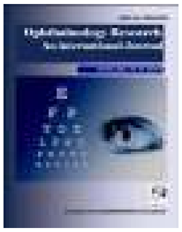

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A Comparison of Accommodation Amplitudes of Three Different Acrylic Intraocular Lenses

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Authors' contributions

This work was carried out in collaboration between all authors. Author RY designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author ME managed the analyses of the study, collected study data, made the critical revision of the article. Authors UEA and BA collected study data, managed the literature searches. Authors IFH and SD provided administrative, technical and logistic support. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aim: To assess the accommodative amplitudes of three different foldable acrylic intraocular lenses (IOLs) by measuring with photorefractor Plusoptix CR03 (Plusoptix GmbH, Nuernberg, Germany).
Methods: Fifty five pseudophakic eyes of 46 patients (mean age 65.25±10.63 years) were analyzed one month after uneventful phacoemulsification and IOL implantation surgery. Rayner Centerflex (C-Flex) (n=17), AcyrSof MA60BM (n=17), Sensar AR40e (n=21) IOLs were implanted. An objective, dynamic measurement technique with R mode of Plusoptix CR03 device was used to measure accommodation. Accommodation was measured at near distance (0.33m) and far distance (5m).
Results: Accommodation amplitudes (mean ± SD) measured with photorefractor at near distance in Rayner, AcyrSof and Sensar groups were 1.45±0.76 diopter (D), 2.82±1.88 D, 2.44±1.02 D, respectively. Accommodative response of AcyrSof and Sensar IOLs was greater than Rayner IOL significantly (p=0.027 and p=0.004, respectively). At far distance,

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measured accommodation amplitudes in Rayner, AcyrSof and Sensar groups were 1.34±0.54 D, 1.87±0.74 D and 1.74±1.70 D, respectively. There were no significant difference between the groups (p=0.109).

Conclusion: The 3-piece hydrophobic acrylic IOLs, AcrySof MA60BM and Sensar AR40e) had a significantly higher accommodative response than the 1-piece plate-haptic hydrophilic acrylic Rayner C-Flex IOL.

Keywords: Accommodation; intraocular lens; photorefractor; pseudophakic accommodation.

1. INTRODUCTION

Accommodation is the ability of the eye to focus on a distant target, projecting this visual image of the target onto the retina. Refractive power of the eye is regulated by two mechanisms: either by adjusting focal point of the imaging system or by removing the projection plane further from the focal plane. Therefore, during accommodation either distance between retina and lens may change or focal point is adjusted with changes in the radii of the curvature or in the refractive indices of the refractive elements of the eye [1].

Some patients with monofocal intraocular lenses (IOLs) have well near visual acuity without correction due to pseudophakic accommodation. Pseudophakic accommodation is the results of the dynamic refractive state change due to accommodative effort of ciliary muscle [1]. Pseudophakic pseudoaccommodation refers to static optical features of the pseudophakic eye independent of the ciliary muscle such as corneal multifocality, minus cylinder, and small pupil size resulting in increased depth of field [1-4].

In our study, we measured and determined the accommodative amplitudes of three different monofacal IOLs with the infrared photorefractor Plusoptix CR03 (Plusoptix GmbH, Nuernberg, Germany) using the principle of eccentric photorefraction.

2. MATERIALS AND METHODS

Forty six patients' 55 pseudophakic eyes were analyzed one month after uneventful phacoemulsification and IOL insertion. The study was conducted at the Fatih University Hospital and reviewed by the local ethics committee. Patients with significant IOL decentration, corneal astigmatism >1.0 D, posterior or anterior synechia formation due to postoperative inflammation or significant eye pathology decreasing visual acuity were excluded. Standard phacoemulsifications with clear corneal incision were performed. From three different types of monofocal IOLs, one was implanted in-the-bag in randomized fashion. Three different monofocal IOLs were either AcyrSof MA60BM (n=17) or Sensar AR40e (n=21) or Rayner Centerflex (C-Flex) (n=17).

The AcrySof MA60BM (Alcon Inc, Fort Worth, TX, USA) is configurated as a 3-piece hydrophobic acrylic IOL with its haptic as flexible polymethyl methacrylate (PMMA) C-loop with 10-degree angulation. Its optic diameter is 6.0mm and overall diameter is 13.0mm. The Sensar AR40e (Abbott Medical Optics, Santa Ana, CA, USA) is configurated as a 3-piece hydrophobic acrylic IOL with its haptics as flexible PMMA C-loop with 5-degree angulation. Its optic diameter is 6.0mm and overall diameter is 13.0mm. The Rayner C-Flex (Rayner Intraocular Lenses Limited, East Sussex, UK) is configurated as a 1-piece hydrophilic acrylic

IOL. Its haptics have a plate-haptic configuration without angulation. Its optic diameter is 5.75mm and overall diameter is 12.0mm.

To measure accommodation, an objective, dynamic measurement technique with R mode of Plusoptix CR03 (Plusoptix GmbH, Nuernberg, Germany) device was employed. All measurements were performed in one session by two experienced ophthalmologists in the same lightning conditions. With the Plusoptix CR03, the patient was alternately fixated on a 5 m far target and a near 0.33m target. Off-axis measurement errors due to eye movements were prevented as the near and far targets were located in a fixation line to the patient with a minimal tilt to the detection path of the infared camera [5]. The Plusoptix CR03 is measuring sphere data and pupil size during the “Dynamic Scan” with the camera working at a temporal resolution of 25 Hz. The original software package allows the user to record the measurements with a maximal duration of 2 minutes. During the “Dynamic Scan” refraction in the vertical meridian (accommodation) is calculated and best performance is achieved with gaze deviations smaller than 5º and the range for pupil size measurement is set to 2–11 mm, but without evaluation of refraction [6].

Statistical Package for the Social Sciences (SPSS 13.0; SPSS Inc, Chicago, Illinois, U.S.A) software was used for statistical analysis; the data were given as mean ± SD. Differences between measured parameters of three groups were evaluated with Kruskal-Wallis test. Mann-Whitney U test was performed for dual comparisons between groups and a P value of 0.05 was set as the level of significance.

3. RESULTS AND DISCUSSION

3.1 Results

Fifty five eyes (37 unilateral and 9 bilateral) of 46 patients (22 men and 24 women) who underwent uneventful phacoemulsification and had received any of these three lenses; AcyrSof MA60BM (n=17), Sensar AR40e (n=21) or Rayner Centerflex (n=17) were included in the study. Mean patient age was 65.25±10.63 years (range 40 to 83 years). Accommodation amplitudes (mean ± SD) measured with photorefractor at near distance in AcyrSof, Sensar and Rayner groups were 2.82±1.88 diopters (D), 2.44±1.02 D, 1.45±0.76 D respectively (Table 1). Accommodative response of AcyrSof and Sensar IOLs was greater than Rayner IOL significantly (p=0.027 and p=0.004, respectively). At far distance, measured accommodation amplitudes in AcyrSof, Sensar and Rayner groups were 1.87±0.74 D, 1.74±1.70 D and 1.34±0.54 D, respectively (Table 1). No statistically significant difference were detected between the groups (p=0.109).

Table 1. Accommodation amplitudes measured with photo refractor

IOL type	**Accommodation amplitude (D)**	
	Near	**Far**
AcrySof MA60BM	2.82±1.88	1.87±0.74
Sensar AR40e	2.44±1.02	1.74±1.70
Rayner C-Flex	1.45±0.76*	1.34±0.54

*Values are given as mean ± SD. (IOL: intraocular lens, D: diopters, *: p<0.05)*

3.1 Discussion

There are several different assessment techniques and devices to measure accommodation [1,7,8]. Subjective techniques are based on the patients capability of reading optotypes on a far or near target whereas objective techniques measure the refraction of the eye [1,9-11]. In the present study, we performed objective measurement with a new photorefraction device.

Automated infrared photorefraction works with the of eccentric photorefraction principle and does not interfere with the actual visual condition. It is potentially useful because it works from a remote distance and video image of the eyes is used for determination of the refractive state [12-15]. The camera could be incorporated into experimental and field settings for the reason that the standard measurement distance from the eyes to the video camera is 1 m [14,16].The TOMEY VIVA (Fortune Optical, Padova, Italy) was the first videorefractor to hit the market using eccentric photorefraction. However later it was found out that the device had poor precision which may be due to using only one light source at one eccentricity [17,18]. The Topcon (PR1000 and PR2000, Tokyo, Japan) has a linear radiation bar unlike the TOMEY VIVA which uses individual eccentricities. Topcon does not allow measurement of accommodation without interruption. Topcon's test results were compared with retinoscopy in children who were under 8 and results indicated that Topcon may have underestimated hypermetropia and astigmatism. Additionaly, repeatability was at moderate levels [19]. The Power Refractor (Plusoptix, Nurnberg, Germany) can measure refractive error over a range of -8 D to +6 D at 25 Hz with pupils greater than 3 mm in diameter. It can carry out both continuous and static measurements besides it can save the direction of the pupil axes and pupil size in both eyes. The Plusoptix CR03 appears to fulfill the requirements which are essential to quantify accommodation for several reasons [18]. It offers three modes which are: Full scan, Gaze scan and Dynamic Scan. Full scan allows binocular full refraction and pupil size evaluation. The latter scan mode lets the user to evaluate and visualize the strabismus angle and/or the fixation angle. With the last mode which is Dynamic scan it is possible to measure temporal changes in accommodation and pupil size [6].

Pseudophakic eyes of some patients have good vision for both near and distance with distance correction only [20-22]. This has been ascribed to diverse optical properties of the eye and IOL like the IOL movement along the anteroposterior axis, corneal multifocality and enhanced depth of focus associated with myopic astigmatism [1,4,20,23].

The amount of accommodation in eyes with monofocal IOLs have been evaluated in a number of studies. Nakazawa et al [22] stated a mean apparent accommodation of 2.01±0.95 D in pseudophakic eyes after implantation of posterior chamber intraocular lenses. The mean depth of focus was 1.27±0.57 D and the mean amplitude of legibility was 2.72±1.10 D in the study by Elder et al [23]. Oshika et al. [20] measured the amplitude of accommodation as 2.03±0.93 D in their study group. Langenbucher et al [1] measured the accommodation to be 0.35±0.26 D using the photorefractor. In our study, accommodation amplitudes measured with photorefractor at near distance in Rayner, AcyrSof and Sensar groups were 1.45±0.76 D, 2.82±1.88 D, 2.44±1.02 D, and at far distance they were 1.34±0.54 D, 1.87±0.74 D and 1.74±1.70 D, respectively.

Nemeth et al. [3] compared the amplitudes of accommodation in pseudophakic eyes with three-piece and single-piece IOLs and they did not find any difference between two types of examined IOLs. However, Vamosi et al. [24] examined the accomodative amplitude of 2 monofocal IOLs with different haptic configurations and found that 3-piece IOL with 10-

degree posterior angulation exhibited a higher accommodative capacity than the single-piece plate-haptic IOL. Also, in our study, the 3-piece IOLs with angulated haptic configuration had higher accommodation amplitudes than the single-piece plate-haptic IOL that is in conjunction with previous study. Wirtitsch et al. [25] evaluated the changes in ACD following the implantation of multipiece and single-piece IOLs and found a significantly decreased ACD in multipiece IOLs compared to single-piece IOLs. They suggested that contraction and merging of the capsular bag may lead a varying degrees of anterior shift in multipiece IOLs due to loss of haptic memory, whereas nonangulated single-piece IOLs conserve their position during capsule contraction and merging, which might probably be associated with the presence of angulation and haptic memory [25]. Therefore the angulated haptic design of 3-piece IOLs seem to more accommodate than single piece IOLs.

4. CONCLUSION

In conclusion, we demonstrated that the 3-piece IOLs with haptic angulation, AcrySof (MA60BM) and Sensar (AR40e) had higher accommodative response than the 1-piece plate-haptic Rayner (C-Flex) IOL.

CONSENT

Oral informed consent of participating subjects was obtained.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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