



ORIGINAL ARTICLE

Short-term comparison between extended depth-of-focus prototype contact lenses and a commercially-available center-near multifocal

Daniel Tilia^{a,b}, Anna Munro^a, Jiyeon Chung^a, Jennifer Sha^a, Shona Delaney^a,
Danny Kho^a, Varghese Thomas^a, Klaus Ehrmann^{a,b}, Ravi Chandra Bakaraju^{a,b,*}

^a The Brien Holden Vision Institute, Sydney, NSW 2052, Australia

^b School of Optometry and Vision Science, The University of New South Wales, Sydney, NSW 2052, Australia

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Presbyopia;
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Higher order aberrations;
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Visual performance

Abstract

Purpose: To compare the visual performance of prototype contact lenses which extend depth-of-focus (EDOF) by deliberate manipulation of multiple higher-order spherical aberration terms and a commercially-available center-near lens (AIR OPTIX Aqua Multifocal, AOMF).

Methods: This was a prospective, cross-over, randomized, single-masked (participant), short-term clinical trial where 52 participants (age 45–70 years) were stratified as low, medium or high presbyopes and wore EDOF and AOMF on different days. Objective measures comprised high and low contrast visual acuity (HCVA/LCVA, log MAR), and contrast sensitivity (log units) at 6 m; HCVA at 70 cm, 50 cm and 40 cm and stereopsis (seconds of arc) at 40 cm. HCVA at 70 cm, 50 cm and 40 cm were measured as “comfortable acuity” rather than conventional resolution acuity. Subjective measures comprised clarity-of-vision and ghosting at distance, intermediate and near, overall vision satisfaction and ocular comfort (1–10 numeric rating scale) and lens purchase (yes/no response). Statistical analysis included repeated measures ANOVA, paired *t*-tests and McNemar’s test.

Results: Significant differences between lens types were independent of strata ($p \geq 0.119$). EDOF was significantly better than AOMF for HCVA at 40 cm (0.42 ± 0.18 vs. 0.48 ± 0.22 , $p=0.024$), stereopsis (98 ± 88 vs. 141 ± 114 , $p < 0.001$), clarity-of-vision at intermediate (8.5 ± 1.6 vs. 7.7 ± 1.9 , $p=0.006$) and near (7.3 ± 2.5 vs. 6.2 ± 2.5 , $p=0.005$), lack-of-ghosting ($p=0.012$), overall vision satisfaction (7.5 ± 1.7 vs. 6.4 ± 2.2 , $p < 0.001$) and ocular comfort (9.0 ± 1.0 vs. 8.3 ± 1.7 , $p=0.002$). Significantly more participants chose to only-purchase EDOF (33% vs. 6%, $p=0.003$). There were no significant differences between lens types for any objective measure at 6 m or clarity-of-vision at distance ($p \geq 0.356$).

* Corresponding author at: Level 5, Rupert Myers Building, North Wing, Gate 14 Barker Street, University of New South Wales, Sydney, NSW 2052, Australia. Tel.: +61 2 9385 7516; fax: +61 2 9385 7401.

E-mail address: r.bakaraju@brienholdenvision.org (R.C. Bakaraju).

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PALABRAS CLAVE

Presbicia;
Lentillas
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Aberraciones de alto
orden;
Lentes de contacto
con profundidad de
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Desempeño visual

Conclusions: EDOF provides better intermediate and near vision performance in presbyopes than AOMF with no difference for distance vision during short-term wear.

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Comparación a corto plazo entre las lentes prototipo de profundidad de campo extendidas y las lentes multifocales de visión central-próxima, comercialmente disponibles

Resumen

Objetivo: Comparar el rendimiento visual de prototipos de lentes de contacto con las de profundidad de campo extendida (EDOF), mediante la manipulación deliberada de múltiples aberraciones esféricas de alto orden y las lentes de visión simultánea centro-cerca comercialmente disponibles (AIR OPTIX Aqua Multifocal, AOMF).

Métodos: Ensayo clínico prospectivo, transversal, aleatorizado, con máscara única (participante), y a corto plazo, en el que se estratificó la presbicia de 52 participantes (de edades comprendidas entre 45 y 70 años) como baja, media o alta; dichos participantes utilizaron lentes EDOF y AOMF en días diferentes. Las mediciones objetivas incluyeron la agudeza visual de alto y bajo contraste (HCVA/LCVA, logMAR), y la sensibilidad al contraste (unidades log) a 6 m, HCVA a 70 cm, 50 cm y 40 cm, y estereopsis (segundos de arco) a 40 cm. La HCVA a 70 cm, 50 cm y 40 cm se midió como "agudeza de confort" en lugar de la agudeza de resolución convencional. Las mediciones subjetivas incluyeron la claridad de visión y la visión fantasma (ghosting) a distancia, la satisfacción con la visión general intermedia y lejana, el confort ocular (escala de clasificación numérica de 1 a 10) y la adquisición de lentes de contacto (respuesta sí/no). El análisis estadístico incluyó la prueba ANOVA con medidas repetidas, la prueba de *t* pareada, y la prueba de McNemar.

Resultados: La significación de las diferencias entre los tipos de lentes fue independiente de los estratos ($p \geq 0,119$). Los resultados de EDOF fueron considerablemente mejores que los de AOMF en cuanto a HCVA a 40 cm ($0,42 \pm 0,18$ frente a $0,48 \pm 0,22$, $p=0,024$), estereopsis (98 ± 88 frente a 141 ± 114 , $p < 0,001$), claridad de visión intermedia ($8,5 \pm 16$ frente a $7,7 \pm 1,9$, $p=0,006$) y próxima ($7,3 \pm 2,5$ frente a $6,2 \pm 2,5$, $p=0,005$), ausencia de visión fantasma ($p=0,012$), satisfacción con la visión general ($7,5 \pm 1,7$ frente a $6,4 \pm 2,2$, $p < 0,001$) y confort ocular ($9,0 \pm 1,0$ frente a $8,3 \pm 1,7$, $p=0,002$). Un número considerable de participantes optó por adquirir únicamente EDOF (33% frente al 6%, $p=0,003$). No se produjeron diferencias significativas entre los dos tipos de lentes en relación a las mediciones objetivas a 6 m, ni a la claridad de visión lejana ($p \geq 0,356$).

Conclusiones: Las lentes EDOF proporcionaron un mejor rendimiento de la visión intermedia y próxima en pacientes con presbicia que las lentes AOMF, sin que se produjeran diferencias en cuanto a visión lejana con el uso a corto plazo.

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Introduction

The most commonly prescribed multifocal contact lenses (CLs) are soft, simultaneous-image.¹ Center-near CLs appear to be the contemporary design of choice as each of the four largest worldwide CL manufacturers (Alcon, TX, USA; Johnson and Johnson, FL, USA; Bausch and Lomb, NY, USA; CooperVision, CA, USA) currently have at least one center-near design in at least two add powers in their inventory. Indeed, the only manufacturer with a true center-distance design recommends a center-distance/center-near combination when reading add is beyond +1.50 D.²

Recent improvements in center-near multifocal designs seem to have positively impacted the presbyopic CL market, aided by an aging population.³ Comparing the years 2005–2009 to 2010–2014 shows an increase in both the proportion of presbyopes prescribed CLs (16%⁴ vs. 22%^{5–9}) and multifocal CL prescribing rates (29%⁴ vs. 45%^{5–9}).

Center-near lenses have a central maximum positive power and negative primary spherical aberration C(4,0), resulting in a monotonic refractive power profile¹⁰ which achieves distance correction in the periphery of the optical zone of the lens.^{10,11} Unlike non-monotonic zonal-refractive multifocals,¹⁰ center-near CLs are pupil-dependent.¹¹

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