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Research Article

The Efficacy of Prismatic Bifocal Spectacle Lenses in Controlling Myopia Progression in Children

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Objective: The progression of myopia can lead to vision impairment and increase the risk of sight-threatening complications. Various treatment methods have been described to control the progression of myopia, including the use of specialized spectacle lenses. This retrospective study aimed to evaluate the efficacy of prismatic bifocal spectacle lenses in controlling the progression of myopia in pediatric patients.

Materials and Methods: Fifty-two eyes of 26 patients who used prismatic bifocal spectacle lenses were retrospectively analyzed. Patients who showed an increase in myopia greater than 0.50 D during the last year of follow-up with single-vision spectacle lenses and whose eyes had a cycloplegic objective refraction measurement of ≥-2.00 D were included in the study. Demographic data of the patients such as age and gender were recorded. The increase in objective spherical equivalent and axial length after one year of using single-vision spectacle lenses were compared with the increase observed after one year of using prismatic bifocal spectacle lenses. The effects of potential variables such as age, sex, baseline myopia degree, and increase in axial length on myopia treatment were investigated.

Results: The mean age of the patients was 11.65 ± 2.70 years. Sixteen patients were male, and 10 patients were female. The increase in mean spherical equivalent after using single-vision spectacle lenses was 1.25 ± 0.76 D, whereas it was 0.24 ± 0.14 D after using prismatic bifocal spectacle lenses and this difference was statistically significant. The increase in mean axial length with single-vision spectacle lenses was 0.66 ± 0.31 mm, whereas with bifocal spectacle lenses it was 0.014 ± 0.015 mm. The difference was also statistically significant. Prismatic bifocal spectacle lenses were found to be more effective in myopia treatment in eyes with high baseline myopia and a higher increase in axial length.

Conclusion: Prismatic bifocal spectacle lenses have been found to be an effective in myopia control, particularly in children with rapid myopia progression. However, further studies with larger sample sizes and longer follow-up periods are needed to fully assess the long-term effects of this treatment method.

Keywords: Axial length, Myopia progression, Prismatic bifocal spectacles, Spherical equivalent

1. INTRODUCTION

Myopia, also known as nearsightedness, presents a significant and growing global health concern. The World Health Organization estimates that by 2050, nearly half of the world's population will be affected by this refractive error.[1] The increasing prevalence of myopia is influenced by various factors, including genetic predisposition, environmental influences such as increased near-work activities and decreased outdoor time.[2] Uncorrected myopia can lead to significant vision impairment and increase the risk of developing sight-threatening complications, such as myopic maculopathy and optic neuropathy.[1,2]

Addressing this issue has become a priority, and researchers have explored various treatment methods to control the progression of myopia, including the use of specialized spectacle lenses, orthokeratology, contact lenses and low-dose

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atropine.[3] Specialized spectacle lenses, such as multifocal and peripheral defocus lenses, work by altering the optical properties of the eye, which effectively slows the elongation of the eyeball and the progression of myopia.[3–5] Extensive research has confirmed the efficacy of these lenses, with major ophthalmic organizations, such as the American Academy of Ophthalmology, recognizing them as a safe and effective intervention.[3]

These lenses are anticipated to play a crucial role in addressing the global challenge of myopia. Bifocal spectacles with a prism component have shown promise in slowing myopia progression by manipulating the optical focus and reducing peripheral hyperopic defocus, a contributor to axial elongation.[6] By creating myopic defocus in the peripheral retina, these specialized bifocal lenses with prisms inhibit elongation of the eyeball and the subsequent increase in myopia.[7–9]

Aim of this study was to evaluate the efficacy of prismatic bifocal spectacle lenses to control the progression of myopia.

2. MATERIALS AND METHODS

The study retrospectively analyzed 52 eyes of 26 patients who used prismatic bifocal spectacle lenses to control the progression of myopia. The study was approved by the Ethics Committee of Sakarya University Faculty of Medicine (10.04.2023/262) in accordance with the Declaration of Helsinki. Informed consent was obtained from all patients' parents.

A prismatic bifocal spectacle lenses made of polycarbonate material were used in the study. The lenses featured a +3.25 D front base curve and a conventional executive bifocal design with a +2.00 D add power. The prescription range encompassed plano to -6.00 D sphere and up to 4.00 D cylinder. A 3-Δ base-in prism was incorporated into the near segment of each lens, resulting in a total of 6 Δ base-in prism (Essilor Myopilux Max, Essilor International S.A.).[10] Incorporating a 6-Δ base-in prism into the near segment effectively neutralized lens-induced exophoria.[6]

Patients who showed an increase in myopia greater than 0.50 D during the last year of follow-up with single-vision spectacles, who were compliant with axial length measurements and whose eyes had a cycloplegic objective refraction measurement of ≥-2.00 D were included in the study. Patients with strabismus, any retinal or anterior segment diseases, or those who had previously undergone other treatment methods for myopia control were excluded from the study. The demographic data of the patients, including age and gender were recorded. During all follow-ups, patients underwent best-corrected visual acuity measurements with Snellen chart, detailed anterior and posterior segment examinations with slit-lamb biomicroscope, as well as cycloplegic refraction and axial length measurements.

The primary outcome variable was the progression of myopia, determined by calculating the change in objective cycloplegic spherical equivalent using an automated refractor (average of 5 measurements, Tonoref II, Nidek Co. Ltd., Japan). Cycloplegia was induced by administering two drops of 1% cyclopentolate, spaced 5 minutes apart. Refraction was measured 30 minutes after the cycloplegia. The increase in objective spherical equivalent after one year of using single-vision spectacle lenses were compared with the increase observed after one year of using bifocal prismatic spectacle lenses. Axial length was measured with optical biometry (average of 5 measurements, IOL Master 500, Zeiss, Carl Zeiss Meditec, Germany) at baseline, after one year of using single-vision spectacle lenses and after one year of using prismatic bifocal spectacle lenses. The change in axial length served

as the secondary outcome variable. To assess the compliance with spectacle lenses, both children and parents were asked whether they paid attention to the child's spectacle-wearing habits.

IBM SPSS Statistics version 24.0 (IBM Corp., Armonk, NY, USA) package software was used for all statistical analyses. The normality of the variables was assessed with the Shapiro-wilk test. As the variables did not show a normal distribution, nonparametric tests such as the Mann–Whitney U test were used to compare changes in spherical equivalent and axial length. The chi-square test was employed to evaluate differences in non-continuous variables. A multiple linear regression analyze was used to evaluate the effects of potential variables such as age, sex, baseline myopia degree, and increase in axial length on myopia treatment. The Pearson correlation test was used to evaluate the relationship between changes in axial length and the progression of myopia. For all statistical analyses, a p value < 0.05 was considered statistically significant. Data were presented as mean ± standard deviation (SD).

3. RESULTS

The mean age of the patients was 11.65 ± 2.70 years (range: 6 to 15). Sixteen (61.5%) patients were male, and 10 (38.5%) patients were female. The mean objective spherical equivalent was 2.53 ± 1.14 D at baseline. After one year of using single-vision spectacle lenses, it was 3.83 ± 1.32 D and after one year of using prismatic bifocal spectacle lenses, it was 4.04 ± 1.27 D. The increase in mean spherical equivalent was 1.25 ± 0.76 D after one year of using single-vision spectacle lenses, compared to 0.24 ± 0.14 D after one year of using prismatic bifocal spectacle lenses, This difference was statistically significant (p<0.001). The increase in spherical equivalent was 0.250 D in 26 (50%) eyes, 0.125 D in 9 (27.3%) eyes, 0.0 D in 6 (11.5%) eyes, 0.375 D in 4(7.7%) eyes and 0.50 D in 7(13.5%) eyes. No eyes experienced an increase exceeding 0.50 D.

The mean axial length was 23.47 ± 0.36 mm at baseline. After one year of using single-vision spectacle lenses, it was 24.13 ± 0.07 mm and after one year of using prismatic bifocal spectacle lenses, it was 24.15 ± 0.07 mm. Similarly, the increase in mean axial length was 0.66 ± 0.31 mm with single-vision spectacle lenses and 0.014 ± 0.015 mm with prismatic bifocal spectacle lenses. This difference was also statistically significant (p<0.001). The increase in axial length was 0.0125 mm in 25 (48.1%) eyes, 0.0163 mm in 9 (17.3%) eyes, 0.050 mm in 7 (13.5%) eyes, 0.200 mm in 6 (11.5%) eyes, and 0.11 mm in 1 (1.9%) eyes. Figures 1 and 2 show the changes in objective spherical equivalent and axial length.

Multiple linear regression analysis revealed that baseline myopia (higher baseline myopia was associated with a greater treatment effect, p=0.016) and increase in axial length (a higher increase in axial length was associated with greater treatment effect, p=0.036) were both statistically significantly associated with the treatment effect. Age and sex did not show a significant association with the effect of treatment. As expected, the progression of myopia showed a significant correlation with increase in axial length (p<0.001, r=0.52).

4. DISCUSSION

The management of myopia, a prevalent and potentially sight-threatening refractive error, has been a subject of extensive research in recent years.[11,12] Among the various interventions explored, prismatic bifocal spectacle lenses have emerged as a promising option for slowing the progression of myopia, particularly in children.[11] Numerous studies have demonstrated the effectiveness of prismatic bifocal spectacle lenses in controlling the progression of myopia.[6,8–10,12,13]

Figure 1.

The changes in mean objective spherical equivalent

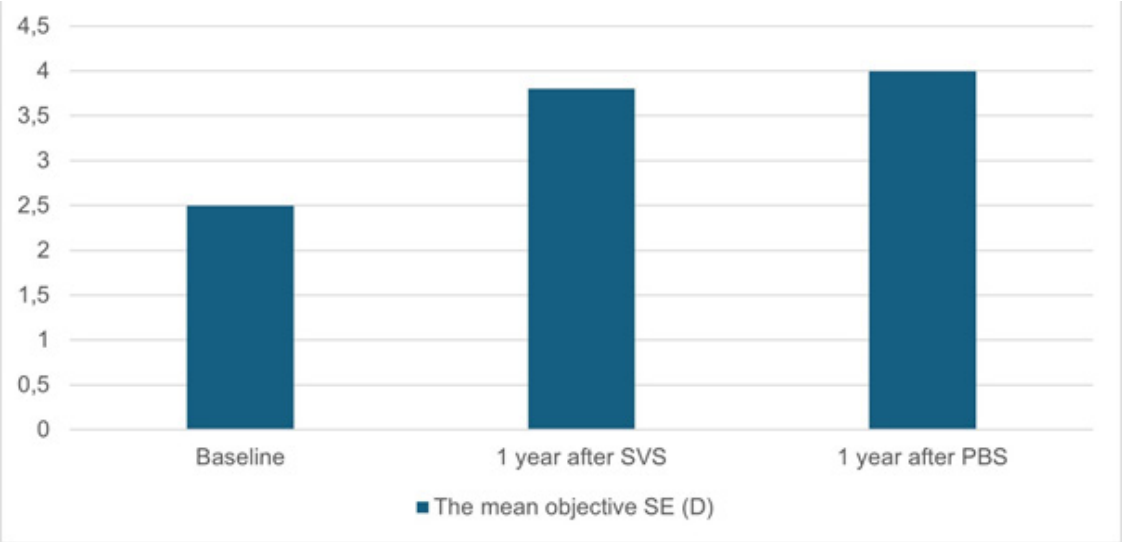
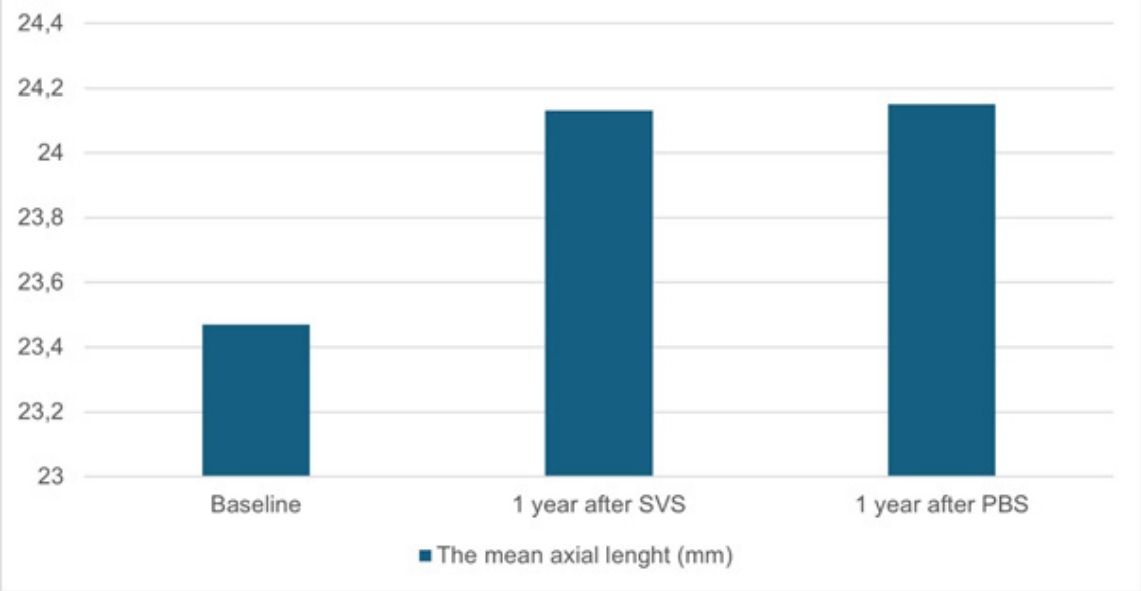


Figure 2.

The changes in mean axial length



Similar to previous studies, prismatic bifocal spectacle lenses were found to be effective in controlling myopia progression after one year of using, compared to single-vision spectacle lenses in same patients in our study.

Axial length measurement provides a quick and objective assessment of myopia progression. Studies have demonstrated that bifocal spectacles are particularly effective in treating myopia in eyes with rapid axial elongation.[10,14] Our results align with these findings, showing that axial elongation is a crucial factor in myopia progression. The treatment effect of prismatic bifocal spectacle lenses was found to be most pronounced during the first year in slowing myopia progression.[10] Huang et al. [15] reported a treatment effect of 0.34 D with prismatic bifocals in the first year.

Similarly, Leung at all[16] and Cheng at all.[10] observed comparable treatment effects with prismatic bifocal spectacles. Our findings were consisted with these results, showing that prismatic bifocals are effective in managing rapid myopia progression during the initial year of treatment. Executive bifocal lenses may be more effective than multifocal lenses in controlling myopia[10]. This could be because the distinct segment line in executive bifocals encourages children to use the appropriate portion of the lens for near work. In contrast, children wearing multifocal lenses may not consistently use the near-addition portion for reading.[17] Additionally, the full-width positive power in the lower portion of executive bifocal lenses might contribute to their effectiveness by creating a wider field of peripheral myopic defocus.[7,8]

The mechanisms through which bifocal prismatic lenses work to control myopia progression are multifaceted. The prismatic component of these lenses induces a relative peripheral hyperopic defocus, which has been shown to inhibit axial elongation.[6,8,10] This peripheral defocus acts to counteract the myopic peripheral defocus that is often associated with the development of myopia. Additionally, the bifocal design of these lenses can reduce the demand for accommodation, which has also been linked to myopia progression.[9,18,19] By addressing both the peripheral defocus and accommodation aspects, bifocal prismatic lenses effectively target key factors contributing to the development and progression of myopia. In our study similar to previous studies, we found that axial elongation was slower in those using prismatic bifocal spectacle lenses compared to those using single vision spectacle lenses.

Given the high accommodation convergence to accommodation ratios observed in myopic children, those with orthophoria and exophoria who wear positive lenses may experience a significant shift towards exophoria.[20,21] This shift increases the demand for positive fusional vergence. Research suggests that this disrupted oculomotor balance could diminish the effectiveness of positive-lens treatments.[6] Subsequent studies have indicated that incorporating near base-in prism when prescribing near additions for myopic children can mitigate the exophoria induced by positive lenses.[6] Therefore, we chose to use bifocal glasses with added prisms.

The limitations of the study were the absence of accommodation measurement, which could have provided insights into the adaptive responses of participants using prismatic bifocal lenses and the lack of measurement of outdoor activities and near work durations. Additionally, the study solely focused on prismatic bifocal spectacle lenses, limiting the exploration of other types of lenses or interventions that could potentially affect myopia control differently. One strength of the study was the use of the same patients throughout the investigation. This approach helped to control for variables such as outdoor activities and near work, which were assumed to have similar characteristics.

In conclusion, the findings indicated that prismatic bifocal spectacle lenses have the potential to decelerate myopia progression in children with high rates of myopic progression. However, prospective studies with larger sample sizes and longer follow-up periods are needed to further investigate this topic.

Ethical Approval

Ethics committee approval dated 10.04.2023 and numbered 262 was obtained from Sakarya University Faculty of Medicine Non-Interventional Ethics Committee.

Conflict of Interest

The authors declare that they have no conflict of interest.

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