Singapore Med J 1998; Vol 39(7):335-336

Refractive Surgery – Then and Now

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INTRODUCTION

Refractive errors are commonplace throughout the world and in Singapore, the problem is particularly acute as the incidence and severity of refractive errors, especially that of myopia, has become a national concern. Over the years, many attempts have been made to study the etiology as well as various means of preventing its progression, especially that of myopia.

Surgical correction of refractive errors began as far back as 1708 when Boerhaave suggested clear lens extraction for the correction of myopia. However many opponents of refractive surgery have questioned the rationale and ethics of its practice as it contradicted the disease-driven nature of medical practice. In the 1930s, a Japanese ophthalmologist, Sato, described posterior keratotomy for the correction of myopia when he noticed that patients with keratoconus who were complicated by splits in the Descemet's layer of the cornea had a reduction of myopia. His procedure was abandoned in the 1960s when it was found that many of the patients who underwent posterior radial keratotomy developed corneal decompensation. However, this led to the subsequent development of anterior radial keratotomy described by Fodorov and Durnev, which matured into radial keratotomy, as we know it today. Since then, refractive surgery has, with the aid of laser technology as well as more precise and delicate instruments, produced increasingly accurate, predictable and safer results, so much so that it has once again captured the attention of eye-care professionals and patients alike.

To date, the cornea is the target of most refractive procedures because: 1) it is the most accessible of the 3 parameters; 2) it accounts for two-thirds of the total refractive power of the eye, and 3) surgery on the cornea is non-invasive.

WHY REFRACTIVE SURGERY?

The current non-surgical means of correcting ametropia ie. with the use of spectacle or contact lens is relatively safe and satisfies the need of most of the ametropes in the world today. However, spectacles are cumbersome and inconvenient. Furthermore, with higher degrees of ametropia, spectacle correction introduces undesired optical aberrations, which decreases the quality of vision. Contact lens has its share of inconvenience of requiring regular cleansing, risks of sight-threatening complications as well as its effects on the normal physiology of the cornea. There are also certain individuals who desire to be rid of their dependence on spectacles or contact lenses because of cosmesis, job requirements and contact lens or spectacle intolerance. Refractive surgery may have a place for them.

Today, the most common surgical procedures for refractive correction are:

1. Excimer laser photorefractive keratectomy (PRK)
This technique utilises the 193-nm excimer laser to ablate corneal tissue, flattening the anterior corneal curvature, thereby reducing myopia[1]. The advantages of this laser are that it is extremely accurate and it causes little or no collateral tissue damage. Results with this technique are excellent especially with the low myopes of up to 6D with more than 90% of treated eyes achieving an unaided Snellen vision of 6/12 or better. More than 90% of these eyes are also within 1 dioptre of intended correction[2]. Results are poorer for the higher myopes of more than 6D of myopia, where only about 75% of treated eyes achieving 6/12 or better of unaided Snellen vision and only 50% of eyes attaining a final refraction within 1 dioptre of intended correction[3]. Modifications of this technique allow for astigmatic correction by differential corrections in different meridians of the cornea. Complications and side effects are largely related to corneal haze.

2. Laser in-situ keratomileusis (LASIK)
LASIK utilises a microkeratome to create a hinged corneal flap, which is flapped over to expose the bed of the underlying corneal stroma. The excimer laser is then applied to this corneal stromal bed. Upon completion, the corneal flap is replaced[4]. Early reports claim to produce better results for the correction of high myopia, causes less post-operative pain and has much less problems with corneal haze[5]. However it requires a higher level of technical expertise. As LASIK is a relatively new procedure, more results will have to be generated to indicate its safety, predictability, stability and accuracy.

3. Radial keratotomy (RK)
This involves making a series of deep radial cuts in the peripheral cornea, thereby causing peripheral corneal steepening and central corneal flattening[6].

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The amount of myopia to be eliminated determines the size of the central zone, the number and depths of these cuts. RK is also more suitable for the correction of low myopes of less than 6 dioptres. The main problem of RK is the tendency of hyperopic shift in the ensuing post-operative years[6] as well as a structural weakening of the globe.

4. Astigmatic keratotomy (AK)
This involves making deep corneal incisions in the astigmatic meridians to alter the overall corneal curvature so as to reduce the corneal astigmatism. The degree of corneal astigmatism corrected depends on the configuration, the optical zone, as well as the number and depth of these cuts. Since Ruiz described the procedure in 1981, many different modifications with their corresponding normograms have been devised.

What is on the horizon?

1. Intrastromal corneal rings
In this procedure, synthetic rings are inserted into the peripheral corneal stroma, which will dictate the new curvature of the corneal surface, thereby altering its refractive power. Its main advantage is the fact that the correction achieved is reversible by removing the ring as well as the fact that a new ring could be exchanged for an existing one should the patient require a change in refractive power. It is largely used for the correction of low myopes presently.

2. Phakic intraocular lens implants
This involves the placement of appropriate intraocular lens implants over an existing crystalline lens to correct existing refractive error. It is used mainly for the correction of high myopia. Largely experimental at this stage, this technique is currently being investigated as a clinical trial.

CONCLUSIONS

Refractive surgery is in an exciting era. However, the practising ophthalmologists, referring physicians and patients considering these corrective procedures must always bear in mind that these procedures are not without risks, which may include that of loss of best corrected vision.

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