Therapeutic use of refractive surgery laser technology

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It is seldom discussed outside of sub-specialist corneal units, but refractive surgery lasers can also be used for therapeutic/rehabilitation purposes. Current laser refractive procedures have excellent refractive predictability and stability, resulting in over 17 million patients having undergone LASIK globally. The technologies involved are excimer lasers (that reshape the cornea) and femtosecond lasers (used as non-mechanical scalpels) – both can be harnessed for therapeutic medical use.

The cornea performs 75% of the focusing of light in the eye. Therefore, a small change in corneal shape has a large impact on vision quality. Various diseases or trauma can opacify the cornea or alter the shape of it, leading to severe vision loss. In selected cases, the lasers mentioned can be used to restore corneal clarity and optimal optical shape. As well, therapeutic laser treatment can sometimes help to delay or even avoid corneal transplantation.

Excimer laser and therapeutic use

Excimer lasers are high energy ultraviolet lasers. The cornea can be reshaped by precise placement of these tissue vapourising laser spots. Modern lasers are fast (up to 1000Hz) and can rapidly follow the patient's eye in four axes during the treatment. Current diagnostic platforms accurately capture the three-dimensional shape of the cornea as well as analyse the optics of the eye, all in unprecedented detail. This data is then fed into software that programs the treatment pulses required.

In therapeutic treatments, the abnormal shape of the cornea is remodeled by the laser to the desired optical shape. The laser can also remove corneal opacities, such as scars in the superficial 1/3 of the cornea. The level of vision restoration is often remarkable (see Figure 1). Painful blistering corneal conditions such as recurrent erosion syndrome can be treated by minimal laser surface ablation to encourage epithelial adhesion.

Femtosecond laser and therapeutic use

Femtosecond lasers are precision non-mechanical cutting tools. These infrared lasers have ultra brief (10^{-15} sec) pulses that can cut three-dimensional shapes within the cornea by causing multiple adjacent minute spots of explosions in it. Currently, these lasers are mainly used to cut LASIK corneal flaps immediately before excimer laser ablation.

Therapeutic uses of femtosecond lasers include cutting both the corneal transplant and host into precise shapes that have complex edges (e.g. zig-zags) to improve wound strength and postoperative optical quality. The laser can also split corneas into lamellae for partial layer transplantation. Precision corneal tunnels can be created for plastic ring segments implantation in treatment of keratoconus. With these treatments, corneal transplantation may be delayed or even avoided.

Fig 1. This patient had moderate Band Keratopathy (a common calcific corneal degeneration) that had reduced his vision to 6/24. A light laser keratectomy cleared the deposits completely and returned vision to 6/6. The large circular clearing in the centre of the cornea (left image) was the treated area.

Such treatments are more common in overseas public hospitals equipped to perform LASIK. In Australia, Medicare does partially fund these therapeutic treatments and some private clinics in WA offer them. ■