

# Measuring Pseudophakic Accommodation

An evaluation of available methods.

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**A**ccommodation is but one component of the synkinetic near reflex triad, which also comprises convergence and miosis. It is important to remember this triad when attempting to measure accommodation as well as to recognize that blocking convergence (eg, by monocular occlusion) decreases both accommodation and miosis.<sup>1</sup> Whereas the ability to accommodate decreases with age, miosis increases as a result of decreased sympathetic activity while convergence remains relatively unchanged. This article evaluates available subjective and objective methods for measuring accommodation.

## DONDER'S "PUSH-UP" METHOD

Although this subjective method is historically considered to identify the near point of accommodation, it more accurately measures the near depth of field, which is dependent on a variety of factors and not accommodation alone. Donders' method could more precisely be described as providing a means for determining the near point of acuity rather than of accommodation.

An individual's depth of field, in addition to his accommodative ability, depends on varying pupil size (both as a part of the reflex triad and in response to light) and on the eye's inherent optical aberrations and multifocality. The diameter of the entrance pupil is equally important as the amount of dioptric defocus in the formation of blurred ocular imagery, and one must account for the former when making any assessment of a patient's depth of focus.<sup>2</sup> Even eyes with perfectly cen-

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tered, monofocal, pseudophakic lenses may demonstrate significant multifocality as a result of corneal effects.<sup>3</sup> Depth of field and near visual acuity also depend significantly on neural processing, an effect not yet fully understood or quantifiable but important in final image appreciation.<sup>2</sup> For instance, neural processing may sometimes select the least blurred image presented to the retina rather than the image of highest contrast.<sup>4</sup>

## OBJECTIVE MEASURES OF TRUE ACCOMMODATION

### Dynamic Retinoscopy

Although first described by Edward Jackson, MD,<sup>5</sup> in 1895 and despite being simple to perform, dynamic retinoscopy is nonetheless fairly unfamiliar to most ophthalmologists.<sup>6-10</sup> This technique should not be confused with near retinoscopy, which may be used to measure distance refraction rather than accommodation.

Using an ordinary retinoscope, when the examiner observes the retinoscopic reflex of a distance-corrected eye without additional lenses, "with" movement is observable. When the patient switches fixation from dis-

tance to an object placed beneath the peephole of the retinoscope, the beam broadens to neutralization as full accommodation occurs. Near targets placed close to the patient in front of the retinoscope produce “against” movement (Figure 1).

Dynamic retinoscopy readily detects the degree and speed of accommodation as well as the presence of irregular light reflexes due to corneal or lens aberrations’ inducing multifocality.

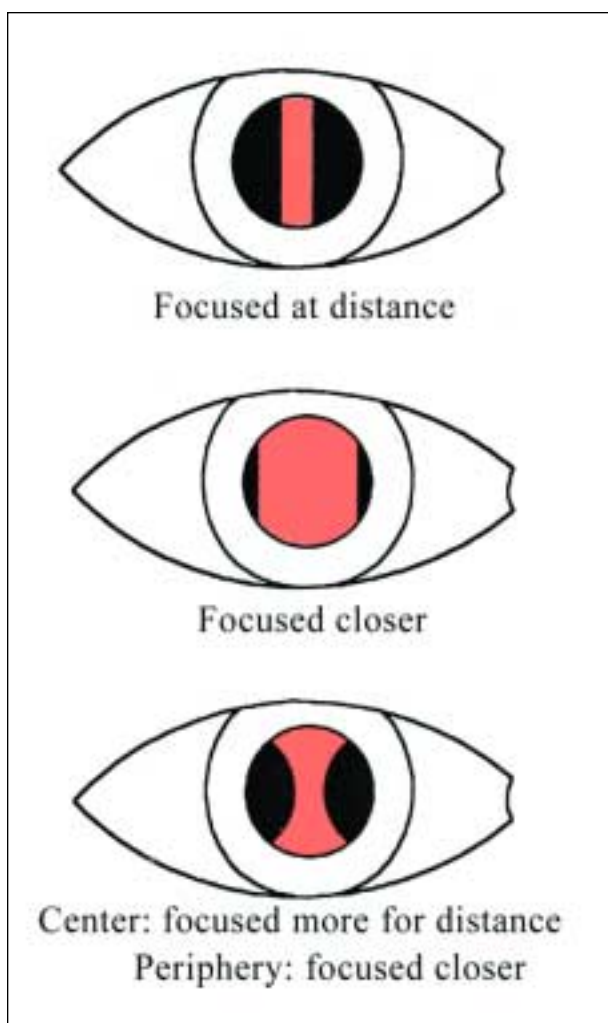


Figure 1. “With” movement of the retinoscopic red reflex is observable when a patient wearing distance correction looks at a distance fixation target (top). As the patient switches fixation to a closer target, the reflex broadens. If the target is placed just below the retinoscope’s peephole, neutralization occurs when accommodation is complete (middle). If spherical aberration is present, multifocality is observable; the central, narrower part of the red reflex indicates rays more focused for distance whereas the broader, peripheral portion is more focused for near (bottom).

### Infrared Optometers Using the Scheiner Principle

Because infrared optometers provide refractive measurement through only a small portion of the eye’s optics, the alignment of the various measuring apertures with the patient’s pupil is critical. Sampling only a small portion of the pupil for the refractive measurement means that small amounts of optical irregularities that are present may render the results unrepresentative of the eye’s optics as a whole.<sup>11</sup>

Newer versions of infrared optometers use photoretinoscopy (such as the PowerRefractor<sup>12</sup> [PlusOptix, Nürnberg, Germany]). They offer the advantage of rapidly measuring the refraction at distance as well as binocularly. These instruments calculate an average refraction for the entire pupil, however, and do not provide any information on multifocality. Because devices are calibrated for the smaller amount of aberrations present when the lens is in a relaxed state, they underestimate the degree to which accommodation increases the amount of aberrations.<sup>13</sup>

### Wavefront Analysis

Wavefront calculations have demonstrated that Donder’s push-up method may have identified as accommodation what could be attributed to corneal multifocality induced by surgery in some pseudophakos.<sup>3</sup> Devices based on the principle of Hartmann-Shack aberrometry are now available for clinical use. They measure the shape of the wavefront of light as it exits the eye from an effective point source on the retina. These aberrometers are able to determine multifocal refractive states across the pupil,<sup>14</sup> both before and during accommodation, and the difference in these values is the exact measure of true accommodation. Best results are obtained with a large, dilated pupil,<sup>15,16</sup> such as is achieved through the administration of phenylephrine without affecting accommodation.<sup>17</sup>

Using Hartmann-Shack aberrometry, researchers have demonstrated small but significant degrees of accommodation in patients who recently received hinged, accommodating IOLs.<sup>18</sup>

### CONCLUSION

Several investigators have emphasized the importance of selecting the appropriate test for the variable to be measured, be it optical image quality, optical image appreciation, or actual accommodation.<sup>7,19,20</sup> Although related, these terms designate distinct entities. For example, multifocality affects optical image quality, whereas neural processing (both retinal and cortical) strongly influences optical image appreciation.<sup>2,4</sup>

In order to measure a dynamic process such as accom-

modation, the clinician must employ a test that measures the dynamic change that occurs within the eye as opposed to image or acuity appreciation endpoints, which are multifactorial. Without the ability or means to control for other factors involved in acuity (eg, variation in pupil size, multifocal optics, neural processing), attempts to measure accommodation through acuity testing will be unreliable. At present, dynamic retinoscopy is the most readily available, reliable, and practical objective method for assessing accommodation, although it is diffi-

cult to quantify. The recent availability of Hartmann-Shack aberrometers for performing wavefront analysis adds an objective, quantitative, and observer-independent tool to clinicians' armamentarium. ■

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