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# Higher spherical equivalent refractive errors is associated with slower axial elongation wearing orthokeratology

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ABSTRACT

*Purpose:* To investigate the relationship between axial length (AL) increase and baseline spherical equivalent refractive errors (SER) in myopic children wearing orthokeratology contact lenses (OK).
*Methods:* One hundred fifteen Chinese (115 right eyes) children wearing OK were enrolled in this cohort study. Gender, age, baseline SER, corneal power, corneal astigmatism, and AL at baseline and 2 years after wearing OK were collected. Univariate analysis and trend test were used to estimate the relationship between change in AL and baseline SER.
*Results:* After univariate analysis, a statistically significant relationship was found between change in AL and baseline SER ($\beta = 0.061$, 95% CI: 0.015–0.111, $P = 0.015$). In the trend test, after adjusting for potential confounders, higher SER was associated with smaller increases in AL ($P$ trend = 0.041).
*Conclusions:* The SER at baseline was associated with AL growth in myopic children wearing OK. The higher SER was associated with slower AL growth and control the development of myopia.


## 1. Introduction

The rising prevalence of myopia and the growing proportion of high myopia have significant economic and social impacts, which have led to increased interests in therapies that slow down myopia progression [1,2]. At present, orthokeratology (OK) is the most effective non-pharmacological method in slowing down myopia progression compared to the use of single-vision spectacle lenses (SV) [3–5], bifocal spectacles [6], progressive addition lenses [7,8], soft lenses [9], and rigid gas-permeable contact lenses (RGP) [10]. However, the biggest challenge is to identify those children who may benefit from the use of OK. Investigators have tried to identify the factors affecting the efficacy of OK in myopic control such as initial age [11–14], spherical equivalent refractive errors (SER) [11–15], pupil diameter [13,16], age of myopia onset [13], myopia progression 2 years before baseline [13], anterior chamber depth [13], and parental refraction [13]. Myopia progression was estimated from changes in axial length (AL), which was evaluated using a noncontact optic biometric device (IOL Master). Recently, there were some contradicting study results about the relationship between pre-treatment SER and AL elongation [11–15]. Hiraoka et al. [11] and Cho et al. [12] found that more myopic children wearing OK showed a slowly increase in Kakita et al. [15] observed the higher SER was associated with slower AL growth only in higher myopic patients wearing OK. Santodomingo-Rubido et al. [13] discovered that lower myopic patients wearing OK showed more slowly increase in AL increase. However, Cho and Cheung [14] and Kakita et al. [15] reported that there was no relationship between them. Currently, there are two kinds of results on the relationship between the baseline SER and AL increase for myopia patients wearing single-vision spectacles whose baseline profiles were similar to our current study. Cho et al. [12] found that more myopia SER showed more increase in Hiraoka et al. [11], Santodomingo-Rubido et al. [13], Kakita et al. [15] and Cho and Cheung [14] observed the SER at baseline was not associated with AL elongation in myopic patients weraing single-vision spectacles. This study evaluated the correlation between baseline SER and AL increase over a 2 year period in myopic children wearing OK.

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**Table 1**
Inclusion criteria.

1. Age 6–15 years at baseline
2. Cycloplegic autorefraction (spherical equivalent refraction) from −7.00 D to −1.00 D
3. Corneal power from 40.75 D to 47.25 D
4. Corneal astigmatism ≤2.00 D
5. Monocular best corrected visual acuity of 20/20 or better
6. Uncorrected visual acuity of 20/25 or better after the removal of OK lens
7. No history of orthokeratology or use of other contact lenses
8. No binocular vision problems; no ocular and systemic conditions that might affect vision or vision development; no contraindications for overnight orthokeratology lens wear

## 2. Methods

### 2.1. Subjects

0ne hundred fifteen (115 right eyes) Chinese myopic children who visited the First Affiliated Hospital of Zhengzhou University and met the inclusion criteria (Table 1) were in recruited this cohort study between July 2009 and May 2012. Written informed consent was obtained from parents after the procedures and possible risks were fully explained before the initiation of treatment. This study conformed to the tenets of the Declaration of Helsinki and was approved by the Medical Ethics committee of the First Affiliated Hospital of Zhenzhou University.

The OK lenses used in this study were four-zoned reverse-geometry lenses (Boston XO material, Autek Corp., Hefei, China) with Dk of $100 \times 10^{-11}\,cm^2/s$ ($ml\,O^2/ml \times mm\,Hg$). The central thickness of the lenses was 0.24 mm and the diameter was between 10.4 and 11.0 mm. The parameters of the lenses were varied to achieve good centration on the cornea and bulls eye topographic change that with a central touch surrounded by a narrow and deep annulus of tears trapped in the reverse curve area. The duration of lens wear was about 1.5 years. After the lenses were dispensed, the patients were advised to wear their OK lenses every night for at least 8 consecutive hours. They were also required to attend routine aftercare (1 day, 1 week, 1 month, and every 3 months after lens delivery) and unscheduled visits when necessary to ensure good ocular response and health.

### 2.2. Procedures

AL was evaluated using a noncontact partical coherence interferometer (IOLMaster; Carl Zeiss Meditec AG, Jena, Germany). On each occasion, five successive measurements were taken and their mean was used as a representative value. Cycloplegic autorefraction was performed after the instillation of four drops of compound tropicamide eye drops(0.5% tropicamide and 0.5% neo-synephrine) (Santen, Japan) separated 10 min apart in each of the patients' eyes. Ten minutes after the instillation of the fourth drop, three autorefraction measurements were taken (Topcon RM 8000A, CA) and a mean was obtained. Corneal power and astigmatism were obtained from the corneal topography, which were captured using the OrbscanIIZ (Bausch & Lomb, San Dimas, CA). The SER, AL, corneal power, and astigmatism were obtained before initiation of OK treatments as the baseline values. At the end of the 2-year monitoring period (according to the month statistics, because the follow-up period was not 2 years for all children), the change in AL at 2 years compared with baseline SER was assessed. Subjects were split into four groups or quartiles depending on their

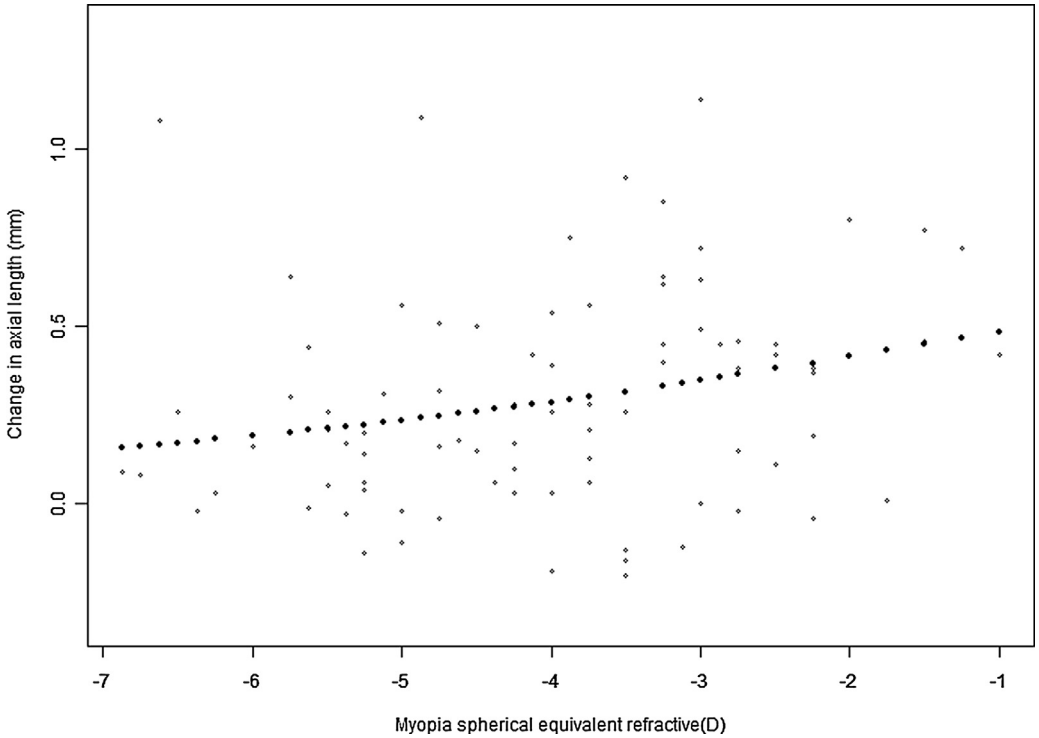


**Fig. 1.** Scatter plots of change in axial length (AL) at 2 years relative to baseline and spherical equivalent refractive error (SER) at baseline in the myopic children wearing orthokeratology lenses. Baseline SER was found to significantly affect the change in AL. ($\beta = 0.061$, $P = 0.015$, $R^2 = 0.132$).