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Refractive Surgery Guide 2011

February 2011

- Patient motivations & case examples
- Refractive surgery myths busted
- Key moments in refractive surgery

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Mr Mark Wevill is an ophthalmologist and was awarded Fellowship of the Royal College of Surgeons in 1995. He holds the "Certificate in Refractive Surgery" from the Royal College of Ophthalmologists. He has performed more than 13,000 laser eye surgery treatments and over 2,000 procedures in his special interest area of cataract and intraocular surgery. Mark is an internationally recognised opinion leader in refractive surgery and has written, presented, and reviewed over 30 scientific papers.

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Graham Cox is Professional Services Manager for Ultralase. After working in hospital and general optometry, he became involved in refractive surgery as a senior optometrist and then as a consultant for Boots Opticians in 2002. He joined Ultralase in 2005 and is responsible for customer service and the quality of training and clinical practice. Graham has presented at the conference of the British Society for Refractive Surgery.

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Introduction

OT and Ultralase are delighted to bring you this definitive guide to refractive surgery. Being the first commercial provider of refractive surgery in the UK, celebrating it's 20 year anniversary in 2011, Ultralase has worked in close collaboration with *OT* to ensure that all the information in this guide is evidence-based, up-to-date and, above all, usable by eye care practitioners in giving advice to their patients. It is often difficult to keep up-to-date with a field such as refractive surgery due to its inherently quick moving pace. This guide therefore puts all the relevant information about refractive surgery in one place as an easy to access and refer-to guide.

We enter 2011 in a difficult economic environment and this has had a clear impact on consumers and their confidence. With regard to refractive surgery in particular, patient expectations have never been higher and the commercial market has never been so challenging. While it may seem counter-intuitive, this is not all bad news since clinical standards have to be exceptional and companies need to have substance, not spin.

The real wish of patients is having a surgeon with the highest qualifications and getting the best clinical outcome. It is fitting that the UK currently leads the world with the unique Royal College of Ophthalmologists Certification in laser refractive surgery. As the clear leader in the UK, it is right and proper that Ultralase work with a quality publication such as *OT* and share knowledge across UK practitioners. *OT* and Ultralase, in association with Abbott Medical Optics and Technolas Perfect Vision, have a common goal in providing the highest level of quality clinical education.

Mark Korolkiewicz
Clinical Services Director, Ultralase

The Optical Confederation and the College put a lot of time and effort into creating opportunities for optometrists in the community to use their scope of practice beyond the sight test, and to be able to offer wider NHS eye care services. However, running alongside these are private services that can and should be undertaken by optometrists in their practices. One such key service is the co-management of refractive surgery patients.

Over the last decade or so, refractive surgery has become a mainstream method of addressing refractive error, and optometrists have the background knowledge and practical skills to provide pre-operative advice to patients as well as post-operative management. Optometry as a profession does not shy away from up-skilling and learning new techniques, and several of the schools of optometry offer specific courses covering refractive surgery co-management.

As a final thought, in some parts of the United States the surgery itself is carried out by optometrists, notably this is the case in the armed forces. Ophthalmology was so cross that they lobbied the Senate to throw out the Army's budget provision. The American Optometric Association comprehensively out-lobbied the ophthalmologists and the Bill went through Congress with the laser budget intact. Several lessons there for us to think about!

Bob Hughes
Chief Executive, AOP

Who should have refractive surgery?

By Yahya Vali

"I feel unsafe and uncomfortable wearing my spectacles when rock-climbing and cannot possibly stop halfway up a rock-face to deal with a gritty contact lens, so I just have to bear the discomfort."

These were the comments of a patient who decided he needed an alternative refractive solution to spectacles and contact lenses. The sentiment repeats itself regularly with a large variety of reasons cited as motivating factors for a surgical refractive solution.[1] Recently-lapsed contact lens wearers tend to be very strongly motivated for refractive surgery as they cannot bear the thought of full-time spectacle wear. Individuals who have been unsuccessful in a contact lens trial usually have a similarly strong desire. More people than ever are looking to refractive surgery as a solution for their visual needs. They are frequently encouraged by successful outcomes and experiences of friends and colleagues.[1]

Motivation

There are many categories in which a person's motivation for refractive surgery can be placed. The main ones are discussed below.

Psychological/personal

- Convenience – eliminating the hassle of spectacle wear (e.g. fogging up, rain droplets on the surface) and contact lens wear (e.g. inserting, removing and cleaning lenses)
- Vanity and improved personal appearance
- Increased self-security and confidence
- Improved lifestyle.

Occupational/task-orientated

- Better vision to gain entry to a particular occupation e.g. armed services, police.
- Improved quality of vision e.g. fewer lens reflections
- Improved vision for sports and hobbies, removing the inconvenience of spectacles or contact lenses.

Ocular health /comfort

- Eliminating dangers to the cornea from contact lens over-wear (e.g. corneal exhaustion, ulcers/keratitis, and dry eye) without losing the convenience of being spectacle independent
- Eliminating ocular discomfort associated with contact lens wear
- Reduced glare at night.

Financial /economical

- Cost saving compared to the cumulative cost of spectacles and contact lens over the long-term.

Even simple matters such as the ability to see on waking or being able to use fashionable non-prescription sunglasses motivate people towards refractive surgery. Parents with young children often cite their children constantly grabbing at their spectacles as a strong motivation too.

Patient demographics

Anyone with a desire and a motivation can have refractive surgery, subject to satisfying suitability criteria. Suitability is assessed on an individual basis, as there are many types of procedure (Table 1). The main procedures are corneal reshaping (LASIK and LASEK), corneal biomechanical modification (Conductive Keratoplasty and IntraCor), and intraocular surgery (refractive lens exchange and phakic lens implantation). The emerging field of Bioptics combines corneal reshaping and biomechanical modification, allowing a large range of ages and refractive errors to be catered for.

A high myope could be turned away from corneal laser treatment, perhaps due to a thin cornea, but instead be offered intraocular lens (IOL) implantation. Likewise, a 75-year-old patient showing no sign of cataract may be offered corneal laser refractive surgery if they were averse to intraocular surgery, and would be counselled accordingly regarding future cataract surgery.

Visual solutions and results

Outcome measures of refractive surgery include post-operative uncorrected vision and refraction. However, from a patient's perspective, the main outcome measure is whether their motivation(s) for surgery has been achieved and success can simply be judged on patient satisfaction in meeting these. Indeed, there is no shortage of people happy to give glowing testimonials about their experience and the huge enhancement their improved vision has had on their lives.

TREATMENT	REFRACTIVE ERROR RANGE (Dioptres)	AGE RANGE (YEARS)
LASIK	Approx +6.00 to -10.00	Approx 18 to 65
LASEK	Approx +2.00 to -10.00	Approx 18 to 65
Artificial lens Implant	> +4.00 > -10.00	Approx 21 to 40 (hyperopes) Approx 18 to 50 (myopes)
Refractive Lens Exchange	> +4.00 > -10.00	Over 40 (hyperopes) Over 50 (myopes)
Conductive Keratoplasty	Plano presbyopes	Approx 45 to 60
IntraCor	Plano presbyopes	Approx 45 to 60

Table 1. Suitability criteria for refractive surgery

The laser refractive surgery journey - a patient experience

By Graham Cox

Refractive surgery is a life-changing decision that must always be made in light of knowing all the risks as well as the benefits. While the safety profile of refractive surgery has continually improved over the last ten years to the point where, for example, infection is less likely than compared to long-term contact lens wear, there are still risks that the patient must understand. It is only once this has happened that the treatment journey truly starts.

Complication	Quoted Incidence	Ultralase audited figure
Eyes achieving less than 6/6 vision after treatment	25%	17.1% (all treatments)
All complications	5% (Up to 40% in some clinics)	2.8%
Persistent dry eye causing dissatisfaction (> 6 months)	No measure outside Ultralase available	0.26%
Persistent night vision problems causing dissatisfaction	No measure outside Ultralase available	0.02%

Table 2. Rates of complications following laser refractive surgery

Suitability assessment

Each patient attends a consultation with a specially trained optometrist. The assessment includes intraocular pressure (IOP) measurement, fundoscopy, anterior eye segment examination, pachymetry, corneal topography, and aberrometry. A detailed ocular and medical history is taken, to rule out any contraindications, and particular attention is paid to lifestyle and occupational considerations.

It is important to only ever act in the patient's best interests and for around 15% of patients, the best option is to continue to use spectacles and/or contact lenses. For the remaining 85% deemed suitable for refractive surgery, a copy of the consent literature is given to the patient to take away with them. Consent is not simply a 'box-ticking' exercise, but a process that starts with a patient's first contact and continues through every assessment and piece of information gathering, whether verbal or written, to when they receive treatment. Ultralase has a Patient Advisory Group to ensure all information provided is clear and easy to understand. The burden of proof of consent is (rightly) rigid.

Treatment

The patient meets their surgeon for further examination and to discuss any outstanding issues. The surgeon will confirm the clinical findings from the initial assessment and discusses all of the benefits and risks of treatment. Immediately prior to treatment, a qualified nurse will give the patient further information about their eye drop regime and instructions they should follow after treatment. Preparatory anaesthetic drops are then given, and the patient is taken to the treatment room. Treatment lasts about 15 minutes, of which the laser application is about 45 seconds per eye. The patient is given time to recover in a quiet room, and is then examined again by the surgeon before returning home.

First aftercare

Patients return 1-2 days after treatment for their first follow-up assessment. The optometrist will check unaided vision and conducts a careful check of the cornea to confirm that recovery is normal and as expected. For most patients receiving LASIK, vision at this stage will already be excellent. Patients receiving LASEK generally have a slightly longer expected recovery period, and their vision will not be perfectly clear at this appointment. This is normal and expected and a bandage contact lens is typically fitted in order to protect the cornea and to promote early healing.

Ongoing aftercare

All patients will normally be seen at 1 week, 4 weeks, and 3-6 months after treatment. These consultations assess unaided vision, refraction, corrected vision, and anterior segment examination. Complications are very rare (Table 2), but will require additional consultations.

During the recovery period, some patients experience temporary effects such as mild dry eye, light sensitivity, or reduced night vision, and these conditions will be managed by the optometrist in accordance with advice from the treating surgeon. About 4% of patients will be given additional surgical treatment to enhance their result.

The recording of accurate and contemporaneous clinical records is a cornerstone of good practice. It provides the full story of patient care and serves to ensure the patient is always well managed. The very act of recording refraction directly improves future patient care, since this allows continual audit of results and optimisation of outcomes. Indeed, analysis of such factors as subtle differences in temperature and humidity at the time of treatment, the time taken by the surgeon, the eye drop regime, and the degree of refractive error, alongside patient outcomes, can ensure optimisation of individual factors so that patients get the best possible outcome for every set of unique conditions. Indeed, the optometrist's influence here, and throughout the process through to patient discharge, is immense and cannot be under-estimated.

25/02/11 REFRACTIVE SURGERY GUIDE 2011

Case studies: refractive surgery for high astigmatism

By Jay Dermott & Mark Wevill

Case Study 1: Aspheric wavefront laser treatment

Background and assessment

The correction of high astigmatism with spectacles or contact lenses potentially brings challenges such as reduced visual quality. A 27-year-old male patient was unhappy with his toric contact lenses and disliked the weight of his spectacles, hence enquired about refractive surgery. The pre-operative refraction details are shown in Table 3.

Advice and surgery

In view of the high astigmatism, the patient was advised to have Personalised Aspheric (Ultra Elite) treatment. A wavefront treatment profile was prepared, based on the pre-operative topography and aberrometry, and this data was incorporated into the treatment plan along with the manifest refraction details. Particular care was taken to ensure that the iris recognition data would allow for 4-dimensional eye tracking during the procedure, since it is quite common for intra-procedural cyclotorsion of more than 3° to occur. The Technolas Perfect Vision 217z100 laser is well-placed in that it has the ability to track cyclo-rotational eye movements in real time.

Outcome

Twenty-four hours after surgery, the patient achieved unaided vision of 6/6-1 in the right eye and 6/6+2 in the left eye. He reported only mild discomfort, similar to a dry contact lens, lasting about 3 hours after the procedure, but no pain either during or after surgery. One month after surgery, the patient was delighted with the result as his unaided vision was 6/5 in each eye and he required no correcting lenses.

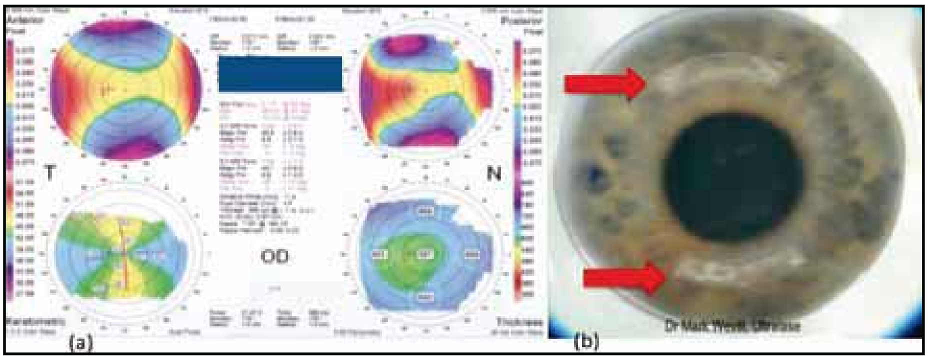

Figure 1. Bioptics. (a) Topography to show the degree of pre-operative astigmatism (b) Positioning of the paired femtosecond laser incisions

	Vision	Binocular Vision	Sph	Cyl	Axis	VA	Binocular VA	Pupil Diameter (mm)	Pachymetry (µm)
RE	6/60	6/60	-2.25	-4.50	50	6/6+2	6/5-1	6.2	536*
LE	6/60		-2.75	-4.00	135	6/6+2		6.2	541*

Table 3. Pre-operative assessments of a 27-year-old male patient presenting for refractive surgery. *Average of three readings

Case Study 2: Bioptics

Background and assessment

The Bioptics procedure is very useful where there is very high astigmatism, as was the case for the right eye of a 22-year-old female patient. The pre-operative refraction was +3.75/-7.00x180, giving a best-corrected VA of 6/7.5. The corneal pachymetry was 565µm and topography showed symmetrical astigmatism with no evidence of keratoconus. No significant ocular or general health complications were found.

Surgery and outcomes

The patient was treated using a two-stage process of femtosecond laser corneal incisions and wavefront-guided excimer laser ablation. The surgery involved making a pair of arcuate keratotomy incisions using a femtosecond laser, followed immediately by the creation of a normal femtosecond LASIK flap. The flap was lifted at the time of creation, but the excimer laser was not applied until five months later, following a refraction and full wavefront evaluation (Figure 1). Figure 2 shows the appearance of the arcuate keratotomy incisions.

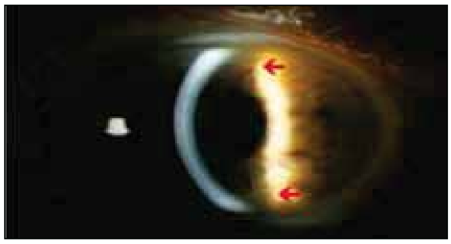

Figure 2. Arcuate keratotomy incisions (indicated by arrows) created using Bioptics

Immediately prior to excimer ablation, the uncorrected vision was 6/12, the refraction was +2.25/-3.75x3 and the best VA was 6/7.5. Six weeks after excimer ablation, the unaided vision and VA were 6/7.5, and the refraction was Plano/-0.25x5. The patient declared that she was delighted with the outcome of her treatment.

As displayed by this case study, the advantage of this two-stage approach is an enhanced effectiveness of the incisions on the final refractive correction.

Case study: refractive surgery for a plano presbyope

By Roshni Soni

IntraCor is a method of creating a multifocal cornea, using femtosecond laser and 3-D topographical analysis. A pattern of five concentric rings of gas bubbles is precisely placed at various depths in the corneal stroma. Under the force of IOP, there is reshaping of Bowman's membrane and a change in central corneal curvature without penetrating the epithelial surface i.e. no flap creation is required. The advantage of this process is a reduction in the risk of complications including infection, inflammation and dry eye.

Background and assessment

A healthy 56-year-old male patient was motivated for refractive surgery because he wanted freedom from the inconvenience of having to use reading spectacles on a daily basis for working on his computer. His distance vision was not problematic and he had never worn a distance refractive correction. The pre-operative findings are summarised in Table 4.

Advice and surgery

The patient was advised to have IntraCor surgery. There have been no reports in the literature of dry eye induced after IntraCor, although every patient should expect minor but temporary post-operative night vision symptoms such as glare or haloes.[2]

Near vision correction is permanent but assistance from ready readers may be required if reading very fine print, or when tired, in poor lighting, or for long periods of time. The average gain in near vision is 4.5 lines but it is important to assess tolerance of slight blur e.g. through a monovision trial. About 8% of patients are non-responders to the treatment meaning that they remain as they were pre-operatively.

Outcome

The post-operative findings are summarised in Table 5. The day after surgery, the patient was impressed with his near vision and did not notice any changes in his distance vision. The left eye achieved uncorrected distance vision of 6/6 and near vision of N10. He felt slight grittiness in the eye and noticed glare whilst driving. Figure 3 shows the corneal appearance at 1 hour after surgery whilst Figure 4 shows the appearance at one week after surgery.

At 6 months after surgery, having used Maxidex (steroid) eye drops and ocular lubricants, the patient reported disappearance of the glare symptoms and he was reading comfortably in good light; he used ready readers in poor lighting or with very fine print, which he was happy to do. His distance vision was unaffected and was at the same level as pre-operatively. The patient was delighted to have his functional unaided near vision restored.

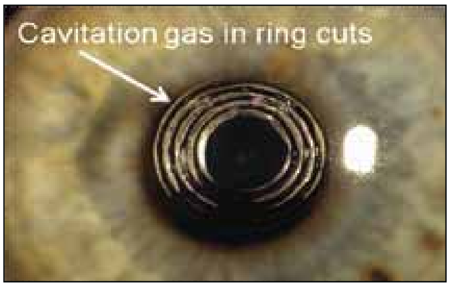

Figure 3. Corneal appearance one hour after IntraCor surgery

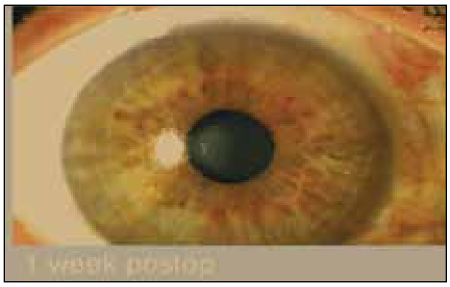

Figure 4. Corneal appearance one week after IntraCor surgery

	Vision	Binocular Vision	Sph	Cyl	Axis	Best Distance-corrected VA	Binocular VA
RE	6/6 N18	6/5 N18	+1.00	-	-	6/5 N12	6/5 N5
LE	6/5 N18		+0.75	-	-	6/5 N14	
RE Cycloplegic Refraction (Cyclopentolate 1%)			+1.00	-0.25	145	6/6+2	**Pupil diameter =** 5.0mm R+L
LE Cycloplegic Refraction (Cyclopentolate 1%)			+1.00	-0.25	150	6/5	**Pachymetry =** 501µm R+L

Table 4. Pre-operative assessment of a 56-year-old male patient presenting for refractive surgery

	Vision	Sph	Cyl	Axis	Best Distance-corrected VA
LE 1 week post-op.	6/7.5 N5	-0.50	-1.00	5	6/5 N5
LE 1 month post-op.	6/5 N8	Plano	-	-	6/5 N8
LE 6 months post-op.	6/5 N8	+0.50	-0.25	180	6/5 N8

Table 5. Post-operative outcomes of a 56-year-old male patient receiving IntraCor refractive surgery

Case study: refractive surgery for occupational reasons

By Alia Hussain

Many occupations require candidates to have particular levels of VA to be able to carry out their duties, for instance fire fighters and police personnel, medical professionals, and sports professionals. If correction is required, optical devices such as spectacles or contact lenses usually allow this to be achieved.

However, certain occupations require a minimum level of unaided vision and this can prove problematic for ametropes. This is an increasingly common reason for people to turn to refractive surgery.

Background and assessment

A 37-year-old male police officer and candidate for tactical firearms unit training had unaided vision of 6/24 in each eye, with a refraction of RE: -1.75DS, LE: -2.00/-0.25x30. He had no history of ocular disease or injury and he was in good health, not taking any medication. This was all confirmed through the detailed and thorough pre-operative assessments.

Advice and surgery

This patient's motivation for refractive surgery was to gain sufficient vision to qualify for firearms duties without the use of spectacles, opening to him career options otherwise not available. Following assessment by the optometrist, he was advised to opt for a LASEK procedure due to the low corneal thicknesses (RE: 493µm, LE: 490µm).

Outcome

The LASEK procedure itself was unremarkable and the patient returned after six days to have the bandage contact lenses removed. His uncorrected vision was 6/7.5 in each eye. At this stage, the patient was happy with the outcome as this enabled him to drive and return to his normal patrol duties. The patient then returned for further follow-up two months later. His unaided vision had improved to RE: 6/6 and LE: 6/5, with no significant refraction found. He was very pleased with the outcome, as he had now achieved his professional ambitions as well as declaring himself more confident in his job because he no longer had reason to worry about any optical devices on his face or in his eyes.

Myths of refractive surgery

By Jay Dermott

When a new field emerges, it brings with it a series of fallacies and half-truths, a sort of mythology that grows up with it. If unchallenged, the mythology will be given credence over the true picture and in a medical setting this means that patients can be given the wrong advice. It is simply not accurate today to give the public the impression that refractive surgery clinics deliver unproven treatments by inexperienced and poorly trained visiting doctors. This may sound like an extreme view, but it represents a précis of what some patients at Ultralase have been told. Refractive surgery is the most studied elective procedure in the world today, with outcomes of over 25,000 treatments analysed and published in the peer-reviewed literature in the United States and Europe alone. Yet, there remain many commonly held myths and misconceptions about refractive surgery, some of which will hopefully be dispelled in the following sections.

Myth 1: Refractive surgeons do not choose surgery for themselves or families

According to a survey amongst refractive surgeons for the American Academy of Ophthalmology, about 25% of surgeons have had the treatment themselves, representing a proportion of some four times that of the general population.[3] Statistics for spouses and family members are equally robust and impressive, proving that the closer you work to refractive surgery, the more likely you are to have it done.

Myth 2: A patient cannot wear contact lenses again after refractive surgery

The overwhelming majority of post-operative keratometry measurements remain within the fitting range of standard contact lenses. It is simple to fit soft lens designs if required after surgery – some post-LASIK patients even still regularly wear cosmetic contact lenses. It is true, however, that some very rare post-surgery contact lens fitting may require an experienced practitioner's skills, for instance fitting a rigid gas permeable (RGP) lens design for a post-LASIK patient.

Myth 3: Refractive surgery cannot correct astigmatism

The correction of astigmatism with wavefront-guided treatment has reached a zenith, addressing up to 6.00DC easily and producing results commensurate with eyes exhibiting low levels of astigmatism; up to 98% of eyes with astigmatism over 2.50D achieved uncorrected VA of 6/6 at the one month stage.[4,5] Eye tracking technology goes hand-in-hand with the correction of astigmatism. The Technolas Perfect Vision laser was the first to introduce true iris recognition technology, being capable of recognizing every eye on the planet, and combine it with real-time rotational eye tracking in order to respond to any eye movement, including cyclotorsion. With each such advance in technology, there has been a simultaneous rise in quality of outcomes experienced by patients with astigmatism (Figure 5).[6]

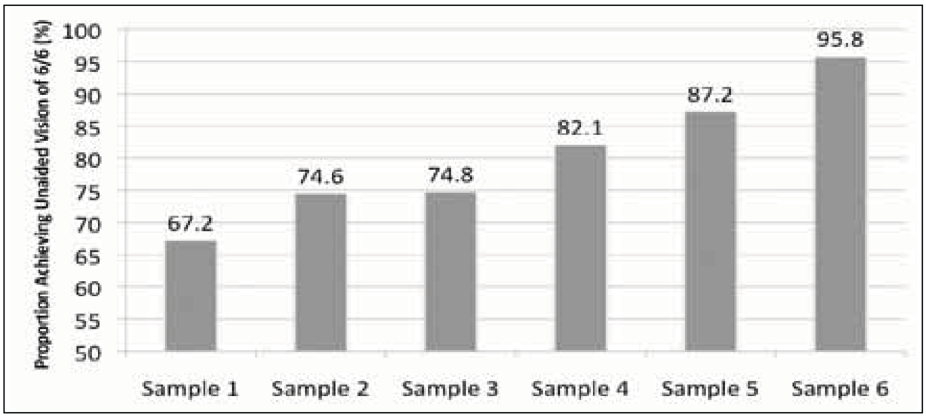

Figure 5. Proportions of people achieving unaided vision of 6/6 with advancement of technology. Each sample contains a minimum of 800 eyes; Sample 1 was treated with uncustomized microkeratome flap; Sample 2 was treated with wavefront-guided microkeratome flap; Sample 3 was treated with 1st generation wavefront-guided femtosecond laser flap; Sample 4 was treated with 2nd generation wavefront-guided femtosecond laser flap; Sample 5 was treated as Sample 4 but with rotational eye-tracking included; Sample 6 was treated with femtosecond flap and aspheric wavefront

Myth 4:
The LASIK flap never truly heals and remains a constant potential danger for spontaneous rupture

When the LASIK flap is replaced it is initially held in position by osmotic pressure due to the expulsion of water by the endothelium. Epithelial regeneration commences almost immediately post-treatment, and it is safe to resume normal activity in two weeks, and even contact sport at twelve weeks, after glycosaminoglycans (GAG) replacement by the keratocytes, collagen fibril deposition, and re-laying of the basement membrane.

The advent of the femtosecond laser for LASIK flap creation has been instrumental in negating the myth of the never-healing flap. Laboratory tests show that flap adhesion is significantly stronger with a femtosecond flap.[7] The only (rare) recorded instances of spontaneous flap lift in the literature followed major blunt traumatic injury to the globe. Therefore, no greater risk to the patient is demonstrated by the presence of the flap. Nevertheless, this has been at the forefront of the planning of all laser treatments, and deeming which patients are suitable. Indeed, a minimum pre-operative stromal bed thickness of about 250µm[8] is required to avoid corneal ectasia and for normal functions to continue, and any calculation of the maximum tissue available for ablation does not acknowledge the contribution from the tissue that makes up the corneal flap.[9]

Myth 5:
Refraction needs to be completely stable prior to treatment

No refractive surgeon would argue against delaying treatment on an eye exhibiting progressive myopia or astigmatism. Such changes may be developmental or even representative of pathology, but are rare in those over the age of 21 years. However, where a prospective patient is under 21 years of age but desires treatment for occupational reasons (e.g. joining the armed forces), the combination of dramatic improvement in vision and entry to the desired occupation is likely to outweigh the risk of regression later.

The clinician has limited insight into the prescribing philosophy used by previous optometrists. It is therefore helpful to consider patients in three specific age groups of 18-21 years, 21-25 years and over 25 years, and applying criteria more strictly in the lower age range. Such a custom approach has been deemed safe in the

(a) Higher Order Aberrations cause annoying glare and haloes which detract from image quality

(b) Sometimes, the aberrations are not totally addressed even with 2nd generation wavefront treatment

(c) The latest aspheric wavefront technology is capable of treating the full range of aberration

Figure 6. Correction of higher order aberrations during refractive surgery can enhance visual quality (see text for details)

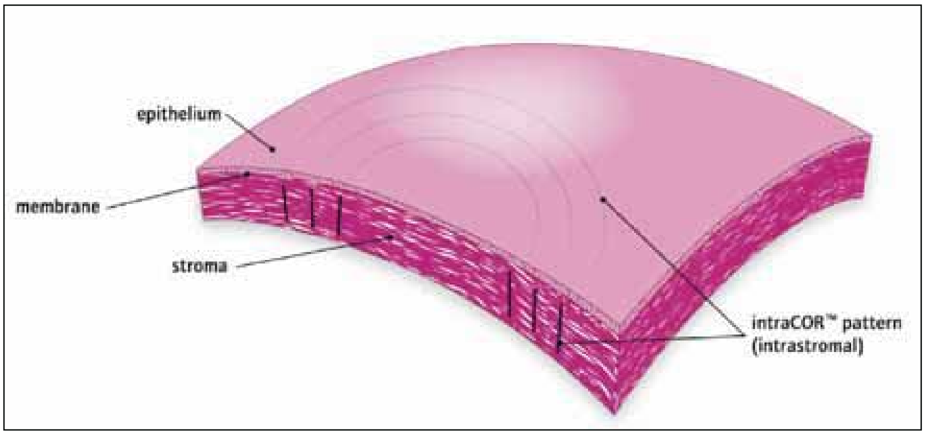

Figure 7. IntraCor procedure for presbyopia (see text for details)

Figure 8. The VUE+ lens

literature.[10] In the case of significant latent hyperopia, it is important to consider that the cycloplegic result is a clue to the manifest situation when the patient is over 50 years of age. Around a 1.00D latency is commonly tolerated well and pre-operative assessment routines cater for this.

Myth 6: Dry eye is a real and inevitable problem

A degree of reduced tear production is a normal and common temporary effect of LASIK. The precise aetiology arises from disturbance of the nerve plexus, which is at a similar depth below the surface as a microkeratome blade flap.[11] However, the incidence of long-term post-LASIK dry eye syndrome is very much reduced in the era of femtosecond flap creation. Thin flap protocols have been shown to decrease the severity and longevity of dry eye symptoms.[12] Patient identification at the pre-operative stage is paramount, and if significant risk factors for possible dry eye are identified, such as age, gender, history, or signs evident on slit lamp examination (e.g. blepharitis), the clinician will counsel the patient toward either surface treatment or a lens-based procedure. If the risk is more minor then the stability of the ocular surface may be optimised prior to surgery through lubricants, punctum plugs or medication. In 2011, any patient experiencing persistent dry eye after surgery is highly likely to have had the condition in advance of treatment. The proportion of Ultralase LASIK patients dissatisfied due to a dry eye is only 0.26%.

Myth 7: Refractive surgery causes night glare

Refined treatment algorithms used with the lasers currently available mean that even patients with large scotopic pupils may have wavefront-guided treatment and experience good results. The elimination of glare symptoms was the very reason for the development of wavefront-guided treatment in the first instance, and work is continuing to build on these results by producing bespoke treatment profiles and ever more sensitive diagnostics. A recent study[13] shows demonstrably better visual quality through addressing higher order aberration with 3rd generation aspheric wavefront so that no further aberration is induced in the act of treatment.[14] Figure 6 illustrates the effect of these latest refinements on glare at night and also on visual quality in daylight, by means of pictures with simulation of convolved aberration added using computer software. The proportion of Ultralase LASIK patients dissatisfied as a result of night glare is 0.02%.

Myth 8: Refractive surgery treatments cannot cater for presbyopia

Many patients are told by their optometrist that they are not a suitable for refractive surgery because they have reached presbyopia. In fact surgical solutions for presbyopia mirror those available with spectacles and contact lenses. Monovision is perhaps the most obvious method, and current thinking tends toward "soft" micro-monovision or "blended" vision that makes up for an ostensibly lower "add" value with an aspheric profile. In a series of 310 presbyopic treatments, 95% of patients achieved a combination of 6/6 and N5 vision at one month after primary treatment.[15, 16] The dividends of this blended vision approach appear to come in the form of fewer disturbances to the distance sight.

The newest addition to the surgical presbyopic market takes this to another level. IntraCor was the first laser treatment capable of correcting near vision in a plano presbyope without long-term induction of myopia, as with a traditional monovision approach.[2] Figure 7 shows the profile of the treatment, the outcome being an increase in depth of field by the controlled addition of spherical aberration. Aside from a temporary initial induced myopia of about -0.50D lasting around 12 weeks, the distance vision remains untouched. SupraCor is an extension of this technology and seeks to extend treatment to myopic and hyperopic nomograms.

Away from laser-based solutions, the Vue+ (Figures 8 and 9) is a lens implanted in the non-dominant eye under a standard LASIK flap and gives comprehensive near vision performance. Ultralase recently carried out the first of these procedures in the British Isles, with all patients comfortably reading N10 or better unaided.

Myth 9: Refractive surgery means a future of inaccurate IOP readings and pre-IOL biometries

This situation arises from the fact that tonometry and biometry measurements have been calibrated for untreated eyes. IOP itself is not altered by treatment but instead may

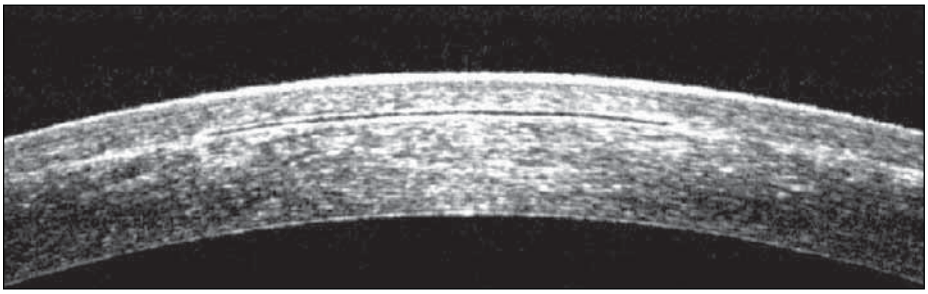

Figure 9 An OCT of the VUE+ lens in situ

be lower due to the vagaries of calibration based on the Imbert-Fick law. The standard advice is to consider that tonometry on a thinner, post-surgery cornea will read about 4mmHg lower than an untreated cornea.[17] In the case of IOL power calculations, correction protocols such as the BESSt formula[18] mean that knowledge of the pre-ablation keratometry readings is no longer required, provided there is no refractive surprise post-LASIK.

Myth 10: There is no long-term follow-up data to confirm stability of outcome

The wealth of peer-review data specialises in short-term outcomes, the main reason being the difficulty in retaining high numbers of patients for follow-up over long periods of time. However, a number of rigorous studies have been published in recent years, reporting long-term results up to 13 years in significant cohorts. The conclusions of these studies provide reassurance over the prospects for long-term outcome quality to both patients and doctors.[19, 20] In the largest and most comprehensive study of its kind, 389 patients were examined up to 13 years after treatment. The results revealed that the treatment achieved long-term efficacy, safety, predictability and stability, with a mean myopic regression of only 0.57D.[20]

Summary

Every eye care practitioner will be asked many times by their patients about the different options of vision correction available to them. Experience shows that when informed, honest, and clear answers are given, the patient's loyalty to the practitioner remains intact even if they subsequently undergo surgical vision correction; they are therefore very likely to return to the same practitioner for their vision care needs even after surgery. In contrast, this is not likely to be the case where inaccurate or poor quality answers are given, whether they proceed with surgical treatment or not. Optometrists have a key role in refractive surgery co-management, as it takes its rightful place as part of mainstream optometry, as contact lens practice did in the 1970s.

The use of femtosecond laser in cataract surgery

By Laura Harper

Originally introduced as an alternative to mechanical microkeratomes for creating LASIK flaps, a new generation of femtosecond laser has emerged that reaches deeper into the eye, to depths of 7500µm, providing uses in cataract extraction procedures. Ocular coherence tomography (OCT) is used to create real time intra-operative imaging (Figure 10), which is crucial to the success and safety of the operation as it allows better control of lens fragmentation, reduced phacoemulsification (phaco) energy to remove the lens, and better placement of the IOL. Outcomes, safety and accuracy are therefore improved in comparison to all other techniques. Indeed, this is supported by clinical studies that reveal several critical aspects of cataract surgery are enhanced,

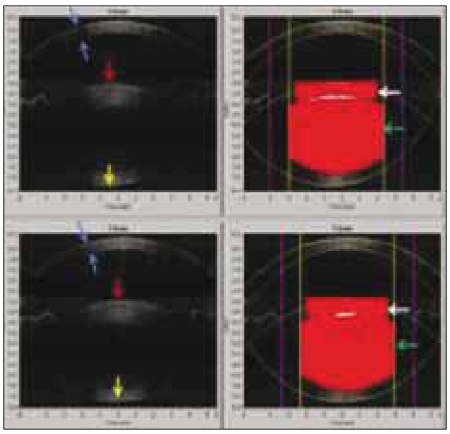

Figure 10. Intra-operative OCT helps to determine the relevant dimensions of the anterior chamber. Courtesy of William W. Culbertson, MD

including the ability to create the perfect capsulorrhexis, the formation of corneal and limbal relaxing incisions (of specific depth and diameter) and lens fragmentation (Table 6).

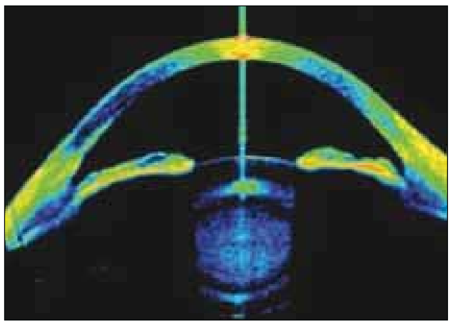

Figure 11. A time-domain OCT (TD-OCT) image of the anterior segment of the eye. Courtesy of Y Li and D Huang

Current manual cataract extraction procedure

Although a highly successful procedure

Liquefy, soften or "chop" the lens
Create a perfectly centred and sized refractive capsulotomy
Create all required surgical incisions with perfect dimension and architecture
Provide a refractive solution to pre-existing astigmatism by creating precision corneal incisions

Table 6. Clinical applications for a femtosecond laser for cataract surgery. Source: Zoltan NNagy, MD, presentation at ASCRS 2009

The perfect capsulotomy	The size of the capsulorrhexis can be customised allowing surgeons to specifically programme and determine the size of overlap of the capsule on the IOL and as such improve refractive outcome, especially for newer generation accommodative/multifocal IOLs, which need a specific amount of overlap.
Exact positioning of the lens	The lens position is customised and accurately centred using the iris boundary, improving refractive outcome. LenSx reported 100% of their procedures achieved an accuracy of ±0.25mm. Only 10% of manual procedures achieved an accuracy of ±0.25mm.[22]
Improved safety	Less trauma - no turning and manipulation of the lens required and fewer instruments in the eye. More independence from the surgeon's skill - no tearing of the capsule and the depth of lens fragmentation can be preprogrammed i.e. 500µm safety zone around posterior capsule, so less risk of a dropped nucleus. The size of cataract can be determined and the energy needed for fragmentation customised, resulting in less energy used; OptiMedica clinical trial results reported 40% reduction in energy with the femtosecond laser in comparison to the manual phaco method and therefore less risk of endothelial and retinal damage.[22] Size of incisions can be programmed to the exact size of the lens the surgeon is implanting. OCT - continuous scanning of the cross section of the anterior chamber and lens.
Improves the accuracy of limbal and corneal relaxing incisions	Depth of incisions can be programmed, replacing a manual knife that has poor predictability and greater risk of perforation. Elimination of corneal astigmatism improves refractive outcome.

Table 7. Benefits of a femtosecond laser cataract procedure

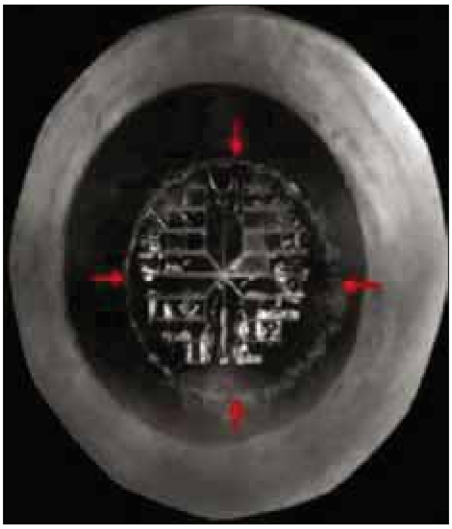

Figure 12. Placement of capsulorrhexis in cataract surgery using femtosecond laser

the world over, the current procedure for cataract removal involves several mechanical steps. First, the surgeon makes two limbal incisions with a scalpel. The capsulorrhexis is then created using forceps, which dig in and tear a round circle in the anterior lens capsule; this poses a risk for the capsulorrhexis to become torn. Viscoelastic fluid is then used for hydrodissection to separate the lens from the capsular bag. Instruments are then inserted, one to hold and turn the lens and another phaco instrument that uses ultrasonic vibrations to fragment and aspirate the lens. This procedure involves lots of manipulation by the surgeon and excessive ultrasonic energy for small cataracts can damage the corneal endothelium and retina.

The use of femtosecond laser in cataract surgery

The patient's eye is docked and the anterior segment structures are imaged and registered using OCT (Figures 11 and 12). The amount of energy required to fragment the lens is calculated. The femtosecond laser then fragments the lens; the gas bubbles go to areas of least resistance around the capsular bag allowing the lens to separate from it. The capsulorrhexis is then cut precisely with the femtosecond laser, with the dimensions of the capsulorrhexis being input into the laser to allow adequate overlap of the implanted IOL. Incisions of specific diameter and depth are then made (limbal and corneal incisions can also be made to correct astigmatism) and the aspirator is inserted to remove the lens fragments. The time taken to complete the femtosecond laser part is approximately 10-15 seconds. This saves time and also offers enhanced patient comfort compared to the manual procedure.[21]

Advantages of the femtosecond laser in cataract surgery

The femtosecond laser offers a fully integrated image-guided platform that offers surgeons the ability to customise key areas of refractive surgery (Table 7), such as creation of the perfect capsulorrhexis, corneal incisions and lens fragmentation, in a single step with efficiency and precision. This results in improved refractive outcome for the patient and reduced complications. This will create a new standard of care for cataract extraction and will revolutionalise the technique in the coming years.

Laser refractive surgery – five key improvements that changed UK practice forever

By Mark Korolkiewicz

When Theo Maiman, an American PhD physicist, created the world's first laser, his tutor reportedly said "great solution, now go and find the problem". After a Nobel Prize, his invention now has applications in everything from medicine to industry, law enforcement to printers. Iterative granular improvements combine to produce safer and more accurate results but quantum changes leading to a new standard of care are rare. Refractive surgery is no exception and the five most important developments in UK refractive surgery are described below.

1. The use of eye trackers

Eye movements produce sub-optimal outcomes if uncorrected. Cyclotorsion in particular can result in misalignment, producing undercorrection of astigmatism. Early lasers had no automated way of tracking such eye movements but advanced tracking technology now means that treatment remains centred and aligned with the optical line of sight providing the best possible outcome for patients.

2. Wavefront-guided ablation

Wavefront changed the face of refractive surgery forever. Original laser models contained mathematical models to flatten the centre of the cornea to correct myopia, but this created aberrations, resulting in night vision problems. Wavefront-guided treatments correct refractive error but still maintain a more natural (prolate) corneal shape, dramatically reducing night vision problems.

3. Femtosecond technology

LASIK flaps created using mechanical microkeratomes can on occasion be sub-optimal, incomplete, become "free", or have a "button-hole", which is distressing for the patient. Femtosecond technology has truly revolutionised this area through Intralase, which uses tiny pulses of laser, a quadrillionth of a second each, to induce a uniform layer of microscopic bubbles just beneath the corneal surface to create a flap. This process creates safer outcomes with superior contrast sensitivity (Figure 13)[22] and biomechanical response.

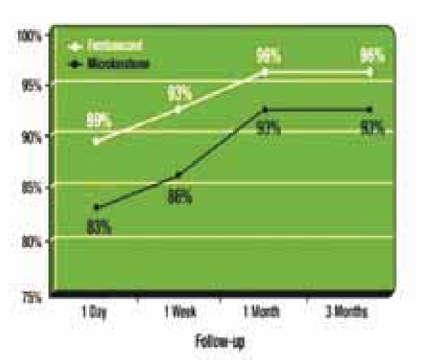

Figure 13. Visual recovery following laser refractive surgery (see text for details)

4. The Royal College of Ophthalmologists certification

This formal accreditation, specifically for laser refractive surgery, laid down a substantial precedent and was the first of its kind in the world. The Royal College of Ophthalmologists devised their Certification to ensure consistency of practice in the UK. Surgeons passing this voluntary qualification prove they are competent in surgical skills, audit, consent, patient management and all other matters required to be a competent laser refractive surgeon. For the first time ever, patients have a way of ensuring their surgeon is properly qualified and the UK is leading in what is another quantum step in refractive surgery.

5. Aspheric wavefront

Standard wavefront is already listed as one of the five important developments but such is the quality of vision from aspheric wavefront that this modality makes it into the top five. Wavefront treatment can itself occasionally induce certain aberrations. Aspheric wavefront addresses the eye's pre-existing aberrations but crucially does so while maintaining a prolate corneal shape. The results are unparalleled accuracy and quality of vision for patients.

The Future

So what will the next five major developments be? With the advent of aspheric wavefront, there is little left to go for distance vision correction. Innovation will be abundant in the area of cataract and refractive lens exchange. Femtosecond has real potential and presbyopia-correcting lenses will keep improving. It is certain that at some point, an IOL will be developed that truly replicates the effectiveness of the pre-presbyopic crystalline lens. Work on filling the capsular bag with a fluid material has so far achieved about 3.00D of accommodation. There is also microfluidic technology, where fluid in an IOL is re-distributed to accumulate centrally upon accommodation, using a pump, to increase the positive power of the IOL. Even more innovative is pixel technology where application of electric charge to an IOL can change the refractive index, providing up to 4.00D of accommodation.

The last 20 years have been spent correcting what nature got wrong for distance vision. Doubtless the next 20 years will be spent replicating what nature got right for near vision.

Course questions

Course code: C-15621 O/D Approved for: Optometrists ✔ Dispensing opticians ✔

General Optical Council Approved CET For Optometrists

General Optical Council Approved CET for Dispensing Opticians

PLEASE NOTE There is only one correct answer. All CET is now FREE. Enter online. Please complete online by midnight on 22nd April 2011 - You will be unable to submit exams after this date – answers to the module will be published on www.optometry.co.uk. CET points for this exam will be uploaded to Vantage on 25th April 2011.

1. Which one of the following is NOT a typical motivating factor for refractive surgery?
a) Spectacle and/or contact lens inconvenience
b) Strabismic amblyopia
c) Occupational VA requirements
d) Improved visual comfort

2. Which one of the following BEST describes Bioptics in relation to refractive surgery?
a) LASIK treatment followed by LASEK treatment
b) Non-wavefront treatment followed by wavefront-guided treatment
c) IOL implantation in combination with a corneal laser treatment
d) Implantation of a dual-optic IOL

3. Which one of the following is a routine part of a pre-operative refractive surgery assessment?
a) A-Scan ultrasound
b) Visual fields
c) Fluorescein angiography
d) Pachymetry

4. Which one of the following is NOT a recognised method for the surgical correction of astigmatism?
a) LASIK with femtosecond laser
b) LASIK with excimer laser
c) Linear radial incisions towards the centre of the cornea
d) Arcuate incisions in the peripheral cornea

5. For how long is a laser typically applied to one eye during a laser vision correction procedure?
a) 4 seconds
b) 45 seconds
c) 90 seconds
d) 150 seconds

6. What is the typical magnitude of cylcotorsion rotation that can be tracked by the Technolas Perfect Vision 217z100 laser?
a) More than 3°
b) More than 13°
c) More than 15°
d) More than 25°

7. What proportion of refractive surgeons have been treated with LASIK relative to the general population?
a) Four times
b) Fourteen times
c) Forty times
d) One hundred times

8. Which one of the following BEST explains why dry eye is less likely to be a long-term problem for refractive surgery patients now compared to 10 years ago?
a) At-risk patients can have their tear film stabilised with lubricants prior to surgery
b) Femtosecond laser flaps are thinner
c) Surface treatment or IOL implants are viable options for those with pre-existing risk factors
d) All of the above

9. Which one of the following is a potential clinical advantage of femtosecond technology in the removal of cataracts?
a) It is safer
b) It is more accurate
c) IOL positioning is better
d) All of the above

10. Which one of the following statements about refractive surgery is TRUE?
a) A post-LASIK IOP reading of 16mmHg represents an actual likely IOP of about 12mmHg
b) Accurate IOL powers cannot be calculated in post-LASIK patients without the pre-operative keratometry
c) LASIK outcomes have only been followed-up for a maximum period of 5 years
d) The long-term mean myopic regression has been shown to be only 0.57D

11. Which one of the following statements about refractive surgery is FALSE?
a) Femtosecond lasers are proven to provide safer profiles for LASIK than manual microkeratomes
b) Wavefront-guided technology is proven to give a superior outcome compared to non-wavefront-guided
c) The Royal College of Ophthalmologists certification is the highest qualification for refractive surgeons in the UK
d) Femtosecond lasers have theoretical advantages but remain the tools of research only

12. Which one of the following technologies is NOT currently being explored for presbyopia correction?
a) Micro-fluidic IOL optics
b) Pixel-based IOL optics
c) Polarised IOL optics
d) A deformable intraocular gel

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