Effect of vertex distance in the treatment area of myopia control spectacles

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Conflict of interest declaration
Abel Szeps, Martin de Tomas and Rafael Iribarren are consultants of NOVAR. Gabriel Martín works for NOVAR and Opulens.

Abstract

Purpose: To analyze the size of treatment area produced by possible myopia control spectacles at two different vertex distances.
Methods: An experimental study was designed. Two visual fields were performed in an Octopus 123 automatic perimeter (Interzeag, Germany), with an opaque frame of 37 mm diameter including a central hole of 8 mm wide, fitted in the trial lenses from the perimeter, with two different vertex distances (6 mm and 12 mm) in a 60 years-old subject. The frame around the central hole represents the treatment area of commercially available myopia control spectacles which have a central round zone for clear distance vision.
Results: The visual field with a 12 mm vertex distance showed an expected circular loss of sensitivity at approximately 12°. While the 6mm vertex distance visual field showed an almost normal visual field.
Conclusion: A normal vertex distance produces better area of treatment than a shorter one in myopia control spectacles. The results of the present study

suggest that vertex distance should be rigorously monitored in myopia control practice and research.
Keywords: myopia control, spectacles, treatment area, visual fields.

Efecto de la distancia del vértice en la zona de tratamiento de las gafas de control de la miopía

Resumen

Objetivo: Analizar el tamaño del área de tratamiento producida por las posibles gafas de control de la miopía con dos distancias de vértice diferentes.
Materiales y métodos: Se diseñó un estudio experimental. Se realizaron dos campos visuales en un perímetro automático Octopus 123 (Interzeag, Alemania), con una montura opaca de 37 mm de diámetro que incluía un agujero central de 8 mm de ancho, colocado en las lentes de prueba desde el perímetro, con dos distancias de vértice diferentes (6 mm y 12 mm) en un sujeto de 60 años. La montura alrededor del agujero central representa la zona de tratamiento de las gafas de control de la miopía disponibles en el mercado, que tienen una zona central redonda para una visión clara de lejos.
Resultados: El campo visual con una distancia de vértice de 12 mm mostró una pérdida de sensibilidad circular esperada de aproximadamente 12°. Mientras que el campo visual con una distancia de vértice de 6 mm mostró un campo visual casi normal.
Conclusiones: Una distancia de vértice normal produce mejor área de tratamiento que una más corta en gafas de control de miopía. Los resultados del presente estudio sugieren que la distancia de vértice debería controlarse rigurosamente en la práctica y la investigación del control de la miopía.
Palabras clave: control de la miopía, gafas, área de tratamiento, campos visuales.

Efeito da distância do vértice na zona de tratamento dos óculos de controle de miopia

Resumo

Objetivo: Analisar o tamanho da área de tratamento produzida por possíveis óculos de controle de miopia com duas distâncias de vértice diferentes.
Materiais e métodos: Foi desenhado um estudo experimental. Dois campos de visão foram realizados em um perímetro automático Octopus 123 (Interzeag, Alemanha), com moldura opaca de 37 mm de diâmetro que incluía um orifício central de 8 mm de largura, colocado nas lentes de teste a partir do perímetro, com duas distâncias de vértices diferentes. (6 mm e 12 mm) em sujeito de 60 anos. A armação ao redor do orifício central representa a zona de tratamento dos óculos de controle de miopia disponíveis no mercado, que possuem uma zona central redonda para visão clara à distância.
Resultados: O campo visual com distância do vértice de 12 mm apresentou perda de sensibilidade circular esperada de aproximadamente 12°. Enquanto o campo visual com distância do vértice de 6 mm apresentou um campo visual quase normal.
Conclusões: Uma distância normal do vértice produz uma melhor área de tratamento do que uma distância mais curta em óculos de controle de miopia. Os resultados do presente estudo sugerem que a distância do vértice deve ser rigorosamente controlada na prática e pesquisa de controle da miopia.
Palavras-chave: controle da miopia, óculos, área de tratamento, campos visuais.

Introduction

During the last years basic and clinical researchers have developed myopia control spectacles based on peripheral myopic defocus or decreased contrast with central distance correction apertures ranging from 7mm to 15mm[1-7]. Recent studies suggest that the retina may detect the sign of defocus which controls ocular growth by computing the relative contrast sensitivity of S and L cones based on longitudinal chromatic aberration[8-9]. As S cones (blue frequency) are absent in the foveal zone, more research on the perifoveal macular areas that include the three types of cones (S, M and L) is important. Using multifocal electroretinogram, a previous study showed that the area around the 6° from de fovea is the most sensitive sector of the retina to detect

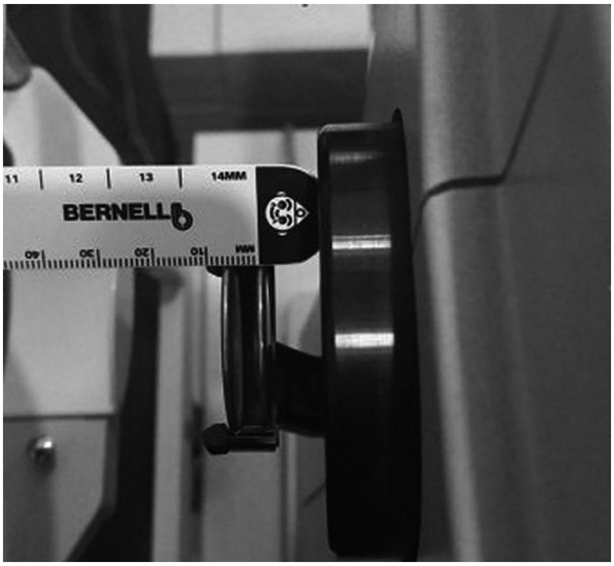

Figure 1. Locations of the two slots for the trial lenses in the Octopus 123 perimeter, with a ruler showing 6 mm distance between them.

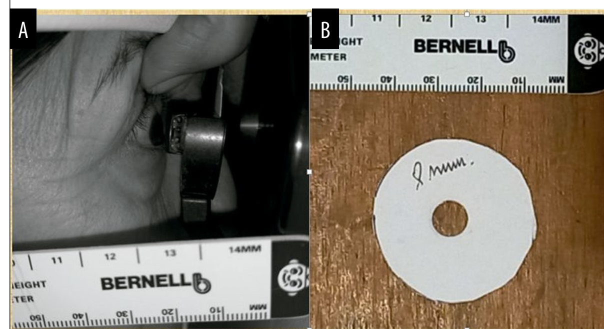

Figure 2. A) Subject's 12mm vertex distance with the opaque frame with an 8 mm hole located in the farthest slot of the perimeter. B). Round whiteboard opaque frame with an 8 mm hole.

defocus[10]. These findings align with previous experiments of Earl Smith in 2005 showing that foveal ablation with laser beams did not alter much the emmetropization mechanisms in the monkey model[11-12]. Additionally, peripheral defocus contact lenses[13] and peripheral defocus spectacles[14] have showed good results in controlling myopia progression in children.

In a previous study, we aimed to know which areas of the retina were out of focus in myopia control spectacles. Using posterior optical coherence tomography (OCT) images we showed for the first time the projection of retinal shadows from different defocus spectacles[15]. During our experiments we noticed that the amplitude of the in-focus and out-of-focus areas in the images depended on the vertex distance at which the glasses were fitted. We also noted that decreasing vertex distance enlarged the central clear zone at the retinal plane (and vice versa). To correctly quantify this effect, we developed a study to determine the corresponding changes in visual fields using a diaphragm at two different vertex distances. This study shows the results of those experiments and discusses our findings in the context of myopia control treatment.

Methods

An experimental study was designed. Two visual fields were prformeed, in an Octopus 123 automatic perimeter (Interzeag, Germany), with a round and opaque whiteboard frame fitted in a 37mm diameter lens probe. The frame included a central hole 8 mm wide and was fitted in the trial lenses slot of the perimeter, with two different vertex distances. Octopus 123 perimeter has two different vertex distances separated by 6mm (Figure 1). All vertex distances were measured with a ruler (Bernell, USA) fitting the subject in place with the opaque frame and taking photographs from the side at 90° angles. The ruler was included in the photograph, such that with computer software and calipers the photos could be studied comparing the vertex distances with the actual millimeters in the ruler (Figs. 1 & 2). Two different vertex distances were used to perform the visual fields (6 mm and 12 mm) considering that the perimeter has two slots for the trial lenses. The visual fields were performed in one voluntary subject of female sex with 60 years-old, with no ocular pathology, and 20/20 uncorrected distance visual acuity with known normal visual

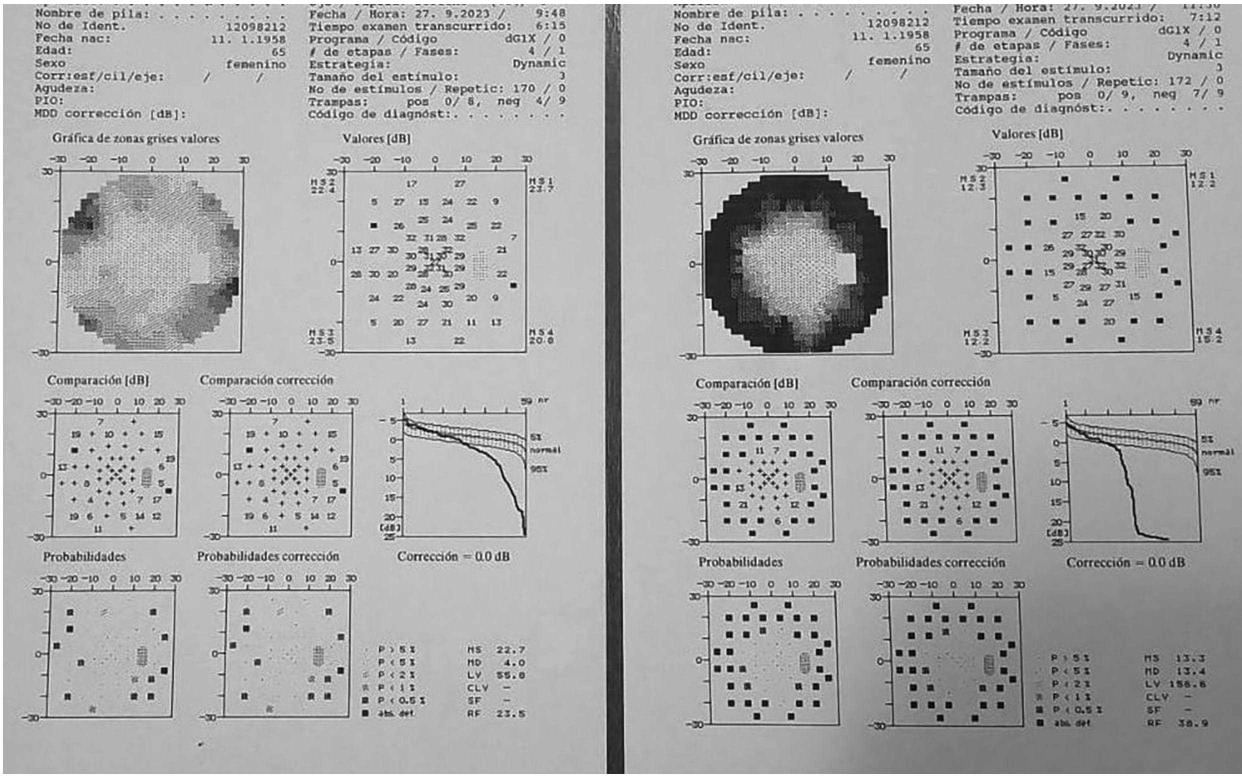

Figure 3. Visual fields of a 60 years-old subject performed with a trial lenses holder with an 8 mm central hole, located at 6 mm (left) and 12 mm (right) vertex distances.

fields. This study was conducted in accordance with the tenets of the Declaration of Helsinki. The Ethics Committee of the Argentinian Council of Ophthalmology stated that no ethics approval was needed for this study that did not include patients or any intervention.

The visual fields (white-on-white automated perimetry) were performed as usual in a darkened room and central fixation was constantly checked in the computer display of the perimeter. Pupil diameter was 4.5 mm during the testing in both visual fields. The testing included the 60° of the central visual field of the right eye and the TOP program of the machine was used with a cross for central fixation. Both visual fields were tested in the same eye on different days after 10 minutes of adaptation to room illumination and each procedure lasted approximately 8 to 10 minutes.

Results

The sensitivity maps of the two visual fields performed with two vertex distances can be seen in Figure 3.

The visual field with a 12 mm vertex distance (right side figure) shows the expected circular loss of sensitivity at approximately 12°.

Instead, the 6 mm vertex distance visual field shows an almost normal visual field with scarce loss of sensitivity outside 15° from the fovea (left side figure).

Discussion

The present study shows the projection of a circular shadow in the visual field produced by a trial probe, with an opaque circular zone

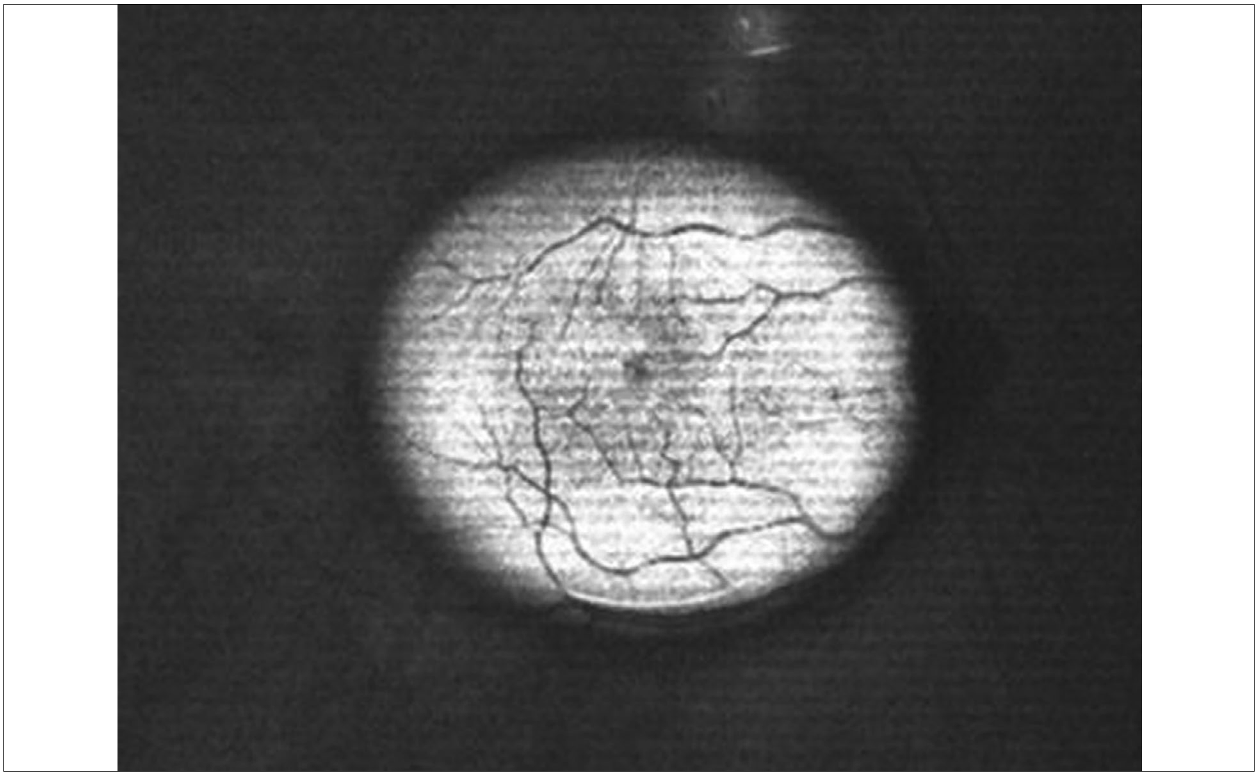

Figure 4. Fundus OCT photograph showing a defocused area around 10° from the fovea with a 8-9 mm center for distance defocus spectacle for myopia control (Myofix, Novar). The papilla and the defocused vessels in the arcades can be seen blurred.

around a central 8 mm diameter central hole, placed in front of the eye. This study shows that the stimulation of the sensitive area necessary for the effectiveness of defocus systems in myopia can be obtained at a usual vertex distance of 12 mm and that stimulation goes beyond the sensitive area when the vertex distance is reduced to 6 mm. To our knowledge, the vertex distance of tight-fitting myopia control glasses has not yet been considered in clinical trials on myopia progression in children[16].

A previous study by using multifocal electroretinogram showed that the most sensitive zone to detect blur is the retina surrounding the fovea at 6 to 12° radius from the optical axis[10]. The present study shows that a normal vertex distance of 12 mm produces a better treatment area than a 6 mm vertex distance. In fact, even with an 8 mm diameter for the distance vision and a 12 mm vertex distance, the treatment area falls at 10-12° of radius around the optical axis according to the results of the visual field testing in our study. With an OCT camera we have shown similar results for a 8-9 mm optical diameter for distance vision in different myopia control spectacles[15], with the defocus zones projecting shadows at the retinal plane in the zones that actually detect defocus with greatest accuracy (Fig. 4). Centering the correct frames for these myopia control spectacles is also crucial for adaptation to these spectacles[17].

Vertex distance can vary according to age, ethnicity and frame adaptation[18]. Children younger than 12 have smaller noses with shorter vertex distances. It is also well known that Chinese children have shorter vertex distance than Caucasians. Thus, frame adaptation is crucial as many children may use their spectacles inadequately (downwards and far from the eyes).

Inadequate use may contribute for differences in effectivity of myopia control spectacles as the treatment area at the fundus of the eye would vary accordingly.

Conclusion

The present study suggests that vertex distance should be rigorously monitored in myopia control practice and research.

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