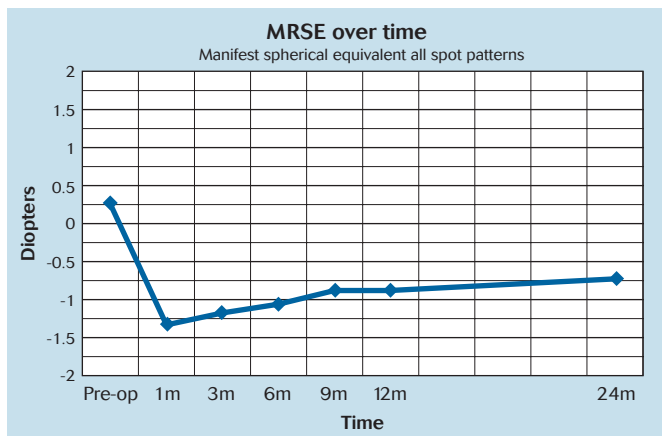


FIGURE 6. Graph showing the changes in manifest refraction spherical equivalent (MRSE) in the 24 months after treatment

References

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