



by Joaquim Neto Murta

Methods to evaluate quality of vision

The ideal refractive and lens surgery would allow patients to detect and recognise large and small objects, of high and low contrast, at all distances and under all lighting conditions.

Numerous scientific studies regarding quality of vision after refractive surgery or intraocular lens implantation (multifocal, aspheric, phakic, etc) have been published in recent years. However, what is the meaning of the term quality of vision and, more importantly, how can it be accurately measured? Because image degradations involve a subjective interpretation of an image, detailed questionnaires (psychometric testing) have been developed; in a recent world literature review of quality of life and patient satisfaction after LASIK surgery, it was demonstrated that it has a higher satisfaction rate (95.4 per cent) compared with several other elective procedures and it has influenced the quality of life of these patients.¹

However, visual acuity, wavefront measurement, contrast sensitivity evaluation and subjective and objective perception of unwanted visual effects such as haloes, glare, shadows and starburst provide a more complete measure of the patient's quality of functional vision. As Rosen wrote "we are now able to measure all these parameters to convince ourselves what one technique or one lens is better than another, which almost assumes a universality of the human response in both sexes and all ages".²

Visual acuity remains important to determine the quantity of vision in relation to the optical impact of low-order aberrations. Waterfront measurements are also crucial to determine the optical impact of high-order aberrations giving the optical quality of the eye in terms of spatial distortion but contrast sensitivity measures the total performance of the visual system.

Multiple scientific studies have demonstrated that contrast sensitivity, which declines with age even in the absence of ocular pathology, represents a robust indicator of functional vision. The contrast sensitivity function measured under varying conditions of luminance and glare, establishes the limits of visual perception across the spectrum of spatial frequencies and determines the relationship between the optical efficiency of the eye and the minimum retinal threshold for pattern detection. Therefore, contrast sensitivity testing effectively describes the function of the physiologic visual system as a whole.

Quantitative computerised psychophysical approaches offer substantial advantages over previously used classical clinical semi-quantitative tests that have been used to assess CS after refractive surgery. These conventional tests including the Pelli-Robson test charts, CSV 1000 and Vistech tables,

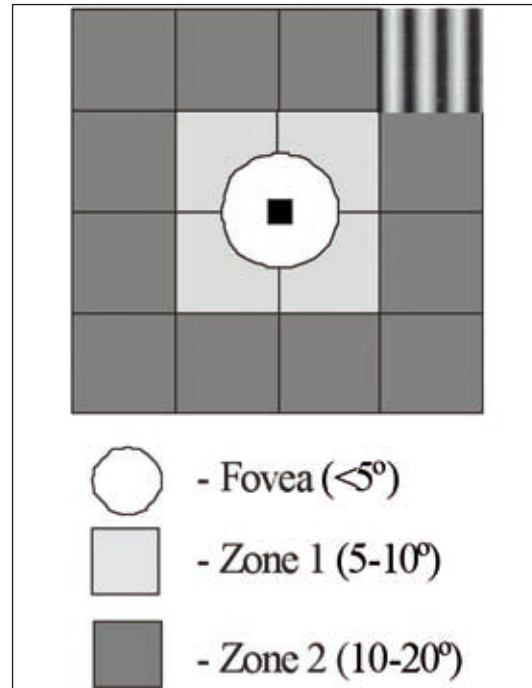


Figure 1- Contrast sensitivity (Intermediate Spatial Frequency, ISF) examination. Basic scheme of the Visual Field locations. Sinusoidal gratings were used as detection target stimuli

probe mainly central vision and in photopic conditions. There is a lack of published studies using more accurate CS methods, in particular under background luminance in the scotopic-mesopic range which may be more sensitive to optical changes than photopic conditions. Furthermore, patients frequently report symptoms such as glare disability only in the scotopic-mesopic range. Most of these clinical tests lack standardisation of lighting conditions, of correlation with symptoms and full scientific validity being therefore hard to interpret by the physician and the patient. They provide limited quantification power and do not allow for the extraction of participants' reliability parameters, due to lack of stimulus randomisation and poor calibration³ while quantitative psychophysical computerised methods are much more sensitive and reproducible. This is due to the fact that testing steps can be calibrated and dynamically changed in a random manner, in a way that is unpredictable for the observer, allowing for the extraction of confidence parameters concerning subjects' performance and reliability. This computerised testing approach uses interleaved staircases keeping attention homogeneously distributed over the visual field, being less prone to artefacts than classical methods.

In a recent study, we adopted a novel method, the Intermediate Spatial Frequency (ISF), to assess spatial vision at an intermediate spatial frequency (3.5 cpd) under mesopic CS testing conditions.⁴ This test strategy measures simultaneously visual

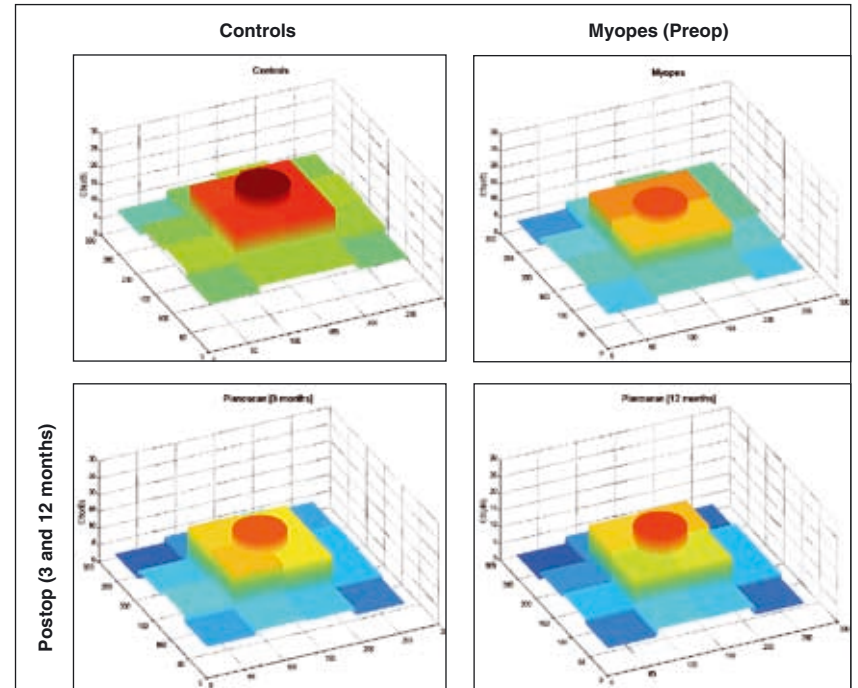


Figure 2. CS in the emmetropic control group, in all myopic patients (pre-op) and in the post-op three months and 12 months

performance in the central and peripheral regions (central 20°) and makes the best compromise to measure visual sensitivity across multiple regions in visual space, in particular in myopic eyes (Figure 1). The rationale for the choice of Intermediate Spatial Frequency (ISF) testing conditions is based on the fact that this spatial frequency is near the acuity limit for peripheral vision, thereby best isolating the parvocellular (high resolution system) in that part of the visual field. That same spatial frequency is near peak sensitivity in central vision in spite of less specifically isolating the parvocellular system near the fovea. Indeed, under these conditions CS performance decays steadily from the centre to the visual periphery, as is typical for the parvocellular pathway, and unlike conditions that isolate the low resolution magnocellular pathway. It has been shown that these parvocellular test conditions are better to test loss of retinal sampling, due to photoreceptor damage, rather than magnocellular testing approaches.⁵ In the former case there is less photoreceptor convergence which enables testing of subtle losses in retinal sensitivity.

These new and comprehensive quantitative methodologies to evaluate CS under mesopic conditions have several advantages: quantitative calibration, presence of reliability criteria, reproducibility and multifocality (since it gathers data from many locations). In fact, its sensitivity is sufficient to detect even physiological asymmetries. CS perimetry is performed in central locations and in

more peripheral regions (up to 20°), while previously studies exclusively tested central regions of the visual field (Figure 2).

The development of precise, reproducible and accurate methodologies to obtain objective measurements of quality of vision, namely night vision, are mandatory in order to create surgical techniques that maximise the quality and function of vision, preventing or surgically correcting high order aberrations and decreasing or eliminating post-refractive vision disturbances.

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