TECHNICAL REPORT

A simple clinical test for perception of progressive addition lens peripheral image blur. A pilot study

Alan Kwok-Hei Mok[a,b,*], Cindy Sin-Ting Chung[a], Terence Wai-Keung Kwok[a]

[a]*Eye'ni, Hong Kong SAR, China*
[b]*Department of Anatomy, Faculty of LKS Medicine, The University of Hong Kong, Hong Kong, China*

Abstract

Purpose: To introduce a simple method for subjective perception of progressive addition lens (PAL) peripheral image blur (PIB). The amounts of PIB induced by traditional PAL trial lenses (plano distant PAL, TPAL) and prescription PAL (FPAL) were also evaluated.

Methods: Subjects wearing the PALs adjusted their heads laterally to view the fixation target for PIB perception. 38 subjects were randomized and recruited from the Eye'ni optical shop. Outcomes were assessed by the high-contrast visual acuity chart (LogMAR scale), and by subjectively indicating the magnitude of PIB on a scale of 0 to 10 (10 is extremely blur) using astigmatism-sensitive optotype (Polatest®, Carl Zeiss Vision, Germany).

Results: Visual acuities (mean ± SD) at the central and temporal fixations were measured at 0 ± 0.03 and 0.2 ± 0.04 with FPAL, and 0 ± 0.03 and 0.1 ± 0.03 with TPAL respectively. Significantly lower visual acuities were found with the temporal fixation than with the central fixation in both PALs ($p < 0.001$). And significant even reduction at the temporal fixation with FPAL than with TPAL was observed ($p < 0.001$). For subjective measures of PIB using astigmatism-sensitive optotype, the average score of FPAL (7.4 ± 0.8, ranged 5-9) was found statistically higher than that of TPAL (6.7 ± 0.8, ranged 4-8) ($p < 0.01$).

Conclusions: Our proposed simple clinical method appears to facilitate PAL peripheral image blur demonstration, which may help potential PAL wearers to effectively experience the peripheral PAL image blur. Opticians may caution the potential PAL wearers that prescription PAL may induce more peripheral image blur than that with the traditional distant plano PAL trial lenses.

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*Corresponding author. A.K. Mok. Eye'ni, G/F 63 Lee Garden road, Causeway Bay, Hong Kong, China
E-mail address: mokkwokhei@gmail.com (A.K. Mok).

Prueba clínica simple para percibir el desenfoque de la imagen periférica de las lentes de adición progresiva. Estudio preliminar

Resumen

Objetivo: Presentar un método simple para la percepción subjetiva del desenfoque periférico de la imagen (DPI) de las lentes de adición progresiva (LAP). También se evaluó la cantidad de DPI inducido por las lentes de prueba LAP tradicionales (LAP planas distantes, TPAL) y las LAP graduadas (FPAL).

Métodos: Sujetos con LAP ajustaron la cabeza lateralmente para mirar el objeto de fijación con el fin de percibir el DPI. Se incluyeron y aleatorizaron 38 sujetos de la óptica Eye'ni. Los resultados se evaluaron mediante el gráfico de agudeza visual de alto contraste (escala LogMAR) e indicando de manera subjetiva la magnitud del DPI sobre una escala de 0 a 10 (10 equivalía a desenfoque extremo) utilizando un optotipo apto para determinar el astigmatismo (Polatest®, Carl Zeiss Vision, Alemania).

Resultados: Las agudezas visuales (media ± DE) en las fijaciones central y temporal se midieron a $0,00 \pm 0,03$ y $0,20 \pm 0,04$ con FPAL, y a $0,00 \pm 0,03$ y $0,10 \pm 0,03$ con TPAL, respectivamente. En ambas LAP se observaron agudezas visuales significativamente inferiores con la fijación temporal que con la fijación central ($p < 0,001$). Asimismo, se observó una reducción significativa constante en la fijación temporal con FPAL en comparación con TPAL ($p < 0,001$). Para las mediciones subjetivas del DPI utilizando un optotipo apto para determinar el astigmatismo, la puntuación media de la FPAL ($7,4 \pm 0,8$; intervalo, 5-9) fue estadísticamente mayor que la de la TPAL ($6,7 \pm 0,8$; intervalo, 4-8) ($p < 0,01$).

Conclusiones: Aparentemente, nuestra propuesta de método clínico simple facilita la demostración del desenfoque periférico de la imagen de las LAP, lo que podría ayudar a posibles candidatos para LAP a experimentar de manera eficaz el desenfoque periférico de la imagen de LAP. Los ópticos pueden advertir a los posibles usuarios de LAP que las LAP graduadas pueden inducir más desenfoque periférico de la imagen que las lentes de prueba LAP planas distantes tradicionales.

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Introduction

Progressive addition lens (PAL) arguably is one of the effective managements of presbyopia nowadays. The primary complications of PAL is the presence of peripheral undesirable astigmatism, which is induced by the continuous change in power through the lens.[1,2] Contour plots of astigmatism and mean add power are the most common measures of the peripheral undesirable astigmatism.[3-5] Subjective assessment[6-8] is a critical test since wearers would judge directly the vision quality of the PAL in combination with their eyes. Peripheral undesirable astigmatism will adversely degrade the vision, and PAL wearers may be aware of the lateral blur which may affect the success of the adaptation process. Most potential PAL wearers, especially the first time PAL wearers, seldom experience of such peripheral image blur. Thus we propose a simple clinical method to facilitate the PAL peripheral image blur demonstration for these people. The main advantage of this clinical method is to aid potential PAL wearers to acquire the PAL peripheral image blur in order to advance the success of adaptation. To best of my knowledge, no similar clinical method has been proposed. Under our proposed method, subject turns his head laterally and looks at the fixation target such as the astigmatism sensitive optotype or visual acuity chart through the PAL periphery to perceive the peripheral PAL image blur. On the other hand, some ophthalmic lens companies may provide some PAL trial lenses, normally are plano-distance with various addition PALs, for potential PAL wearers to experience the PAL optical characterization. However, these PAL trial lenses are considered incapable of simulating comprehensively the optics of a PAL design across the spectrum of distance prescriptions. In this pilot study, we also evaluate the degrees of peripheral image blur between traditional plano distance PAL trial lenses (TPAL) and prescription PAL (FPAL) using our proposed clinical method.

Methods

Subjects

This is a single centre randomized controlled pilot study. Thirty-eight subjects, twenty men and eighteen women, were recruited from the Eye'i optical shop. Subjects were selected by three optometrists, who committed to inform patients, check selection criteria, obtain informed consent and collect information. All subjects were presbyopic (46 ± 2 years old) and all were not PAL wearers. Refractive error ranged from —3.00 to —6.00 D sphere with lower than —0.50 D cylindrical power (mean ± SD, SE —3.90 ± 0.36 D). Only right eye was assessed. All subjects were screened and enrolled from March to May 2009.

PAL trial lenses

We have our own set of 36 mm diameter full aperture multi-coating crown glass (n = 1.52) general-purpose PAL trial lenses (Gradaul Top®, Carl Zeiss Vision, Germany, spherical power: plano, −3.00 to −6.00 with −0.25 per step with additions of +2.00 D) (Figure 1). Since the amount peripheral image blur is directly proportional to the
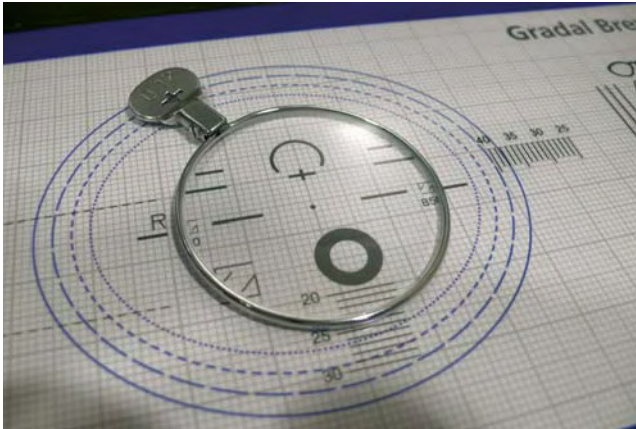

Figure 1 PAL trial lens.

Figure 2 PAL trial frames.

Figure 3 Astigmatism-sensitive optotype.

addition, higher addition (+2.00 D) is adopted for better trends in image blur perception. Two PAL trial frames (Figure 2) were prepared with two different trial lens systems (combination of plano distance PAL and spherical power single vision lens for TPAL, and combination of spherical power distance PAL and plano power single vision lens for FPAL). The sequence of the dual lenses mounted was that PAL (plano-distance or spherical power distance) was placed close to the eye, and single vision lens was mounted in front of the PAL lens. Pantoscopic tilt angle and back vertex distance of trial frame were adjusted to 10 degrees and 12 mm respectively. Subject's pupil center was matched exactly with the PAL fitting point.

Fixation targets

Two fixation targets, astigmatism-sensitive optotype (Figure 3) and high-contrast visual acuity were employed in this study. The fixation target was projected by Carl Zeiss vision Polatest® visual testing equipment at a distance of four meters. The astigmatism-sensitive optotype, which was a pattern of high contrast dark 9 mm diameter dots against the white background, was designed specifically for cylindrical power and axis assessments. For visual acuity assessment, high contrast numerals were presented in LogMAR scale.

Clinical procedure for perception of PAL peripheral image blurs

To perceive the peripheral image blur, subject wearing the PAL trial frame was instructed to turn the head laterally to left to view the fixation target through lens periphery. Tested region was located at 15 mm temporally along the line of the PAL fixation cross, equivalent to about 30 degrees temporally. The tested zone was marked off as 4 mm diameter circle. To ensure adequate blinding the equipment provided to the patients was strictly similar, same trial frame and trial lenses. Two identical trial frames with different trial lens combinations were prepared for swift interchange. Subjects were masked with the type of PAL trial lenses since all PALs were mounted on same metal rings. Particular attention was paid to ensure the subjects viewed the target through the exact same point on each PAL trial frame. The circle was carefully marked for each PAL trial lens. When these trial lenses are packed together, the circles were shown well concentric. Examiner would monitor the subject to fixate well through the marked circle during each measurement. The order of trial frames was randomized.

Outcomes

Two outcomes were assessed in this pilot study. For the first outcome, high-contrast numeral at LogMAR scale was employed. The instruction and procedure were same as the regular visual acuity assessment. For the second outcome, subjects were informed to compare the clarity of the astigmatism-sensitive optotype (Polatest®, Carl Zeiss Vision, Germany) in term of darkness, sharpness, contrast and shape of the dots. The instruction was based on the cross-cylindrical test for assessing cylindrical power and

axis. They were asked to indicate the magnitudes of image blur on a scale of 0 to 10 (10 is extremely blur). Subjects were allowed to practice several times if needed.

Data analysis

Pair-t test was carried out to detect differences between pairs of measures. The level of statistical significance was taken as 0.01. Approval for the study was obtained from the Eye'ni clinical trial ethics committee. All clinical investigations were conducted according to the principles of the Declaration of Helsinki. Informed consent had been obtained for all participating subjects.

Results

LogMAR scale visual acuities (mean ± SD) at the central and temporal fixations were measured at 0 ± 0.03 and 0.2 ± 0.04 with FPAL, and 0 ± 0.03 and 0.1 ± 0.03 with TPAL respectively. No statistically significant difference was noted at the central fixation between TPAL and FPAL ($p = 0.71$). Significantly lower visual acuities were found with the temporal fixation than with the central fixation in both TPAL and FPAL ($p < 0.001$). And significant even reduction at the temporal fixation with FPAL than with TPAL was observed ($p < 0.001$). For subjective measure of peripheral image blur using astigmatism-sensitive optotype, the average score of FPAL (7.4 ± 0.8, ranged 5-9) was found statistically higher than that of TPAL (6.7 ± 0.8, ranged 4-8) ($p < 0.01$).

Discussion

PAL arguably is one of the effective managements of presbyopia. Peripheral PAL optics is complicated and induces both lower (defocus and astigmatism) and higher (coma and trefoil) aberrations. [9,10] PAL wearers may be aware of the lateral image blur which may adversely affect the success of the adaptation process. Since most potential PAL wearers who are used to the single vision lenses seldom experience such peripheral optical restriction, we introduce a simple clinical method to facilitate the PAL peripheral image blur demonstration. The advantage of this simple clinical method may assist the potential PAL wearers to advance the success of adaptation by acquiring the PAL peripheral image blur. Under our simple clinical method, subject turns his head laterally and looks at the fixation target such as the astigmatism sensitive optotype or highest contrast visual acuity chart through the PAL periphery. All our non-PAL wearers appeared to practically detect peripheral image blur with the evidence of visual acuity reduction when fixating through the periphery of the PAL. Since the procedure is simple and an optotype is already in existence, this clinical method can be applied effectively at the general optometric clinic.

Secondly, we compared the peripheral image blur of traditional plano distance PAL trial lenses and prescription PALs. With objective to aid potential PAL wearers to experience the unique PAL optical features, PAL trail lenses may be provided by the ophthalmic lens company which are usually the distant plano PALs trial lenses with various additions. To our knowledge, no study has assessed the optical performances between PAL trial lenses and final prescription PALs. Under our proposed clinical method, prescription PAL was shown to induce more amount of peripheral image blur than that with the traditional PAL trial lens. The findings are expected, and suggest that the traditional PAL trial lenses probably underestimate the amount of PAL induced peripheral image blur. Opticians are advised to notify potential PAL wearers that the final PAL possibly generates more amount of peripheral image blur than do the PAL trial lens. In this pilot study, we measured only a particular distant peripheral zone, but other zones would perhaps be assessed by patient looking through such as on and beside the corridor of power progression where the aberrations of unwanted astigmatism, defocus error and higher aberration are higher.

In conclusion, our proposed simple clinical method appears to facilitate PAL peripheral image blur demonstration, which may help potential PAL wearers to effectively experience the peripheral PAL image blur in order to advance the process of adaptation. Opticians may caution the PAL wearers that prescription PAL may induce more peripheral image blur than that do the traditional distant plano PAL trial lens.

Conflict of interests

Authors declare that they don't have any conflict of interest.

Acknowledgments

References

1. Meister DJ, Fisher SW. Progress in the spectacle correction of Presbyopia. Part 1: Design and development of progressive lenses. Clin Exp Optom. 2008;91:240-250.
2. Meister DJ, Fisher SE. Progress in the spectacle correction of presbyopia. Part 2 Modern progressive lens technologies. Clin Exp Optom. 2008;91:251-264.
3. Alonso J, Gómez-Pedrero JA, Bernabeu E. Local dioptric power matrix in a progressive addition lens. Ophthal Physiol Opt. 1997; 17:522-529.
4. Sheedy J, Hardy RF, Hayes JR. Progressive addition lenses-measurements and ratings. Optometry. 2006;77:23-39.
5. Sheedy J, Campbell C, King-Smith E, Hayes JR. Progressive powered lenses: the Minkwitz theorem. Optom Vis Sci. 2005;82: 916-922.
6. Boutron I, Touizer C, Pitrou I, Roy C, Ravaud P. The VEPRO trials: A cross-over randomised controlled trial comparing 2 progressive lenses for patients with presbyopia. Trial. 2008;9: 54-57.
7. Fisher S. Relationship between contour plots and the limits of "clear and comfortable" vision in the near zone of progressive addition lenses. Optom Vis Sci. 1997;74:527-531.

8. Selenow A, Bauer EA, Ali SR, Spencer LW, Ciuffreda KJ. Assessing visual performance with progressive addition lenses. Optom Vis Sci. 2002;79:502-505.

9. Sheedy J. Correlation analysis of the optics of progressive addition lenses. Optom Vis Sci. 2004;81:350-361.

10. Villegas EA, Artal P. Comparison of aberrations in different types of progressive power lenses. Ophthal Physiol Opt. 2004; 24:419-426.

11. Zhou C, Wang W, Yang K, Chai X, Ren Q. Measurement and comparison of the optical performance of an ophthalmic lens based on a Hartmann-Shack wavefront sensor in real viewing conditions. Applied Optics. 2008;47:6434-6441.

12. Fowler CW. Technical note: Apparatus for comparison of progressive addition spectacle lenses. Ophthal Physiol Opt. 2006;26:502-506.