

## A Review of Refractive Surgery

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### Abstract

Refractive surgery has become the most rapidly developing field in ophthalmology over the last two decades. Several modern refractive procedures have become available over the last 10 years including phakic intraocular lenses (pIOLs), epithelial laser-assisted *in situ* keratomileusis (epi-LASIK), wavefront-guided (WG) laser treatments and a few others. Laser and non-laser refractive surgical procedures are currently used to address refractive errors. No single procedure works best for everyone; each one has its own set of advantages and disadvantages. Careful patient selection is the key for optimum visual outcomes. Treatment algorithms have been refined over the years, improving accuracy. Laser technology and delivery platforms are under continuous improvement, leading to increasingly precise results. Further modifications and refinements are ongoing, offering expanding surgical options in this rapidly evolving field.

### Keywords

Laser-assisted *in situ* keratomileusis (LASIK), photorefractive keratotomy (PRK), laser subepithelial keratectomy (LASEK), epithelial LASIK (epi-LASIK), surface ablation, phakic intraocular lens, refractive lens exchange, incisional refractive surgery, thermal keratoplasty, wavefront-guided, astigmatic keratectomy

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Refractive surgery has enjoyed a vast increase in demand over recent years, not just as a cosmetic and lifestyle-improving procedure, but also as a means of complying with occupational vision standards.<sup>1</sup>

The main principle of any refractive procedure is to change the refractive state of the eye towards emmetropia where light rays are perfectly focused on the retina. The two main refractive components of the eye are the cornea and the crystalline lens; therefore, all refractive surgery is directed towards altering the refractive power of one or both of these components.<sup>2</sup> The four principle types of refractive errors, i.e. myopia, hyperopia, astigmatism and presbyopia, singly or in combination, can be corrected by refractive surgery. There is a wide range of available surgical modalities and this range is expanding all the time.<sup>2,3</sup> Refractive surgery procedures can be divided into incisional, thermal, excimer laser ablation and intraocular.

### Incisional Refractive Surgery

The first report of using an incision to alter the shape of the human cornea was in the 19th century, when Schiøtz used a limbal relaxing incision in a patient who underwent cataract surgery.<sup>4</sup> In 1894, Bates noticed that traumatic peripheral corneal scars could flatten the cornea in the meridian of the scar without affecting the meridian that was 90° away. This supported the idea that anterior corneal incisions could create more symmetry in astigmatic corneas.<sup>5</sup> In 1939, Sato performed posterior corneal incisions to correct myopia and astigmatism. Unfortunately this technique led to corneal decompensation and was only in use for a short period.<sup>6</sup> Yanaliev performed 426 incisional refractive surgery between 1969 and 1977 and found that peripheral anterior corneal incisions could treat myopia

up to 4D.<sup>7</sup> Thereafter, anterior corneal incisions were introduced by Fyodorov, Durnev and other Russian ophthalmology surgeons.<sup>8</sup>

### Radial Keratotomy

Fyodorov and Durnev developed an efficient system of anterior radial corneal incisions around a pre-determined optical zone and treated thousands of myopic patients with great predictability.<sup>9</sup> This procedure became known as radial keratotomy (RK). The desired amount of correction was achieved by altering the diameter of the optical zone and the number of radial cuts. RK could be combined with tangential (or horizontal) smaller cuts in the steep meridian, to correct astigmatism.

In 1981, a prospective evaluation of RK (PERK) study recruited 435 patients to determine the outcomes of a single RK technique in patients with -2.00 to -8.00D of myopia with -1.50D or less of astigmatism.<sup>10</sup> The 90% prediction interval of the PERK study at four years was spread over a range of 4.42D.<sup>11</sup> Only 53% of eyes achieved uncorrected visual acuity (UCVA) of 20/20 or better and 43% of eyes experienced a hyperopic shift of 1.00D or more at 10-year follow-up.<sup>12</sup> Furthermore, a persistent diurnal change in the corneal curvature, refraction and visual acuity of 71 patients from the PERK study was also reported at the 11-year follow-up.<sup>13</sup>

The results of the PERK study were discouraging. Other disadvantages such as infection, weakening of the cornea and night vision problems were also undesirable. This, combined with the increased accuracy and predictability of laser surgery relegated RK to a more or less obsolete procedure. Nevertheless, RK remains an important milestone in the history of refractive surgery.

## Incisional Management of Astigmatism

Incisional keratotomy procedures to address naturally occurring astigmatism have become more limited, due to the availability of improved toric phakic intraocular lenses (pIOLs) and the development of laser refractive surgery. These offer better predictability compared with incisional techniques. Nevertheless, astigmatic keratotomy (AK) is the procedure of choice to correct high post-keratoplasty astigmatism and small degrees of pre-existing astigmatism at the time of cataract surgery.

### Astigmatic Keratotomy

AK is an established method of the management of post-keratoplasty astigmatism.<sup>14-16</sup> Different patterns for AK have been developed over the years but all of them share the principle of placing an incision at the steep axis of astigmatism. Currently, transverse incisions and arcuate incisions are most commonly used.<sup>17</sup> Arcuate incisions have the advantage of being equidistant from the optical zone.<sup>18</sup> AK is a relatively safe and easy procedure involving placement one or two incisions perpendicular to the steep axis of astigmatism. This flattens the given corneal meridian with reciprocal steepening of the meridian, which is 90° away. The ratio of the flattening of the steepest meridian to the steepening of the flattest meridian is known as 'coupling ratio'.<sup>19</sup> Incisions can be performed by freehand techniques,<sup>15,19</sup> mechanically by using Hanna arcitome<sup>20</sup> and, recently, by femtosecond laser.<sup>21,22</sup> Several factors affect the refractive outcome of AK; the number of incisions, incision length, incision depth, gender and age of the patient.<sup>23</sup>

Wilkins et al. reported a significant reduction of the mean of the astigmatism from 10.99 to 3.33D after performing a pair of standardised arcuate incisions.<sup>19</sup> Similarly, Nubile et al. showed a mean reduction of astigmatism of 5.00D after arcuate incisions by femtosecond laser.<sup>22</sup> Arcuate incisions may be combined with compression sutures placed 90° away from them to reduce large degrees of astigmatism after keratoplasties. The compression suture is often placed across the graft-host junction in the flattest meridian to increase the curvature of the cornea in that meridian.<sup>24,25</sup>

### Relaxing Incisions

Limbal relaxing incisions (LRIs) and peripheral corneal relaxing incisions (PCRIs) are incisional procedures used to correct small degrees of astigmatism. They are commonly used to correct pre-existing astigmatism in patients undergoing cataract surgery. They have the advantage of sparing the optical zone, thus minimising night vision problems.

Different nomograms for relaxing incisions are available in the literature. In general, the number, depth, length and placement of incision(s) are dependent on the age of patient, the degree and the type of pre-operative astigmatism.<sup>26</sup> Relaxing incisions are believed to be safe and effective for correcting astigmatism up to 2.50D.<sup>17</sup> However, Amesbury and Miller suggested that patients with more than 1.50D are better treated by toric IOLs.<sup>27</sup>

### Thermal Procedures

Thermal procedures are non-invasive and non-excimer-based modalities. The principle of using thermal energy to treat hyperopia via stromal collagen shrinkage within the cornea was used over 40 years ago.<sup>28</sup> The most common types of this class are laser thermal keratoplasty (LTK) and conductive keratoplasty (CK). They promote collagen fibre shrinkage within the mid-peripheral and/or peripheral

cornea inducing steepening of the central cornea thus correcting mild to moderate hyperopia and can also address presbyopia.<sup>29,30</sup>

### Laser Thermal Keratoplasty

The non-contact holmium:yttrium aluminium garnet (YAG) laser is used to place radial spots outside the visual axis. This heats the corneal surface, resulting in a cone-shaped zone of collagen shrinkage. The apex of the cone extends up to approximately 60% of the stroma.<sup>31</sup> There are few well-controlled LTK studies in the literature. LTK has been used to correct hyperopia up to 4.00D and has shown some initial promising results in the correction of low hyperopia.<sup>31</sup> However, it has been associated with induced irregular astigmatism and a significant regression rate.<sup>31-33</sup> Alió et al.<sup>33</sup> reported a regression rate of 31% after six months.

### Conductive Keratoplasty

CK is a non-invasive procedure that delivers radiofrequency current (350kHz) directly into the corneal stroma. CK uses the electrical properties of corneal tissue to generate heat in the cornea. The resistance of stromal tissue to the current flow generates gentle and controlled collagen heating and causes optimal collagen shrinkage when temperature reaches 65°C. This produces a cylindrical footprint that extends approximately to 80% of the depth of the peripheral cornea.<sup>31,34</sup> Deep penetration is desirable and necessary to minimise regression, because permanent collagen contraction is dependent on achieving a consistent deep zone of collagen shrinkage.<sup>35</sup> A probe is used to create eight to 32 points in a ring pattern at 6, 7 or 8mm optical zones. The number of treatment spots is determined by the level of hyperopia.<sup>34</sup>

CK offers several advantages over LTK. As previously discussed, the footprints of CK are deeper, homogeneous and cylindrical than those created by LTK. Therefore, CK shows mild to moderate regression rates compared with LTK.<sup>36</sup> A low regression rate has been estimated to be +0.024D per month between the first and the second year after CK.<sup>37</sup> Furthermore, it has a more controlled delivery system and causes less thermal damage to the surrounding collagen lamellae compared with LTK.

Low to moderate hyperopic patients who are not suitable for excimer laser surgery may be candidates for thermal techniques, CK in particular.<sup>29</sup> Furthermore, thermal procedures have the advantage over excimer laser ablation techniques in the following domains: they take place outside the optical zone, avoid flap-related complications, preserve the integrity of the cornea and are cheaper and easier to perform.<sup>36</sup> In comparison with pIOLs, CK has the advantage that it can be used to treat hyperopia and astigmatism of less than 1.00D whereas pIOLs are available only from +1.00D for sphere and astigmatism.<sup>38</sup>

Nevertheless, thermal procedures currently have a small place in the refractive surgery market due to their limitations in the effective treatment of high levels of hyperopia. Moreover, recent advances in laser ablation surgery including femtosecond flap and wavefront-guided (WG) treatments have enhanced their potential of achieving greater accuracy and predictability. Similarly, the development of multifocal and accommodative IOLs provides a wider spectrum of addressing hyperopia and/or presbyopia.

Most studies reported that 100% of treated eyes had best corrected visual acuity (BCVA) of 20/40 or better with no loss of more than two

lines of BCVA, and at least 89% of eyes achieved UCVA of 20/40 or better.<sup>29,34,37,39,40</sup> The major complication of the CK treatment appears to be surgically induced astigmatism (SIA). McDonald et al. and Lin and Manche reported SIA of 1.00D or more in 10% of treated eyes. However, no patient experienced an increase of  $\geq 2.00$ D of cylinder.<sup>34,37</sup>

In summary, CK is an effective, predictable, stable and safe procedure to treat low to moderate hyperopia.<sup>30,37,39,40</sup> In addition, monovision CK has been shown to be successful for the management of presbyopia.<sup>29-30</sup>

### Excimer Laser Refractive Surgery

The invention and development of excimer laser technology had a great impact on the transition from incisional to corneal ablation techniques. In 1983, Trokel et al. reported that excimer laser, using argon fluoride gas to emit ultraviolet pulses with a wavelength of 193nm, could be used to ablate bovine corneal stroma.<sup>41</sup> Later, Seiler<sup>42</sup> and L'Esperance<sup>43</sup> carried out the first excimer laser in blind eyes. McDonald et al. performed the first excimer laser ablation treatment on a seeing myopic eye.<sup>44</sup> Several effective options of excimer laser surgery are now available and can be divided into surface or lamellar ablations.

### Surface Ablation Techniques

This class of laser refractive surgery includes photorefractive keratectomy (PRK), laser subepithelial keratectomy (LASEK) and epithelial laser *in situ* keratomileusis (epi-LASIK). They differ mainly in the manner in which the corneal epithelium is removed prior to laser ablation. Excimer laser is then applied to photoablate the anterior corneal stroma. In PRK, the first available treatment modality from this group, the epithelium is removed either mechanically by scraping it with a blade or chemically by using a diluted solution of ethanol. In the latter approach the epithelial sheet is not repositioned after laser ablation. On the other hand, in LASEK the flap is repositioned gently over the ablated tissue. An alternative surgical procedure to separate the epithelium mechanically by using an epi-keratome was introduced by Pallikaris et al. in 2003. The technique is widely known as epi-LASIK.<sup>45,46</sup>

The application of 18–20% solution of ethanol breaks the hemi-desmosomal attachments, cleaving the basement membrane between lamina lucida and lamina densa, allowing the sheet to be removed or peeled off without disintegrating. Using dilute solution of alcohol to remove the epithelium is easy, fast and safe compared with mechanical debridement,<sup>47</sup> although alcohol can be potentially toxic to the epithelial and stromal cells. In addition, alcohol-assisted PRK can produce sharp wound edges and a smooth Bowman's zone and thus less haze and corneal irregularities than with mechanical removal.<sup>48,49</sup>

The advantage of epi-LASIK over LASEK is that the epithelium can be peeled off as a complete sheet without the use of alcohol. Several epi-keratomes have been developed for the epithelial dissection, which will allow the creation of epithelial sheet. These devices differ from LASIK microkeratomes in that the blade and its angle of cutting are designed for a clean subepithelial dissection in anterior Bowman's zone, without disrupting the stromal tissue.<sup>50</sup>

Laser surface ablation is a better option than LASIK in patients with epithelial irregularities, dry eye syndrome, large pupils, thin corneas, patients with possible risk of post-LASIK flap dislocation and in patients with possible risk of keratectasia.<sup>45,46</sup>

As PRK has been around for longer than any of the other procedures, data from several long-term follow-up studies are available. Myopic-PRK has been reported to be a safe, stable and effective procedure in the long term.<sup>51-54</sup> Alió et al. reported that 77% of patients with myopia less than 6.00D had UCVA of 20/40 or better 10 years after PRK.<sup>52</sup> This rate dropped to 63% in patients with myopia more than 6.00D.<sup>51</sup> Minimal haze and good stability were reported in eight- and 12-year follow-up studies.<sup>53,55</sup> In a meta-analysis study, refraction stabilisation was achieved three months after PRK.<sup>56</sup>

Comparative studies of surface ablation techniques showed similar refractive outcomes.<sup>57,58</sup> Zhao et al. compared 499 eyes that underwent PRK to 512 treated with LASEK and found that LASEK had no significant visual benefit over PRK but corneal haze was less in the LASEK group one to three months post-operatively.<sup>58</sup> O'Doherty et al. compared the three surface modalities and showed that the epi-LASIK group reported lower levels of pain.<sup>57</sup> Lee et al. reported significantly less pain scores in the LASEK group with a mean score of 1.6 out of 4.0 compared with 2.3 for PRK.<sup>59</sup> By contrast, Pirouzian et al. showed no difference in pain scores.<sup>60</sup>

The most common complications of all surface ablation techniques are pain and corneal haze. Haze is significantly less common and less severe following correction of low myopia compared to high myopia.<sup>51,52</sup> Mitomycin-C (MMC) is often used during surface ablation procedures to prevent haze by modifying the corneal wound-healing process.<sup>61,62</sup> A recent meta-analysis showed that MMC led to significantly less corneal haze in PRK. However, no advantage of MMC was found in LASEK and epi-LASIK.<sup>63</sup>

### Laser In Situ Keratomileusis

In the early 1990s, Pallikaris<sup>64</sup> and Buratto<sup>65</sup> independently described a technique of laser ablation of the corneal stroma, which involved the creation of a flap of anterior stroma including Bowman's and epithelium with the aid of a microkeratome. LASIK was the name given by Pallikaris to this globally adopted procedure. The development of laser technology and the improvement of LASIK surgical techniques including tracking systems, refined nomograms, femtosecond flaps and WG treatment, have all taken place in the rapid evolution of LASIK which proudly celebrated its 20th anniversary in 2010.

LASIK has been used to treat 15.00D of myopia, 6.00D of hyperopia and 6.00D of astigmatism.<sup>66</sup> However, due to risk of long-term ectasia, the recommendation have been revised down to around 10.00D ensuring that a residual bed of 275 $\mu$ m is maintained allowing for the flap thickness.<sup>66</sup> LASIK is a lamellar laser ablation technique in which a superior or nasal hinged corneal flap is created by mechanical microkeratome or femtosecond laser. The flap is reflected at the hinge away from the stroma prior to laser ablation. The flap is then repositioned. Pre-placed marks on the flap and corresponding peripheral cornea ensure accurate repositioning.

Automated mechanical microkeratomes create flaps of 130–180 microns. Femtosecond lasers have been reported to create more accurate, uniform and thinner flaps (100 $\mu$ m or less).<sup>67,68</sup> Furthermore, they induce less astigmatism, higher-order aberrations and epithelial ingrowth compared with mechanical microkeratomes.<sup>69</sup> However, femtosecond lasers are more expensive and have their own complications, such as increased incidence of diffuse lamellar keratitis (DLK), anterior chamber bubbles and opaque bubble layer.<sup>70,71</sup>

LASIK has been reported to be superior to PRK in terms of patient comfort post-operatively, visual stabilisation and rehabilitation, and stromal haze formation. Moreover, LASIK tends to offer higher rates of efficacy and predictability and a lower rate of regression, especially in high degrees of ametropias.<sup>72,73</sup>

On the other hand, LASIK appears to have its own specific complications. Flap-related complications including free flaps, buttonhole flaps, irregular flaps and post-LASIK traumatic flap displacement are serious complications unique to this technique.<sup>74-76</sup> Recent improved designs of microkeratomers have led to a decrease in the rate of some of these complications.<sup>77,78</sup> Epithelial ingrowth, dry eye syndrome and DLK also known as 'sands of Sahara syndrome', are specific complications to LASIK.<sup>46</sup>

In a review of US Food and Drug Administration (FDA) approved clinical studies, LASIK has been reported to be effective, predictable and safe technique for treating low to moderate myopia. Ninety-six per cent of patients that underwent LASIK achieved UCVA of 20/40 or better and at least 67% were at 20/20 or better. In the same study, 96% were between  $\pm 1.00D$  of intended treatment. Loss of two or more lines of BCVA occurred in less than 1%.<sup>79</sup>

In a 10-year, control-matched study, Alió et al. found that both PRK and LASIK were safe for moderate myopia ( $-6.00$  to  $-10.00D$ ). LASIK was slightly better in terms of efficacy and predictability, with a lower rate of re-treatment than PRK.<sup>80</sup>

LASIK re-treatment for residual myopia is an effective option. Refractive results are fairly predictable, and refraction stabilises by three months after re-treatment.<sup>81,82</sup> However, epithelial ingrowth and flap melting are more frequent after LASIK re-treatment.<sup>82,83</sup>

### Wavefront-guided Treatment

There are currently different laser profiles in the market of refractive surgery. Conventional or standard profiles treat simple spherocylindrical refractive errors. Topography-guided treatments use information from both the spherocylindrical refractive error and the corneal shape to find out the profile of excimer laser ablation.<sup>84</sup> Wavefront-optimised ablations are designed to preserve the asphericity of the cornea by removing more tissue in the periphery of the ablation zone, thus inducing less spherical aberration compared with standard LASIK.<sup>85</sup> More recently, WG treatments are designed to treat both of spherocylindrical refractive errors and HOAs.<sup>79</sup>

Most studies reported that WG laser ablation induces less HOAs compared with non-WG ablations.<sup>86-88</sup> Furthermore, Alió et al. has concluded that using WG LASIK is more effective and safer than standard LASIK for re-treatments.<sup>89</sup> Although subtle improvements in quality of vision cannot be excluded, there appears to be little advantage in WG over non-WG ablations in terms of UCVA.<sup>90</sup>

### Intraocular Surgery

Keratorefractive procedures, which have become popular in the last two decades, fall short of correcting high refractive errors.<sup>91,92</sup> Complications include lack of predictability, regression, prolonged visual rehabilitation and corneal ectasia.<sup>93</sup> Transient or permanent symptoms can occur, including dry eyes and induced high-order aberrations (HOAs) causing night vision disturbances.<sup>94</sup> They are therefore not suited for individuals with high errors both spherical and

**Table 1: The Correction Range of Each Model of Phakic Intraocular Lenses<sup>38</sup>**

	Myopia	Hyperopia	Astigmatism
Angle-supported			
Acrysof®	6.0 to -16.5D	Not available	Not available
Kelman Duet	8.0 to -20.0D	Not available	Not available
Iris-fixated			
Artisan/Verisyse	-3.0 to -23.5D	+1.0 to +12.0D	2.0 to 7.5D
Artiflex/Veriflex	-2.0 to -20.0D	Not available	1.0 to 5.0D
Posterior chamber			
Implantable	-3.0 to -23.0D	+3.0 to +22.0D	1.0 to 6.0D
collamer lens			
Phakic refractive lens	-3.0 to -20.0D	+3.0 to +15.0D	Not available

astigmatic, thin corneas and pre-existing dry eye syndrome. Another perceived disadvantage is that the ablation is irreversible. Alternative surgical procedures that leave the corneal plane intact and preserve the prolate shape of the cornea are becoming an important addition to the refractive procedures repertoire. Refractive lens exchange and pIOL implantation have assumed greater popularity and acceptance globally as a consequence of the unsatisfactory results with corneal refractive surgery, especially in higher ranges of refractive errors.

### Refractive Lens Exchange

Refractive lens exchange (RLE), also known as clear lens extraction, does not require expensive laser equipment and is within the surgical capability of most ophthalmic surgeons. This has been performed in preference to keratorefractive surgery for the correction of refractive errors beyond the safety range of laser ablation and in patients with early symptoms of cataract. The availability of a wide range of lens powers both for sphere and cylinder have made this approach more attractive.

RLE dates back to 1890 when Fukala and Vacher reported the first series of high myopia managed by clear lens extraction.<sup>95</sup> Today, in addition to crystalline lens removal, the procedure involves implanting a replacement IOL. With the recent developments in cataract surgery and the ongoing improvement of IOL designs, clear lens exchange is a viable option for correction of refractive errors. A variety of 'premium' IOLs are currently available including monofocal, multifocal and accommodative IOLs.<sup>8</sup>

Similar visual refractive outcomes between patients with monofocal and multifocal IOLs have been reported, although multifocal IOLs have lower spectacle dependence for near vision.<sup>96,97</sup> Multifocal IOLs have a higher rate of halos and glare compared with accommodative lenses.<sup>98</sup> The choice of lens depends on each patient's individual preferences and goals for their vision.

RLE offers satisfactory refractive outcomes, but high myopes have the risk of retinal detachment and non-presbyopic patients lose part or all of their accommodation, even with accommodative lenses.<sup>99</sup>

### Phakic Intraocular Lenses

In the 1980s, the concept of pIOL implantation progressed rapidly due to the advent of microsurgery and the invention of viscoelastic substances. Parallel to this, pIOLs underwent a remarkable change with lens materials and haptic design; becoming more flexible, thinner and more polished. pIOLs can be performed to correct a broader range of myopia and hyperopia compared with currently available

laser ablation techniques.<sup>94</sup> Currently, there are three main types of pIOLs for the treatment of myopia and hyperopia in clinical use: posterior chamber (PC) IOLs; known as implantable contact lenses (ICLs), anterior chamber (AC) angle-supported IOLs and iris-fixated IOLs. The correction range of each model is shown in *Table 1*.

In a recent, major review of various pIOLs, it has been shown that pIOLs have good efficacy, safety and predictability with a tendency towards undercorrection in AC angle-supported models.<sup>100</sup> In a comparative study, AC iris-fixated pIOLs were shown to be superior to LASIK for high myopic correction, with no significant difference in moderate myopia.<sup>101</sup> Similar results were reported with ICLs.<sup>102</sup>

The principle advantage of pIOLs is especially in people with high refractive errors. Other advantages include high optical quality, preserving accommodation and corneal asphericity and relative reversibility of the procedure. However, pIOLs are not a complication-free procedure. The spectrum of complications includes endothelial cell loss, cataract formation, raised intraocular pressure and lens dislocation. Halos, glare and surgically induced astigmatism have been reported.<sup>100</sup>

## Future of Refractive Surgery

Femtosecond lenticule extraction (FLEX) is a new procedure that does not utilise a microkeratome or an excimer laser. In FLEX, a femtosecond laser is used to create the flap and the refractive lenticule in one step.<sup>103,104</sup> Small incision lenticule extraction (SMILE) is a new modification to this technique.<sup>105</sup> The first peer-reviewed publications on this new technology and procedure have appeared in the published literature.<sup>105,106</sup>

The first microwave keratoplasty in human corneas as a non-invasive alternative to laser surgery in correcting myopia has recently been reported.<sup>107</sup> The development of treatment algorithms to determine the optimum depth, duration and power of treatment to produce specific refractive changes is a work in progress.

As the technology of refractive surgery has evolved, so has the ability to test the range of its effects on all aspects of visual quality, leading to a more customisable approach. Improvements in refractive lens designs, especially accommodation lenses and other modalities to address presbyopia, are other interventions to look forward to. ■

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