Refracting Refractive Surgery Patients

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Since its first appearance, numerous, important advances have been achieved in the field of Refractive Surgery: technological, medical and optometric. Nevertheless, the success of the procedure invariably depends on an appropriate pre-operative ocular examination in order to assess both the suitability of the candidate for the surgery and to measure the parameters needed for the surgical plan.

The importance of accurate refraction cannot be overemphasised for those patients contemplating Refractive Surgery of any kind. There are many reasons for this, not least the fact that the success of the surgery is most frequently judged on the final mean spherical equivalent of the patient post-operation, and clinical audits depend entirely on accurate information. In the post-operational period, it is also used in order to evaluate the healing process, possible regression of ametropia, and any enhancements that need to be considered to improve the final result.

The pre-operative evaluation serves both to assess the suitability of the candidate and for surgery planning. Refraction here plays a major role, first identifying the condition in order to choose the most appropriate surgical technique, and second to quantify the amount of correction needed, when ocular refraction results are combined with the rest of the ocular parameters measured. The awareness of the importance of accurate refraction can be seen in the common pre-consultation advice that is given to patients. It is well accepted that contact lens wearers should be are asked to remove their contact lenses several weeks prior to their pre-operative consultation, to ensure that any corneal distortion that could change the refraction is eliminated. Also, patients are often asked to produce past refractive details for up to the past three years to show that they have retained a level of stability. If the patient had a recent change in their refraction then they may be asked to wait until their prescription has stabilised. With pregnancy, a period of at least three months post-partum should be left before the assessment of the refractive status for Refractive Surgery, since the hormonal changes occurring during pregnancy may significantly alter the refraction. If a patient were to have Refractive Surgery and then find that their prescription has had a natural myopic or hyperopic change, they may unsurprisingly feel wrongly disappointed with the results of the surgery.

The patient's acuity is normally recorded in Snellen format. However, it has been suggested that recording the logMAR acuity would be more relevant especially if any analysis is to be completed on the results.[1] The Bailey Lovie charts use letters of approximately equal legibility, where there is the same number of letters for each size level, and the spacing between letters and the rows is a constant proportion of the letter size. These charts are available in both high and low contrast and the geometrical size progression leads to a better scoring method.

One of the most important reasons why refraction preoperatively needs to be accurate is that the treatment plan will differ depending on the refraction of the patient. A proposed treatment plan is shown in Figure 1.[2] The level of myopia or hypermetropia will strongly dominate the surgery process with the patient needing to be counselled as appropriate. For example, many patients do feel that their level of myopia is worse than it really is. It is fundamental that an accurate prescription is measured for all probable patients as it can be difficult to tell from history and symptoms those patients with an inaccurately corrected refractive error. A patient whose current prescription is too minus will end up over corrected and therefore hyperopic. The patient that has an undetected latent hyperopia will end up under corrected and therefore still hyperopic. It is for this reason that cycloplegic refraction is recommended before refractive surgical treatment.[3] Cyclopentolate is the most commonly used drug for blocking the responses of the sphincter muscle of the iris and accommodative muscle of the ciliary body to cholinergic stimulation resulting in mydriasis and cycloplegia. The results obtained in cycloplegic refraction should be then compared to manifest refraction, normally using fogging with plus lenses, in order to better estimate the correction required. When dealing with hyperopic patients in whom manifest and cycloplegic refractions differ by more than 0.5D, the correction would then move towards the cycloplegic refraction values. This will result in any latent hyperopia being picked up which will allow the surgeon to fully correct the prescription.

The binocularity of a patient must also be considered before the cycloplegic is instilled and prior to the surgery plan being decided. It is important to note that correcting the refractive error might cause a binocular problem, which was previously balanced with the normal prescription. Normally, situations such as a highly exophoric patient with hyperopia would be known previously from the optometric history. However, it is always useful to ensure that these secondary complications, easily avoidable, do not appear. An example of this would be if a patient who is +3.00DS R & L with an 8Δ exophoria. If they wear a +2.50DS correction in spectacles this makes them accommodate, so helping to control the phoria. Full surgical correction will remove this option.

In most cases amblyopia is considered a contraindication for any type of Corneal Surgery, but sometimes the difficulties are more subtle. It is also necessary to counsel non-contact lens patients with a high myopic prescription that they may have some discomfort in reading for long periods of time after having Refractive Surgery. Theoretically, the accommodation and vergence demands are different between single vision contact lenses and spectacle lenses. Myopes are required to exert more accommodation and vergence after Refractive Surgery (or

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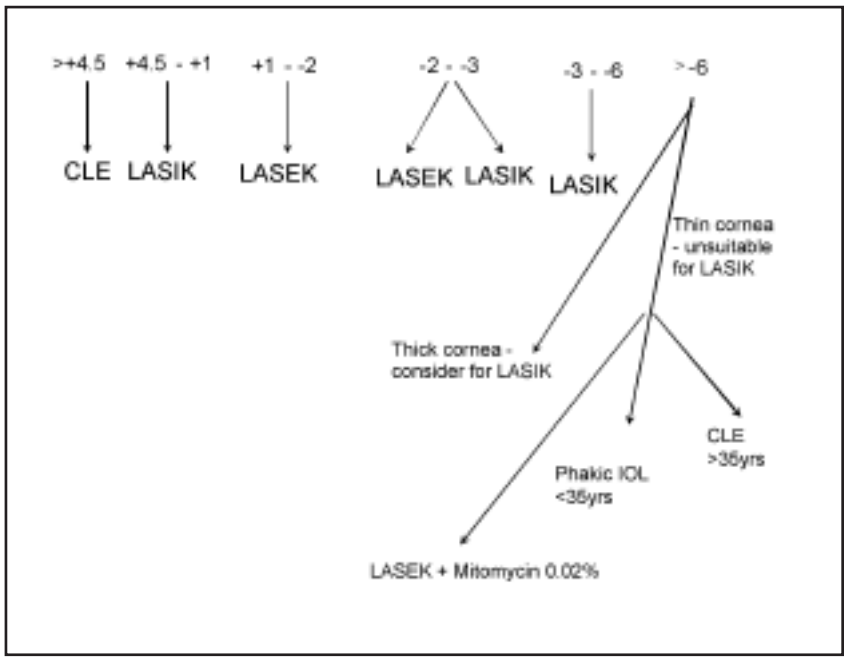

Figure 1: From Shah 2004 (Reference 2).

Figure 2: Nidek ARK 700A (courtesy of Birmingham Optical Group).

when wearing single vision contact lenses), compared to spectacles and conversely hypermetropes are required to exert less accommodation and vergence when corrected by corneal surgery compared to spectacles. This was first proposed by Alpern in 1949.[4] For myopic patients, spectacles lenses provide a base-in prismatic effect when fixating at near, resulting in a decreased need for convergence. When corrected by Corneal Surgery in place of spectacles this effect is lost, so in comparison a greater convergence effort is required. The converse is true for hypermetropic prescriptions in which spectacle lenses present a base-out prism in front of the eyes, reducing the convergence effort required. In addition, the reduced vertex distance of the cornea compared to spectacle lenses results in greater effective power of a myopic prescription and a reduced effective power of a hypermetropic prescription when wearing surgically corrected compared to spectacle lenses. If this is not compensated for in the prescription fitted, as long as the individual had residual accommodation, they could over-accommodate for a myopic contact lens prescription to maintain a clear image, also resulting in excessive vergence.[4,5] Most people do adapt well to changes in the accommodative convergence: accommodation (AC:A) ratio, but a careful pre-operative assessment is essential to identify those who may suffer from a binocular vision problem post-surgery as a prismatic correction is difficult to incorporate in a plano prescription and somewhat defeats the object of undergoing surgery.

The refractive error of the eye can be measured objectively (using an automated device) and/or subjectively. Standard subjective refraction is usually done using an endpoint criterion of maximum plus consistent with best vision[6] and is still considered the gold standard, although there can be some inter-subject variability. In normal healthy eyes it is reported that there is a good correlation between objective and subjective measures.[6,7] However, it has been suggested by several authors that the accuracy of autorefractors post-Refractive Surgery is not so exact.[8,9] It has been demonstrated that the objective autorefractor measures delivered erroneous results, especially in patients who were treated with LASIK for hyperopia, with differences in reading of up to 4D on the spherical component. The authors suggested several possible explanations for the loss of accuracy and reliability in autorefraction compared to subjective refractions, including the fact that the anterior curvature of the cornea is altered. It was noted that if a 5.0mm optical zone is created with the PlanoScan LASIK, the entire ablated area will measure 8.6mm in diameter and the key aspect is where the infrared rays of the autorefractor go through this part of the cornea.[8] When the infrared rays pass through the transition they may be artificially deflected which could cause poor refractive results. It was also felt that the cuts could lead to an irregular corneal surface and a possible change in the refractive index of the cornea, which may cause poor results. However, Pesudovs[10] has recently challenged the findings of previous studies using a more recent autorefractor the Nidek ARK 700A (Figure 2). The author found that in patients that had been treated there was good agreement between the results obtained with the autorefractor and subjective refraction except on patients that had been treated for hyperopia. These results taken together would suggest that autorefractors can be used as a basis for subjective refraction, but possibly should not be used solely for clinical audits etc, without also reporting subjective results.

Retinoscopy, the usual basis of subjective refraction can also prove difficult post-surgery because of the irregularity of the reflex, particularly in the early stages after surgery or if the ablation zone is small compared to the pupil or decentred in relation to the centre of the pupil.[11] This is more prominent in patients with large pupils. Large induced spherical aberration can be produced leading to a confusing reflex with a different reflex centrally compared to the periphery. A 3-4mm pinhole is useful in these circumstances as it 'concentrates' the reflex and may make it easier for the practitioner to observe the proper reflex and thus help correct the true refractive error. The retinoscopy reflex can also help detect cases of corneal ectasia if it develops as it is characterised by a swirling reflex.

Subjective refraction is also convoluted by the irregularity of the cornea and the multifocal nature of the post-operative cornea. An increase in spherical aberration following the laser treatment of myopia alters the equivalent defocus by 0.25D or more for large pupils occurs in approximately 27% of eyes.[11] The advantage for the patients is that they tend to see better than would maybe be expected for their refractive error. However, the disadvantage is a shift toward myopia when the pupil is dilated, which may impact slightly on night driving.

If we consider objective ways to measure refractive error, it is necessary to leave a few words for wavefront analysis. The main reason for the rapid development in the ocular wavefront sensing over the last 10 years is Refractive Surgery. It has been widely reported by several investigators that there is an increase in the high order aberrations after traditional Refractive Surgery procedures.[12,13]

These can, but do not always, affect visual performance of the eye under photopic conditions, but can become manifest with low contrast targets or in a scotopic environment.[14] These increases in high order aberrations (HOAs) are thought to be responsible for complaints of glare, halo and night vision disturbances reported by some Refractive Surgery patients. Customised excimer laser ablation procedures are the same as the traditional procedure, except for the pattern of the laser ablation. This pattern is calculated from the wavefront error measured with the wavefront analysers. The direct benefits of customised ablation come from the reduction in HOAs and, therefore, increase in contrast sensitivity and visual performance, mainly under scotopic conditions.[15] However, the ablation affects the structural integrity of the cornea and hence the aberrations.

Overall, there are several aspects that should be taken into account when refracting a Refractive Surgery candidate/patient. Firstly take a good optometric history of the patient to ensure stability of the refraction status and absence of conditions that may affect the refraction (eg. contact lens wear, pregnancy). An accurate prescription is compulsory, since errors may lead to hyper or hypocorrections. As a result, cycloplegic refraction is highly recommended to unveil the whole amount of refractive error, and then be compared with the results from manifest refraction. The assessment of binocularity is important in order to ensure that the surgical procedure will not induce a binocular unbalance. Furthermore, in high prescriptions, the variations in vergence demand compared to spectacle correction should be considered to ensure an accurate result.

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