Comparison of Axial Elongation Rates Before, During, and After Orthokeratology

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Background

It is estimated that global prevalence of myopia and high myopia increases to approximately 50% and 10%, respectively, by 2050.[1] Myopia progression and axial elongation are generally irreversible and associated with increased risks of vision-threatening eye abnormalities such as cataract, glaucoma, retinal detachment, and myopic maculopathy.[2,3] Several strategies have been developed for the prevention of myopia progression and reduction of axial elongation. A representative strategy is the optical approach, which involves the modification of the optical properties of the eyes using spectacles or contact lenses (CLs). Orthokeratology (OK) is one of the most effective modalities for myopia control, and the efficacy has been shown in many clinical studies.[4,5] Regarding the rebound phenomenon after discontinuation of OK, Cho et al.[6] reported that stopping OK lens wear at or before the age of 14 years led to a more rapid increase in axial length. However, no reports have examined changes in axial length before the initiation of OK treatment, leaving uncertainty regarding whether a rebound phenomenon truly occurs after the cessation.

Purpose

The aim of this study was to retrospectively investigate the annual rate of axial elongation before commencement of OK (before OK) , during OK treatment (during OK), and after discontinuation of OK (after OK) to determine the presence of a rebound phenomenon.

Patients

This study included school children who were initially prescribed regular contact lenses or glasses for myopia correction at Itami Central Eye Clinic, then underwent OK treatment using "***Alpha Ortho-K***" lenses (Alpha Corporation, Nagoya, Japan) for a certain period, and continued to visit the same clinic after discontinuing OK treatment.

A total of 10 patients (18 eyes) from medical records were selected for analyses, and their baseline characteristics are shown in Table 1. The age distribution is also shown in Figure 1.

Table 1. Baseline characteristic of patients

Starting age of OK (years)	11.9±2.1 (9 to 16)
Sex (male:female)	2 : 8
Spherical Equivalent Refraction (D)	-2.85±1.76 (-5.63 to -0.88)
Cylinder (D)	-0.52±0.47 (-1.75 to 0.00)
UCVA (logMAR)	0.79±0.35 (0.30 to 1.22)

UCVA=uncorrected visual acuity mean±SD (range)

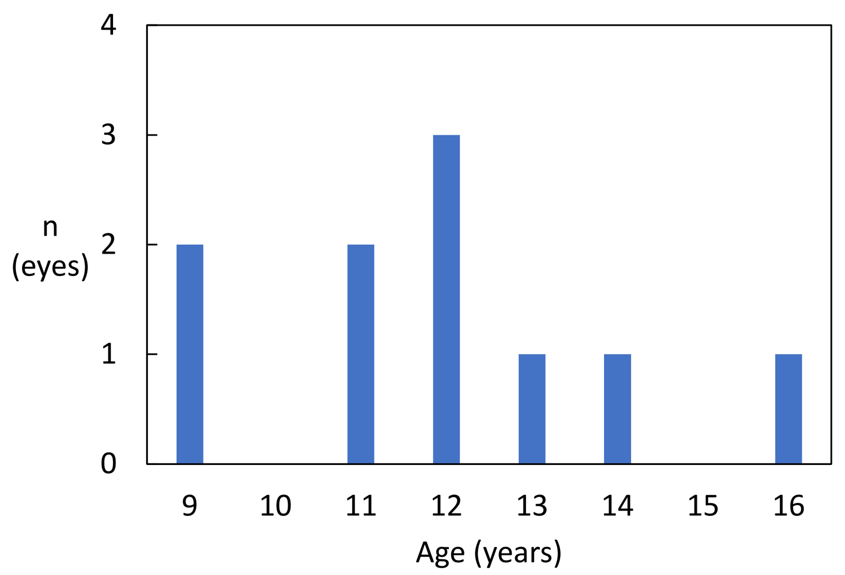

Figure 1. Distribution of starting age of OK
The vertical bar shows the number of eyes.

Methods

The annual rate of axial elongation (RAE) was determined for each treatment period (before, during, and after OK). Additionally, factors influencing RAE after OK were assessed.

Results

RAE was 0.54±0.33mm/year before OK, 0.03±0.17mm/year during OK, and 0.30±0.14mm/year after OK. The RAE was slowest during OK, followed by after OK and before OK (Figure 2).

In the simple correlation test, the RAE after OK was significantly correlated with the duration of OK treatment and the starting age of OK (Figures 3&4). Multivariate analysis was also performed by including other factors to clarify significant factors influencing the RAE after OK (Table2). As a result, only two factors (duration of OK treatment and starting age of OK) were selected as significantly contributing factors.

In this study, there was no significant difference in RAE before OK and after OK discontinuation. That is to say, it was suggested that no rebound phenomenon of axial elongation was observed after OK discontinuation.

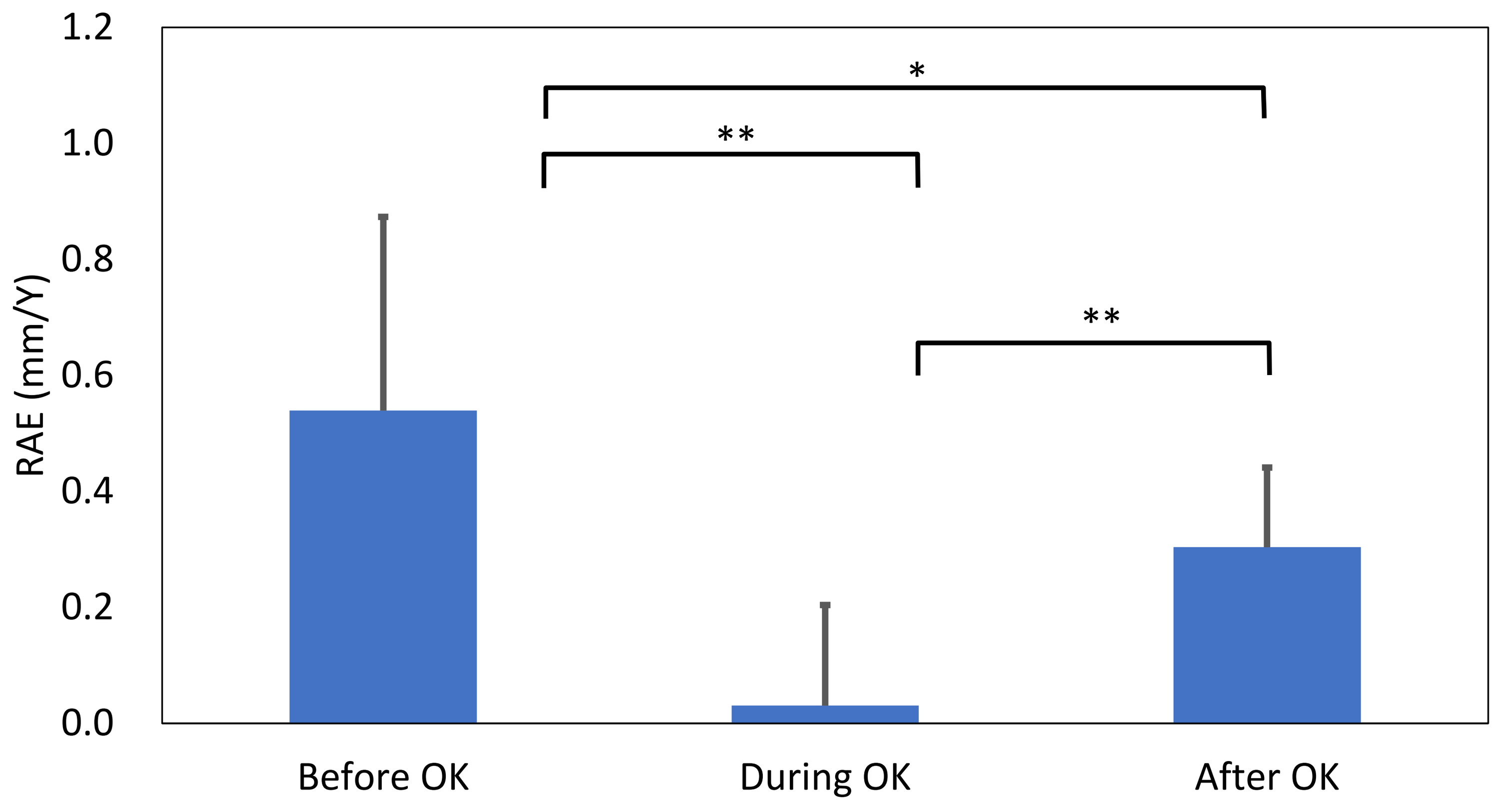

Figure 2. Comparison of RAE among 3 periods
Significant differences were observed in all combinations (*:p<0.05, **:p<0.01 Tukey-Kramer).

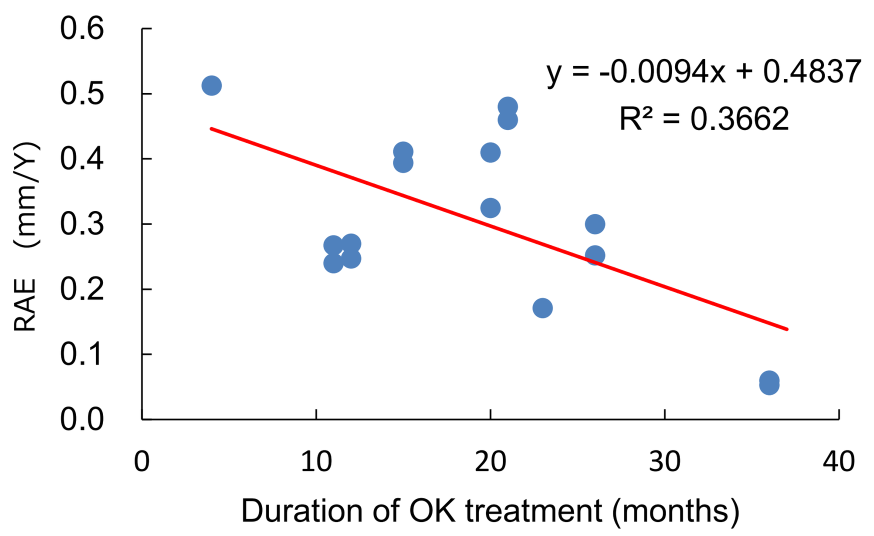

Figure 3.
Correlation between duration of OK treatment and RAE
RAE was negatively correlated with the duration of OK treatment (r=-0.6051, p=0.0130).

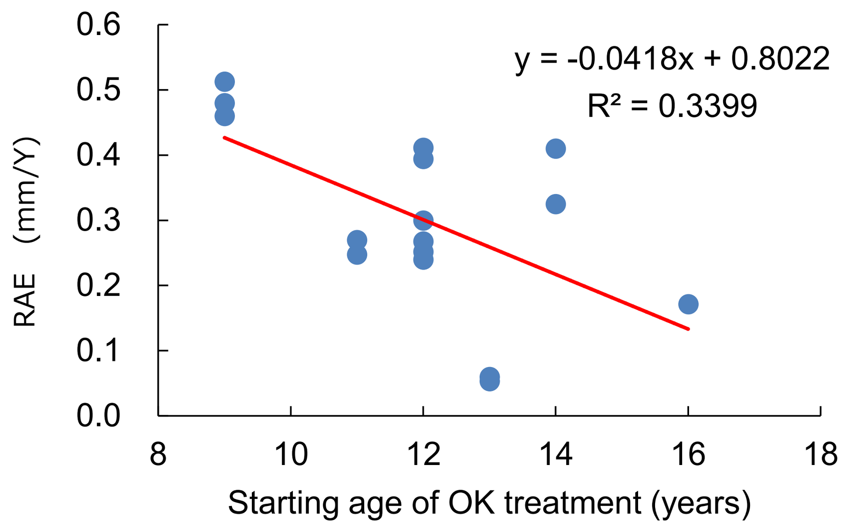

Figure 4.
Correlation between starting age of OK and RAE
RAE was negatively correlated with the starting age of OK treatment (r=-0.6037, p=0.0133).

Table2. Correlation between "RAE after OK" and various factors by multivariate analysis (Pairwise testing)

	Corr. Coefficient(r)	p-value	average
RAE after OK (mm/Y)	-	-	0.303
duration of OK treatment (month)	-0.6051	0.0130	19.8
starting age of OK treatment (years)	-0.6037	0.0133	11.6
age at the end of OK treatment (years)	-0.4878	0.0553	13.4
age at the last visiting (years)	-0.4685	0.0672	14.8
axial elongation before OK (mm)	-0.1325	0.6247	25.2
duration before OK (month)	-0.1727	0.5223	6.8
RAE before OK (mm/Y)	0.0939	0.7603	0.539
axial elongation after OK (mm)	0.7675	0.0005	25.3
duration after OK (month)	-0.1466	0.5580	15.8
Flat k-readings (D)	0.3485	0.2669	42.43
variation of SE before OK (D/Y)	0.2630	0.5777	0.89
variation of SE after OK (D/Y)	0.1727	0.6333	0.82

〈Representative Cases〉

Case1. She visited to the clinic when she was 9 years old. Her myopia was corrected with single-vision glasses for 3years, but myopia progressed during that period. Therefore, at the age of 12, she switched to OK and used it for 1year. After discontinuation of OK, she switched to soft CL and was followed up for another year. The time course of change in axial length is shown in the Figure 5. The RAE was 0.58 (mm/Y) for the right eye and 0.59 (mm/Y) for the left eye before OK. Although the axial elongation stopped during OK, the elongation began again and the RAE was 0.29 and 0.26 (mm/Y), respectively, after OK. However, no rebound phenomenon of RAE was observed after OK.

Case2. She visited to the clinic when she was 8 years old. Her myopia was corrected with single-vision glasses and soft CLs, but myopia progressed within that period. Therefore, at the age of 14, she switched to OK and used it for 1.5 years. After OK, she switched to soft CL and was followed up for another 2 years. The time course of change in axial length is shown in the Figure 6. The RAE before OK was 0.75 and 0.67 (mm/Y) for the right and left eyes, respectively. Although the axial elongation slowed down during OK, the RAE increased after OK (0.41 and 0.33 mm/Y, respectively). No apparent rebound phenomenon of RAE was observed after OK.

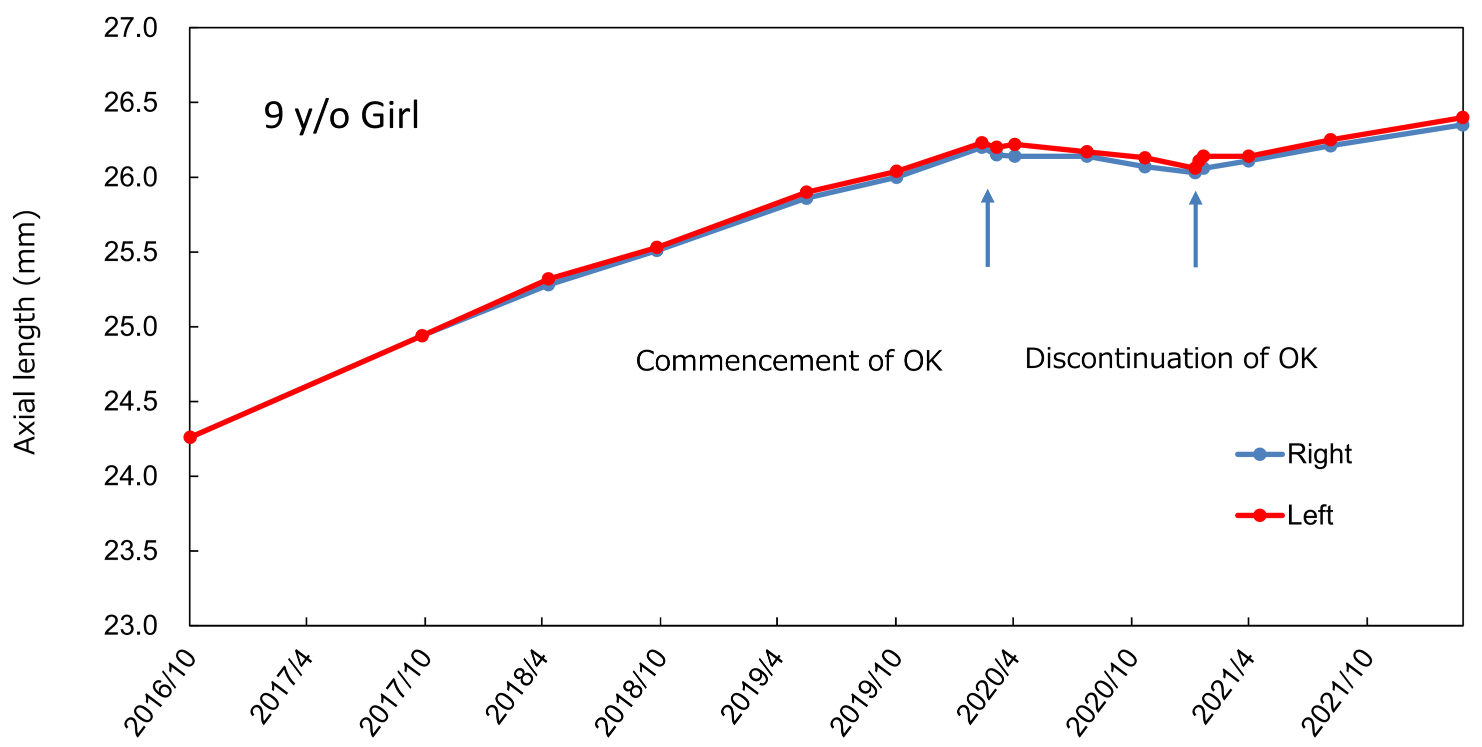

Figure 5. Time course of change in axial length before, during, and after OK in Case 1.

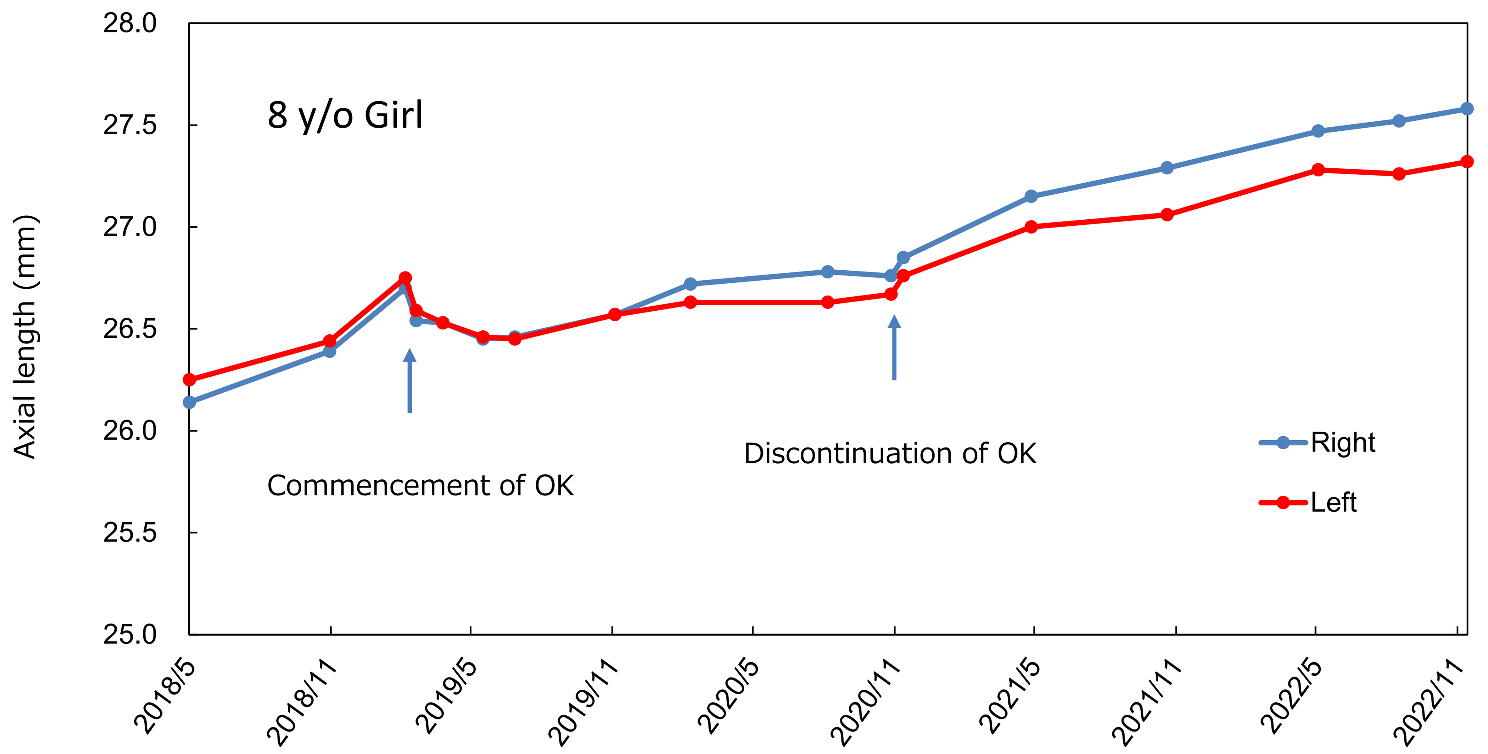

Figure 6. Time course of change in axial length before, during, and after OK in Case 2.

Conclusion

There were differences in RAE before, during, and after OK. During OK, RAE was the slowest (average 0.03mm/Y), followed by after OK (average 0.30mm/Y), and then before OK (average 0.54mm/Y). No significant rebound phenomenon was observed after OK, and overall, RAE was strongly suppressed during OK. Factors affecting the RAE after OK included the duration of OK treatment and the starting age of OK, with longer treatment durations and later initiation of OK treatment associated with slower RAE after OK discontinuation.

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