Contact Lens & Anterior Eye 37 (2014) 168–174

Contents lists available at ScienceDirect

Contact Lens & Anterior Eye

journal homepage: www.elsevier.com/locate/clae

Objective and subjective visual performance of multifocal contact lenses: Pilot study

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ARTICLE INFO

Article history:
Received 9 July 2013
Received in revised form
17 September 2013
Accepted 28 September 2013

Keywords:
Visual performance
Multifocal
Accommodative response
Presbyopia
Optical aberrations
Contrast sensitivity

ABSTRACT

Purpose: The aim of the present study was to compare the objective and subjective visual performance of three different soft multifocal contact lenses.

Methods: 10 subjects (habitual soft contact lens wearers) between the ages of 40 and 45 years participated in the study. Three different multifocal silicone hydrogel contact lenses (Acuvue Oasys, Air Optix and Biofinity) were fit within the same visit. All the lenses were fit according to the manufacturers' recommendation using the respective fitting guide. Visual performance tests included low and high contrast distance and near visual acuity, contrast sensitivity, range of clear vision and through-focus curve. Objective visual performance tests included measurement of open field accommodative response at different defocus levels and optical aberrations at different viewing distances.

Results: Accommodative response was not significantly different between the three types of multifocal contact lenses at each of the accommodative stimulus levels ($p > 0.05$). Accommodative lag increased for higher stimulus levels for all 3 types of contact lenses. Ocular aberrations were not significantly different between these 3 contact lens designs at each of the different viewing distances ($p > 0.05$). In addition, optical aberrations did not significantly differ between different viewing distances for any of these lenses ($p > 0.05$). ANOVA revealed no significant difference in high and low contrast distance visual acuity as well as near visual acuity and contrast sensitivity function between the 3 multifocal contact lenses and spectacles ($p > 0.05$).

Conclusions: There was no statistically significant difference in accommodative response, optical aberrations or visual performance between the 3 multifocal contact lenses in early presbyopes.

1. Introduction

Presbyopia refers to a normal, naturally occurring, age-related, irreversible reduction in maximal accommodative amplitude sufficient to cause symptoms of blur and ocular discomfort or asthenopia at the customary near working distance [1]. One of the management options for presbyopia is to prescribe contact lenses.

Monovision has been a very successful contact lens option, which involves the use of correcting vision with a contact lens in one eye to allow adequate distance vision and a contact lens in the other eye to allow for adequate near vision [2]. Monovision is independent of pupil size and thus, there is no compromised vision in dim lighting or low contrast conditions. The other benefits of monovision include the ease of fitting, ability to utilize any contact lens material with a full range of powers, and minimum lens cost. However, with monovision contact lens correction, there is a loss of stereoacuity [2], especially at higher add powers. Also, some patients have difficulty suppressing one eye and are unable to adapt to monovision correction [3].

Multifocal contact lenses have become a very popular choice of contact lens correction. Multifocal contact lenses have two or more refractive zones that contain different powers [3–5]. They have been developed actively in the last 10 years to address the shortcomings of monovision but still account for only 5% of the worldwide market [6]. Recent survey [6] of practitioners reveals that multifocal contact lenses (69%) are preferred over monovision (19%) and spectacles (12%), with soft multifocals and soft monovision being prescribed more than gas-permeable (GP) lenses. In addition, soft multifocal lenses only account for 12% of the daily fits and refits. Richdale [3] reported that 76% of presbyopic patients preferred multifocal soft contact lenses to monovision. Multifocal lenses are broadly categorized based on two types of designs namely: simultaneous vision – containing multiple powers that are typically positioned within the pupillary region at the same time – and translating, consisting of two or more separate zones that require a vertical shift in gaze to look through the appropriate

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http://dx.doi.org/10.1016/j.clae.2013.09.013

portion of the lens. Aspheric lenses incorporate a gradual change of curvature along one or both of their surfaces that produces an add power. In center-distance aspheric lenses, the eccentricity in some of the designs is located on the posterior surface and produces an increase in plus power from center to periphery. In center-near aspheric lenses, plus power is significantly increased in the center of the lens and gradually decreases in the periphery [5]. Lenses vary in their optical design to provide adequate near vision while preserving distance visual acuity. Most of these different designs can be fit on most of the normal presbyopes, but there may be individual differences in their visual performance.

The Acuvue Oasys for Presbyopia (AVOP) lens system consists of three variations on a center-distance concentric design, providing three levels of add power indicated as Low, Mid and High [7,8]. Acuvue Oasys for Presbyopia is a combination of design concepts that results in an "aspheric zonal" design consisting of a center-distance aspheric zone surrounded by alternating aspheric zones on the front surface of the lens. This innovative Stereo Precision Technology design is intended to provide balanced vision at all distances across varying illumination levels with minimal ghosting, glare, and halos. Acuvue Oasys for Presbyopia also features an aspheric back surface to help maintain lens centration, preserving the front-surface optics. The lens is also designed to leverage the eye's natural depth of focus. The high Dk/t (147) of the senofilcon A material may yield a lower incidence of hypoxic complications.

The Air Optix Aqua Multifocal (AOMF) lens system consists of three variations of a center-near aspheric design, providing different levels of "add" specified by the manufacturer as Lo, Med, and Hi. Air Optix Aqua Multifocal's "Precision Profile Design" has a smooth power transition from center to edge, which creates a more evenly controlled rate of change [7]. The power gradient is also designed to be uniform across the wide power range, so it provides the same effective add power at −3.00D as at +3.00D, which was not always true with previous center-near designs. The lotrafilcon B material has a high Dk/t (138 at −3.00D) and uses the Aqua Moisture System.

The Biofinity multifocal (MF) contact lens is made of Comfilcon A [8]. The balanced presbyopic design combines multifocal optics with one lens for distance viewing and the other lens for near viewing. This design combines spherical and aspheric optics and unique zone sizes to yield a "distance" lens for the dominant eye (center-distance design), which emphasizes distance vision, and a "near" lens for the non-dominant eye (center-near design), which optimizes near vision. The distance lens has a spherical central zone 2.3 mm in diameter for distance vision, surrounded by a 5.0-mm annular aspheric zone and an 8.5-mm spherical annular zone both increasing in add power. In contrast, the near lens has a 1.7-mm spherical central zone dedicated to near vision followed by a 5.0-mm aspheric annular zone and an 8.5-mm spherical annular zone both with decreasing add power. In lower add powers, such as those used in this study, the fitting guide calls for a distance (D) lens to be used in both eyes.

Visual performance is influenced by many factors including changes in pupil size, inherent optical aberrations, ambient lighting levels, magnitude of astigmatism, etc. Each of the multifocal contact lens brands has a unique lens design and material that differentiates it from its competitors. Individual practitioners, however, may not often have sufficient time to trial the same patient in several lens brands, and thus get a true sense for which of these lenses perform better for a particular patient. This is due to time limitations or abandonment of multifocal modality altogether with failure of the first design used. Few studies [2,3] have reported on the visual performance comparing different lens brands. A comprehensive visual performance study of Acuvue Oasys for presbyopia, Air Optix multifocal and Biofinity multifocal has not been done in the past. The results may help clinicians choose one lens design over another depending on the needs of the patient and the lens features.

Thus, the purpose of the present investigation is to assess and compare the visual performance of three multifocal soft contact lens designs currently available on the market.

2. Methods

A total of 10 subjects between the ages of 40–45 years (mean ± SD = 41.3 ± 1.2 years) participated in the study. Subjects were recruited either from the university population or from the university clinic patient database. Subjects were habitual soft lens wearers with no more than 6.00D of myopia or hyperopia and 0.75D of astigmatism. Spherical equivalent of the subjects refractive error ranged from −1.00D to −2.87D. Current monovision contact lens wearers or subjects with a history of refractive surgery, binocular vision abnormalities, ocular and systemic diseases were excluded. All subjects had a best-corrected visual acuity (VA) of 20/20 in each eye. The study followed the tenets of Declaration of Helsinki. The Institutional Review Board of Midwestern University approved the study protocol. Informed consent was obtained from all the subjects after all the procedures and consequences of the study were explained.

The three different multifocal silicone hydrogel contact lenses selected for the investigations were Acuvue Oasys multifocal (distance-centered concentric ring/aspheric combination; Vistakon, Florida), Air Optix multifocal (near-centered aspheric; Alcon, Texas) and Biofinity multifocal (aspheric distance/near centered; Coopervision, California). These lenses were all fit within the same visit in each subject using a randomization scheme to determine sequencing of the lenses fit. All subjects were refracted by the same investigator. Lenses were fit based on the best subjective refraction (best distance correction) and according to the manufacturers' recommendation using the respective fitting guide. Subjects adapted to the lenses on the eyes for 10–15 min before the measurements were taken. Both the investigator and the subject were unaware of the brand of contact lenses being fit. Dominance was identified using the sensory dominance method and recorded in the chart, though not necessary for lens selection. With both contact lenses, the optimal distance and near VA and on-eye lens fit were measured for each eye using standard optometric techniques.

Visual performance tests were obtained including low (36%) and high (94%) contrast visual acuity at distance (20 ft) using log MAR acuity chart for both the right and left eye. Near visual acuity measurements were also obtained for high and low contrast levels at 33 cm for both left and right eyes. Contrast sensitivity test was performed (OD and OS) at 8 ft using CSV-1000 (Precision-vision, La Salle, Illinois) using a logarithmic scale for 3, 6, 12 and 18 cpd. Range of clear vision (OD and OS) was obtained using a near vision chart placed along the optical axis and displaced proximally/distally (counterbalanced) slowly until the subject reported the first consistent blur with a 20/30 optotype. This was then repeated in the opposite direction and the findings recorded. Through-focus curve (OD and OS) measurements were also performed by assessing visual acuity at distance using low contrast optotypes in the presence of defocus lenses (0–3.00D in 0.5D steps) in a phoropter. Stereoacuity was measured at both distance (10 ft) and near (40 cm) using Randot stereo test. While the Randot stereo test is conventionally performed at near, newer stereo tests are available to test at a distance of 10 ft that could provide a stereo threshold between 400″ and 60″.

Objective accommodative response and optical aberration measurements were obtained with either the subjective refraction in a trial frame or with multifocal contact lenses. Open field static accommodative response was obtained monocularly under binocular viewing conditions using WAM-5500 (AIT Industries, Illinois [9]) at different stimulus levels (0D, 2.00D, 2.50D, 3.00D and 4.00D)