By Pierre-Jean Pisella, MD, PhD

KR-1W: The all-in-one visual function evaluator

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Refractive correction without the use of spectacles is growing increasingly common. The widespread use of laser-assisted in situ keratomileusis (LASIK), photorefractive keratectomy (PRK), and intraocular lenses (IOLs) illustrates just how varied and sophisticated refractive correction techniques have become.

The outcomes achieved with these techniques can be exceptional when rigorous pre-, peri- and post-operative assessments of visual parameters and overall ocular health are performed. Such assessment typically involves the use of topography to evaluate corneal health and curvature, aberrometry to measure refractive error, and pupillometry to determine pupil size. Conventional practice would call for a different device per assessment performed. However, a comprehensive machine, such as the KR-1W (Topcon, Oakland, NJ) can assist in significantly reducing the time, equipment and spatial requirements associated with visual assessment.

Less is more

The KR-1W is a wavefront analyzer designed to perform the five most important types of visual assessment required by refractive surgery patients: topography, aberrometry, pupillometry, refractometry, and keratometry. By combining technologies specific to wavefront aberration,

Figure 1: The 5-in-1 KR-1W significantly reduces the time, equipment and spatial requirements associated with visual assessment.

corneal topography, and auto-refraction, the desktop sized system speeds up patient throughput while taking up significantly less space than the numerous pieces of equipment that would otherwise be required. The KR-1W is an easy-to-use system, with user-friendly features, such as complete auto-alignment, onboard evaluation software, a large color touch screen, simulated visual acuity assessment, and wavefront image sequencing. Results captured by the various modes are presented as maps – including corneal, pupillometry, IOL selection, and ocular maps. This visual presentation of data assists decision making and increases the ease with which the cause of a patient's visual complaints can be identified.

The KR-1W in clinical practice

I started using the KR-1W approximately 3 years ago, with the aim of evaluating how helpful such a system would be in the pre- and postoperative management of cataract surgery patients. This idea arose from my awareness that three key surgical steps – pupillometry, IOL selection, and IOL implantation – are all supported by the capabilities of the KR-1W. Specifically, the system permits the measurement of the types of aberration – higher order aberration (HOA) – that cannot be corrected by IOL implantation. Corneal asphericity and astigmatism are also measurable with the system. Doing so at a preoperative stage allows the physician to ascertain the amount of correction and asphericity required from any toric IOL proposed for astigmatism correction and for the correct IOL power to be selected before implantation. It also helps to identify and rule out candidates who are unsuitable for multifocal IOL implantation by nature of very high levels of astigmatism.

Figure 2: Results captured by the KR-1W are presented visually as maps, allowing the doctor to easily identify the cause of a patient's visual complaints.

The system is also designed to perform post-refractive surgery index calculations – a function that I have found important when presented with post refractive surgery patients who wish to undergo cataract surgery. In such patients, this calculation ensures that residual corneal irregularities from previous surgery can be identified, and non-conventional formulas devised to accommodate the presence of such corneal irregularities can be used to calculate preoperative lens power rather than standard formulas. Finally, postoperative measurement of residual ocular astigmatism can be conducted with the machine to ensure prompt identification of required postoperative refractive adjustments.

Pupillometry – during which pupil diameter and centration are measured – is another function of the KR-1W that I find useful for accurate IOL selection and implantation, particularly in patients opting for a multifocal IOL. Not only does it facilitate the selection of the most appropriate type of IOL for each patient, it also allows patients with marked decentration to be identified and ruled out for IOL implantation.

Figure 3: The KR-1W features a component map display which shows the high order aberrations for the entire ocular system.

A variety of uses

Although I have only used the KR-1W in the cataract surgery setting, it is important to highlight that the machine holds value in several other settings – namely the detection of corneal pathology and the assessment of refractive surgery candidates. Pupillometry is an examination always required by preoperative refractive surgery

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patients, as a pupil diameter greater than 6.5 mm when in scotopic conditions, puts an individual at elevated risk of poor night vision after LASIK and flags them as poor LASIK candidates.
Poor visual quality and blur can be troublesome for patients and their physician if the true cause is not identified. The KR-1W is designed to identify the source of blur – corneal or lens pathology – and quantify the level of existing blur via map plotting and root mean square (RMS) value calculation. This capability of the system has numerous roles in clinical practice, allowing correct diagnosis of patient pathology, determination of cataract severity, and assessment of visual quality before and after contact lens treatment, cataract surgery, or corneal transplant.

The potential way forward

While researching the clinical applications of the system, my colleagues and I identified potential future clinical uses for the KR-1W. For example, we investigated the machine’s continuous measurement function and found it assisted in the evaluation of visual quality in patients with dry eye syndrome. This tool, which is currently only used in a research capacity, allows up to 10 continuous measurements of visual quality to be captured as RMS values, which can then be analyzed to determine existing changes in higher order aberrations over a 10 second period. Given the high prevalence of dry eye in the general population, I believe it will be exciting to see the use of this function move from research to clinical in the near future.

We also observed that although the KR-1W is currently designed for use by ophthalmologists during patient consultations, my experience with the machine has highlighted that the KR-1W is extremely adaptable and may provide great benefit when used during pre-consultation workup by optometrists or trained technicians. Nonetheless, I believe that the KR-1W is a highly relevant machine in ophthalmic practice today. Not only is it valuable in determining procedural suitability and maximizing postoperative visual outcome among refractive and cataract surgery patients, it is also useful in general ophthalmology – assisting in the identification of ocular pathology.

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