

### Comparison of pupil diameter measurement with Lenstar LS 900 and OPD Scan II. *Not interchangeable devices*

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Dark-adapted pupil measurement is of great concern in corneal refractive surgery, as well as when phakic or multifocal intraocular lens (IOL) implantation is planned.<sup>1,2</sup> Pupil size may influence the choice of ablation zone in refractive surgery and IOL design in cataract surgery, and it should be measured accurately so as not to end up with unfavorable postoperative outcomes, such as halos, glare, or poor night vision. Although several types of devices, such as infrared pupillometers and infrared photography methods, are available for measurement of pupil diameter, in clinical practice, surgeons may prefer the use of one device for measurement of many parameters related to the cornea or the anterior segment of the eye.<sup>3-5</sup> The OPD Scan II (Nidek, Osaka, Japan) is a corneal aberrometry-topography (CAT) device that can simultaneously evaluate corneal topography, high order aberrations, and mesopic and scotopic pupil diameter measurement. The Lenstar LS 900 II (Haag Streit, Koeniz, Switzerland) is a low coherence optical reflectometer that is capable of measuring anterior segment parameters, including corneal thickness, anterior chamber depth, lens thickness, and white-to-white distance, as well as pupil diameter. The objective of this study was to compare the capability of optical low coherence reflectometry (OLCR) and CAT to measure pupil diameter, and to evaluate their correlation in the assessment of cataract and refractive surgery.

This comparative, observational study, conducted in the Department of Ophthalmology, Faculty of Medicine, Selcuk University, Konya, Turkey, between July and August 2011, adhered to the tenets of the Declaration of Helsinki, and the local ethics committee approved the study protocol. All patients gave their informed consent for the study.

Seventy-two eyes (one randomly selected eye) of 72 emmetropic patients were recruited for this study.

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Inclusion criterion included no history of systemic or ocular disease. A complete ophthalmic examination was performed on every participant, and any history of ocular trauma, surgery, or usage of topical eye drops composed the exclusion criteria. All the measurements were performed in mesopic room conditions (2 lux illumination (measured with International Light IL 1700 Radiometer, Newburyport, MA, USA), and with native pupils. For dark adaptation, the subjects wore dark wrapped cataract glasses for 5 minutes. After dark adaptation, the pupil diameter was measured with a topography-aberrometer (OPD Scan II, Nidek, Osaka, Japan), and low coherence optical reflectometry (Lenstar LS 900, Haag-Streit, Koeniz, Switzerland) in random order. The time interval between the 2 measurements was 15 minutes; the same experienced examiner performed the measurements. All the measurements were taken between 3 and 4 p.m.

Independent t-test using the Statistical Package for Social Sciences version 16.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. A *p*-value less than 0.05 was taken as statistically significant. Intraclass correlation and Spearman's coefficients were calculated.

The mean age of the 72 patients (38 female, 34 male) was 26.2±8.1 years (range 19-43 years). The mean results of pupil size measured with OPD under photopic conditions were 4.31±0.49 mm (range 3.14-5.42), and under mesopic conditions were 6.26±0.61 mm (range 4.74-7.76), while the mean results of pupil size measured with OLCR in mesopic conditions were 5.82±0.99 mm (range 3.20-8.97). Statistically significant differences were observed in the results of the photopic and mesopic conditions with OPD (*p*=0.001). The OPD measured the mesopic pupil diameter 0.44 mm larger than the Lenstar did; this difference was statistically significant (*p*=0.001). The intraclass correlation coefficient for mesopic pupil diameter measurements with OPD and Lenstar was 48.59% (95% confidence interval: 28.78%–64.41%). Spearman's correlation coefficient was *r*=0.54.

The preoperative evaluation of patients is as important as the surgery itself in refractive procedures, including corneal refractive surgery, phakic IOL implantation, and multifocal IOL implantation.<sup>1,2</sup> The ablation zone is the area of the cornea that includes the fully corrected optical ablation zone and the transition zone. It is adjusted for mesopic pupil diameter, as the dark-adapted pupil diameter can influence the choice of ablation optical zone diameter. In the planning of multifocal IOL implantation, dark-adapted pupil diameter should have been measured objectively to determine the IOL design.

There are several reports concerning the precise measurement of mesopic pupil diameter.<sup>3-5</sup> These studies have evaluated the accuracy of various pupillometers, both infrared and computed video types. Bradley et al<sup>3</sup> compared the clinical performance of a handheld digital infrared monocular pupillometer (PLR-200, NeurOptics, Inc., Irvine, CA, USA) to infrared digital photography. They reported that there was some negative bias in the handheld photography, but not clinically significant, at one lux illumination. They also proposed that monocular occlusion may have induced involuntary accommodative convergence. There have been some studies comparing infrared pupillometers with topography devices, aberrometers, and wavefront analyzers. Wickremasinghe et al<sup>4</sup> performed a study to compare scotopic pupil size measurements taken with a digital pupillometer and a Hartmann-Shack wavefront aberrometer, and they found good agreement between the 2 methods. They found similar results for scotopic measurements with both instruments. Kohnen et al<sup>5</sup> reported good clinical correlation between pupil diameter measurements obtained with aberrometers and infrared pupillometers, but significantly low measurements with a topography system.

In our study, the difference between the 2 devices for pupil diameter measurement was found to be statistically significant. Although the luminance of the environment was kept at 2 lux to simulate mesopic conditions during measurement with the 2 devices, the OPD Scan II measured the mesopic pupil diameter 0.44 mm larger than the Lenstar did. This difference may be due to more stimulated accommodation during measurement with the Lenstar LS 900. Moreover, monocular occlusion during the measurements with Lenstar might have caused an involuntary accommodation, as proposed in the study of Bradley et al.<sup>3</sup>

Our study has some limitations. First, we did not compare the pupil size measurements of these 2 devices with infrared digital photography, which is accepted as more accurate and objective for pupil size assessment. The mean results of the pupil diameter measurements

taken by both devices were lower than expected from a population of that age (for example, as low as 3.20 mm in a 32-year-old patient for mesopic measurements with Lenstar, and 4.74 mm in a 40-year-old patient for mesopic pupil diameter with OPD Scan II). This outcome might be due to induced accommodation during the measurement process by these devices

In conclusion, these 2 devices cannot be used interchangeably for measurement of mesopic pupil size and follow up of the same patient. Both devices cannot be accepted as the gold-standard for mesopic or scotopic pupil size measurements, and further studies are necessary to demonstrate the agreement of these 2 devices with a gold-standard pupillometry device for measurement of pupil diameter.

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