



Collagen cross-linking A new treatment for keratoconus

Clare McDonnell describes a treatment likely to change the way we view keratoconus management

Keratoconus is a condition in which the biomechanical strength of the cornea's collagen fibres is reduced to about half their normal strength, causing the cornea to bulge forward in a conical shape, with an off-centre apex. This change in shape of the cornea results in high levels of irregular astigmatism, which is initially corrected with spectacles but, as the disease progresses, the astigmatism increases and requires correction with specialist contact lenses. Eventually, if the keratoconus becomes very advanced, some patients will require a corneal graft.

A new procedure aims to halt the progression of keratoconus, before it reaches the stage where a graft is required. This procedure is based on increasing the tensile strength of the cornea by cross-linking. Until recently cross-linking was not widely known in ophthalmology, but it is a standard technique used in polymer science, for increasing the mechanical strength of a material.

Professor Theo Seiler, of the Institute for Refractive and Ophthalmic Surgery, Zurich, Switzerland, first described a method of increasing the strength of the cornea using cross-linking, in 1998.¹ Before undertaking a feasibility



David Jory using the collagen cross-linking machine

study in keratoconus patients, he and his colleagues used *in vitro* and animal models, to evaluate the efficacy and safety of different methods, for inducing corneal cross-linking.^{2,3,4} The treatment technique they devised, involves abrasion of the central corneal epithelium and application of photosensitising riboflavin 0.1 per cent eye drops in dextrane solution to the denuded cornea, followed five minutes later by irradiation with 365nm UVA light for 30 minutes.

The ultraviolet light causes the riboflavin to release oxygen radicals, which in turn create new cross-linking bonds between collagen lamellar fibres and within the collagen molecules. This causes an increase in corneal rigidity, similar to that which occurs naturally as a result of ageing or diabetes.

To date the longest Prof Seiler's patients have been followed up is five years post-operatively. All eyes have shown no further progression of the keratoconus and in 65 per cent of eyes the keratoconic corneas have assumed a more normal shape, with consequent improvements in visual acuity.⁵ The procedure has now been adopted by various ophthalmologists, in different countries, with all of them reporting similar results.⁶ Moreover, no adverse effects have occurred during follow-up

Optician talks to David Jory, the first UK surgeon to train in collagen cross-linking, about the London Centre for Refractive Surgery

'My father set it up as the first refractive surgery clinic in the UK in 1987 to much opposition (including from several now doing it!).

Only Peter Choyce was supportive. Initially we did just incisional surgery ie radial and astigmatic keratotomy. I still use this with very good results to correct low myopia, astigmatism and cases where the laser can't be used, eg nystagmus, thin corneas, dry eyes etc, as well as to correct laser problems such as remaining myopia

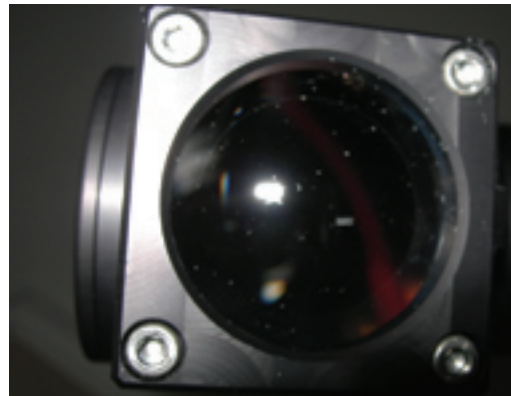
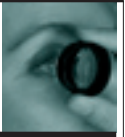
or astigmatism. Then my father tried PRK and I did some as well after I joined in 1997. We were disappointed with the results, but when we found the loss of contrast sensitivity and tried to report this, we could not find a research journal to accept this study.

'Since then this has been widely accepted and laser surgeons and companies trumpet how much better they are than old lasers for night vision.

'We were the first to perform diode thermokeratoplasty in 1998 and one of the first with CK in 2003. I was the first to use the OII phakic 6 lens implant in 2000. I employ two other surgeons in the clinic for refractive lens exchanges and cataracts and

use multi-focal lens implants. I use ReSTOR multifocal lens implants as well as standard lenses. Last year I was the first surgeon to go from the UK to train on the collagen cross-linking machine in Zurich. I have used prototypes here for a year now on an experimental basis and in January I started using the first EU approved IROC machine, which can be combined with Intacs corneal implants (which I also do here) to treat keratoconus, post-Lasik ectasia and pellucid marginal degeneration as well as a number of other possible uses.

'So you can see that while the LCRS is derided as being of the dinosaur age by many, in fact we are often the first into areas of refractive surgery.'



Two views of the collagen cross-linking machine

and safety evaluations show no apoptosis of endothelial cells, if the corneal thickness is at least 400 microns pre-treatment and there has been no change in the clarity of the cornea or the lens.⁷ Professor Seiler has, however, reported that the long-term data available in rabbits treated with the riboflavin/UV light cross-linking technique, show that keratoconus eventually begins to progress again.

The future for collagen cross-linking is a very exciting one. It may also be used to treat other ectatic disorders – pellucid marginal degeneration, post-Lasik keratectasia – and because of its low cost, it may have applications in developing

countries, where corneal grafts are not readily available. ●

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● Clare McDonnell is an optometrist working in the refractive surgery sector

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