Impact of intraocular lens haptic design and orientation on decentration and tilt

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PURPOSE: To assess the effect of intraocular lens (IOL) orientation (vertical versus horizontal) and haptic design (1-piece versus 3-piece) on centration and tilt using a Purkinje meter.

SETTING: Moorfields Eye Hospital NHS Foundation Trust, London, United Kingdom.

DESIGN: Randomized pilot study with intrapatient comparison.

METHODS: In part 1 of this study, patients received plate-haptic IOLs (Akreos Adapt) in both eyes that were positioned vertically in 1 eye and horizontally in the other eye. In part 2, patients received a 1-piece IOL (Acrysof SA60AT) in 1 eye and a 3-piece IOL (Acrysof MA60AC) in the contralateral eye. Decentration and tilt were measured 1 month and 3 months postoperatively with a new Purkinje meter.

RESULTS: In part 1 ($n = 15$), the mean decentration of plate-haptic IOLs was 0.4 mm $\pm$ 0.2 (SD) with vertical orientation and 0.4 $\pm$ 0.2 mm with horizontal orientation and the mean tilt, 1.5 $\pm$ 1.1 degrees and 2.9 $\pm$ 0.9 degrees, respectively. In part 2 ($n = 15$), the mean decentration was 0.4 $\pm$ 0.3 mm with 1-piece IOLs and 0.6 $\pm$ 0.8 mm with 3-piece IOLs and the mean tilt, 2.2 $\pm$ 7.2 degrees and 5.3 $\pm$ 2.4 degrees, respectively.

CONCLUSIONS: Three-piece IOLs had a greater tendency toward more decentration than 1-piece IOLs, perhaps because of slight deformation of 1 or both haptics during implantation or inaccuracies in production when the haptics are manually placed into the optic. The IOL orientation for plate-haptic IOLs appeared to have no effect on IOL position. The Purkinje meter was useful in assessing the capsule bag performance of the IOLs.

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With recent advances in intraocular lens (IOL) technology, cataract surgery has transitioned from being solely a treatment for visual rehabilitation to also being a refractive procedure with the aim of gaining visual function comparable to that of the noncataractous elderly eye. Examples are aspheric IOLs to compensate for the spherical aberration of the cornea and increase contrast sensitivity, multifocal IOLs to decrease spectacle dependence, and toric IOLs to correct corneal astigmatism and enhance uncorrected distance vision. Intentionally, these IOL designs should increase visual function and ultimately the patient's quality of life. The performance of these new IOL designs is highly dependent on the position of the IOL in the optical system of the eye. Theoretical simulations by Holladay et al.[1] showed that aspheric IOLs should be decentered less than 0.4 mm and tilted less then 7 degrees to exceed the optical performance of conventional spherical IOLs. Another theoretical study by Piers et al.[2] showed slightly more tolerance for decentration and tilt. The authors report 0.8 mm as the critical decentration point and 10 degrees as the critical tilt point for these IOLs. For multifocal IOL designs, decentration of the optic may alter the light distribution between the distance focus and near focus, resulting in poorer performance of the IOLs. For toric IOLs, orientation and centration in the bag are important because misalignments can result in a shift of the axis and possibly in decreased visual quality. Even though an IOL may appear centered at the end of surgery, capsule collapse and contraction resulting from capsule opacification can induce decentration, tilt, or both.

There are several ways of assessing decentration and tilt of an IOL. These include slitlamp assessment,

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Table 1. Mean decentration and tilt 1 month and 3 months postoperatively for the vertical and horizontal axis position of plate-haptic IOLs. Negative values indicate inferior or temporal movement.

	Mean ± SD			
	Decentration (mm)		Tilt (Degrees)	
IOL Axis/Follow-up	X	Y	X	Y
Vertical				
1 month	0.09 ± 0.26	0.21 ± 0.25	0.4 ± 1.2	−0.4 ± 1.4
3 months	0.07 ± 0.28	0.23 ± 0.27	−1.5 ± 1.1	−1.6 ± 1.2
Horizontal				
1 month	0.06 ± 0.19	0.30 ± 0.19	0.6 ± 1.0	−0.4 ± 1.5
3 months	0.11 ± 0.13	0.34 ± 0.15	2.9 ± 0.9	−1.9 ± 1.4

IOL = intraocular lens, X = horizontal axis; Y = vertical axis

retroillumination photography,[3] Scheimpflug imaging,[4] and measurements using Purkinje reflections.[5–12] The most commonly used is the slitlamp method, which is entirely subjective, can vary between examiners, and is more qualitative than quantitative. Furthermore, because slitlamp grading of IOL decentration and tilt can only be performed with a dilated pupil, the assessment may be difficult to relate to the pupil center or fixation axis. Also, because there is no fixation target for the patient, a slight change in the direction of gaze during slitlamp examination, which might not be spotted by the examiner, will result in the wrong impression of a decentered and tilted IOL.

Rotating Scheimpflug imaging requires sufficient pupil dilation to visualize the optic edge and the posterior IOL surface; in addition, it requires the cooperation of the patient to fixate steadily during the 1.5 seconds of scanning without moving. Also, Scheimpflug images are not corrected for optical distortion by the cornea.[13] Additional problems may be the identification of the anatomic structures of the eye that are used as reference points.[8] The observation of Purkinje reflexes dates back to the 19th century, when candles were used to generate ocular reflections. The use of lasers and light-emitting diodes (LEDs) was proposed by Guyton et al.,[14] who used a simple hand light to illuminate the eye and look for the alignment point of the Purkinje III and IV reflexes. Their experiments provided qualitative information about IOL alignment. Newer methods allow calculation from Purkinje images. It was shown that the method using Purkinje images was more accurate than Scheimpflug imaging.[13] The Purkinje meter used in the present study[15] allows simple and quick acquisition of images in pseudophakic eyes. The method was shown to be highly reliable and repeatable in measuring tilt and decentration of IOLs.[8]

This pilot study compared the effect of IOL haptic orientation and of haptic-loop design on IOL centration and tilt using a Purkinje meter.

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PATIENTS AND METHODS

This prospective randomized study with intraindividual comparison comprised patients with age-related cataract. It adhered to the tenets of the Declaration of Helsinki and was reviewed by the local ethics committee. After receiving an explanation of the study, all patients signed a consent form.

Exclusion criteria were age younger than 21 years, pseudoexfoliation syndrome, pigment dispersion syndrome, and history of ocular trauma or other ocular comorbidity that could affect position of the IOL in the eye after implantation.

The study consisted of 2 parts. In part 1, decentration and tilt between the horizontal orientation and vertical orientation of a plate-style IOL (Akreos Adapt, Bausch & Lomb) were compared. In part 2, decentration and tilt between a hydrophobic acrylic 1-piece IOL (Acrysof SA60AT, Alcon Laboratories, Inc.) and a 3-piece IOL (Acrysof MA60AC, Alcon Laboratories, Inc.) with the same optic material were compared. Both IOLs have an optic diameter of 6.0 mm and an overall length of 13.0 mm. The 1-piece IOL is not angulated, and the haptic material is the same as the optic material.