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OPTOMETRY AND VISION SCIENCE

CASE REPORT

Discontinuation of Orthokeratology and Myopic Progression

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ABSTRACT

Purpose. To report the effect of stopping orthokeratology (ortho-k) lens wear on the changes in refractive errors and axial elongation in a girl who has been wearing ortho-k lenses for myopic control for over 2 years.

Case Report. A girl with a history of fast myopic progression enrolled in ortho-k treatment when she was 6 years old. She switched to spectacle wear after receiving ortho-k treatment for 38 months and then switched back to ortho-k lens wear. Refractive errors and axial lengths were monitored for 8 months with ortho-k lens wear, followed by about 6½ months of lens discontinuation and spectacle wear, and finally another 6 months of resumed ortho-k lens wear. The residual refractive errors in the 8 months before discontinuation of ortho-k lens wear were not more than ±0.25 diopter (D) and −0.50 D in spherical and cylindrical powers, respectively, and the average increases in axial length were 0.02 mm (OD) and 0.03 mm (OS) per month. Myopia increased by 0.75 D (OD) and 1.25 D (OS) during the lens discontinuation period, with corresponding axial elongations of 0.06 mm (OD and OS) per month. No significant changes were observed in axial elongation or residual refractive errors during the 6-month period of resumed lens wear.

Conclusions. When a child who had been wearing ortho-k lenses for myopic control for over 2 years ceased lens wear, small net amounts of axial elongation were observed during the subsequent months with spectacle wear. These changes took place at a faster rate relative to the ortho-k lens wear period. Ortho-k lens wear appeared to slow myopic progression for this child. (Optom Vis Sci 2010;87:1–●●●)

Key Words: orthokeratology, axial elongation, myopic progression, refractive errors, discontinuation

Modern overnight orthokeratology (ortho-k) effectively reduces low to moderate myopia[1–4] and has the potential to slow myopic progression.[2,5] Thus, ortho-k is becoming increasingly popular as a means of myopic reduction and myopic control, especially in places where the prevalence of myopia is high.[6] The rates of myopic progression in children wearing ortho-k lenses were reported to be about 50% of the rates in children wearing spectacles or contact lenses.[2,5]

However, information concerning the mechanism by which ortho-k slows myopic progression, the critical age of intervention, or whether the myopic control effect will last after ceasing lens wear is currently not available. The main concerns of parents who enrolled their children for ortho-k are the following: What would happen to the refractive errors of their child if the child ceased lens wear after ortho-k treatment for myopic control for a period of time? Will the refractive errors increase drastically (rapid increase within days or weeks after ceasing lens wear)? Would the refractive errors catch up with the amount of myopia that would have been present if the child has never received ortho-k treatment? This is a case report about a young girl who has worn ortho-k lenses for a period of time for myopic control, who ceased lens wear for a period of time and used spectacles for vision correction, and then resumed ortho-k lens wear. We monitored changes to her refraction and axial length (AL).

CASE REPORT

This young girl was 6 years old when she was enrolled in ortho-k for myopic control. Her parents enrolled her because of their concern about myopic progression as she had a history of myopic progression of about 1.00 diopter (D) per year. Her mother reported that she was first found to be myopic (about −1.50 D in both eyes) when she was about 4 years old. Her pretreatment subjective refraction was OD $-2.75 - 1.00 \times 10$ and OS $-3.25 - 0.75 \times 7$. She was fitted with a pair of five-curve reverse geometry lenses targeted for full myopic reduction. The lenses were made of Boston XO material (eLens; E&E Optics, Hong Kong) with a five-zone design (lens parameters: matched flat K = 43.25

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D, fitting curve = standard, alignment curve = −10 μm, peripheral curve = 12.5 mm, lens diameter = 10.6 mm, target = 3.00 D). The lens parameters for the right and left lenses were the same. After 2½ years of ortho-k treatment, the mother and the girl consented to a three-phase assessment of ortho-k wear (phase I, 8 months), spectacles lens only wear (phase II, 6½ months including 1 month of washout period; ortho-k was resumed sooner because of the increased rate of axial elongation during this phase), and resumed ortho-k wear (phase III, 6 months including 1 month of stabilization period when ortho-k was resumed). A pair of new ortho-k lenses targeted for full myopic reduction was used in phase III. The girl did not return for data collection until about 2 months after resuming ortho-k lens wear.

During the investigation period (phases I to III), refractive errors, visual acuities (VAs), AL, and external ocular health were monitored on a monthly basis. At each visit, subjective refraction and AL measurements (IOLMaster; Carl Zeiss, Germany) were made. Ocular health was monitored by slitlamp biomicroscopy.

Changes in Refractive Errors

Table 1 summarizes the refractive or residual errors and AL measurements over the 21-month study period. The residual refractive errors during phase I were not more than ±0.25 D in spherical power and not more than 0.50 D in cylinder power. The monocular-unaided VA was 20/30 or better at all visits, and the parameters of ortho-k lenses worn before and during phase I were unchanged. After stopping the treatment, refractive errors returned to the pretreatment level within 2 weeks and stabilized within 1 month (i.e., the refractive errors were not different at two consecutive visits after ceasing lens wear). At the end of phase II, the refractive errors were OD −3.50 − 1.50 × 175 and OS −4.50 − 1.50 × 180, indicating increases of 0.75 D (OD) and 1.25 D (OS) in myopia. The parameters of the new pair of ortho-k lenses used in phase III were not different from those worn in phase I except that the target reduction was increased for full reduction. Although the cylinder powers in the residual refraction were slightly higher in phase III than in phase I, the unaided VAs were not significantly affected and were 20/30 or better at most of the visits.

Changes in AL

Fig. 1 shows the AL measurements during the three phases of study. ALs were 24.68 mm (OD) and 24.89 mm (OS) at the beginning of phase I. In phase I, AL increased by 0.02 mm (OD) and 0.03 mm (OS) per month. In phase II, including 1 month of washout period, AL increased by about 0.06 mm (OD and OS) per month of spectacle wear. These changes were about double the rates of change in phase I. In phase III, no increases in AL were observed in both eyes during the period of resumed ortho-k lens wear.

In view of the significantly faster increase in myopia during the spectacle lens wear phase compared with ortho-k lens wear phases, the parents decided to let the girl continued with ortho-k treatment after completion of phase III. The girl is now, at the time of

TABLE 1.
Refractive status and axial lengths during orthokeratology/spectacle wear periods

	Age of the child (yr)	Duration of lens wear (mo)	Duration of cease lens wear (mo)	Residual refractive errors (D) (pretreatment refractive errors)		AL (mm)		Monthly changes (mm)	
				OD	OS	OD	OS	OD	OS
Pretreatment	6	0	—	−2.75/−1.00 × 10	−3.25/−0.75 × 7	—	—	—	—
Beginning of phase I (ortho-k)	8.5	30	—	Plano/−0.50 × 180; target: 3.00 D	−0.25/−0.25 × 180; target: 3.00 D	24.68	24.89	0.02	0.03
End of phase I	~9	38	—	Plano/−0.50 × 170; target: 3.00 D	−0.25/−0.50 × 10; target: 3.00 D	24.84	25.10		
Beginning of phase II (spectacles)		—	0	−1.50/−0.50 × 160	−2.00/−1.00 × 160	24.79	25.12	0.06	0.06
Stabilized refractive errors		—	~1	−3.00/−1.50 × 5	−3.50/−1.50 × 170	24.99	25.26		
End of phase II	~10	—	~6	−3.50/−1.50 × 175	−4.50/−1.50 × 180	25.18	25.53		
Phase III (stabilized ortho-k effect)		2	—	−0.25/−1.00 × 180; target: 3.50 D	−0.75; target: 4.50 D	25.10	25.49	0	<0
End of phase III	10.5	6	—	−0.25/−0.50 × 180; target: 3.50 D	−0.50/−0.75 × 180; target: 4.50 D	25.10	25.41		

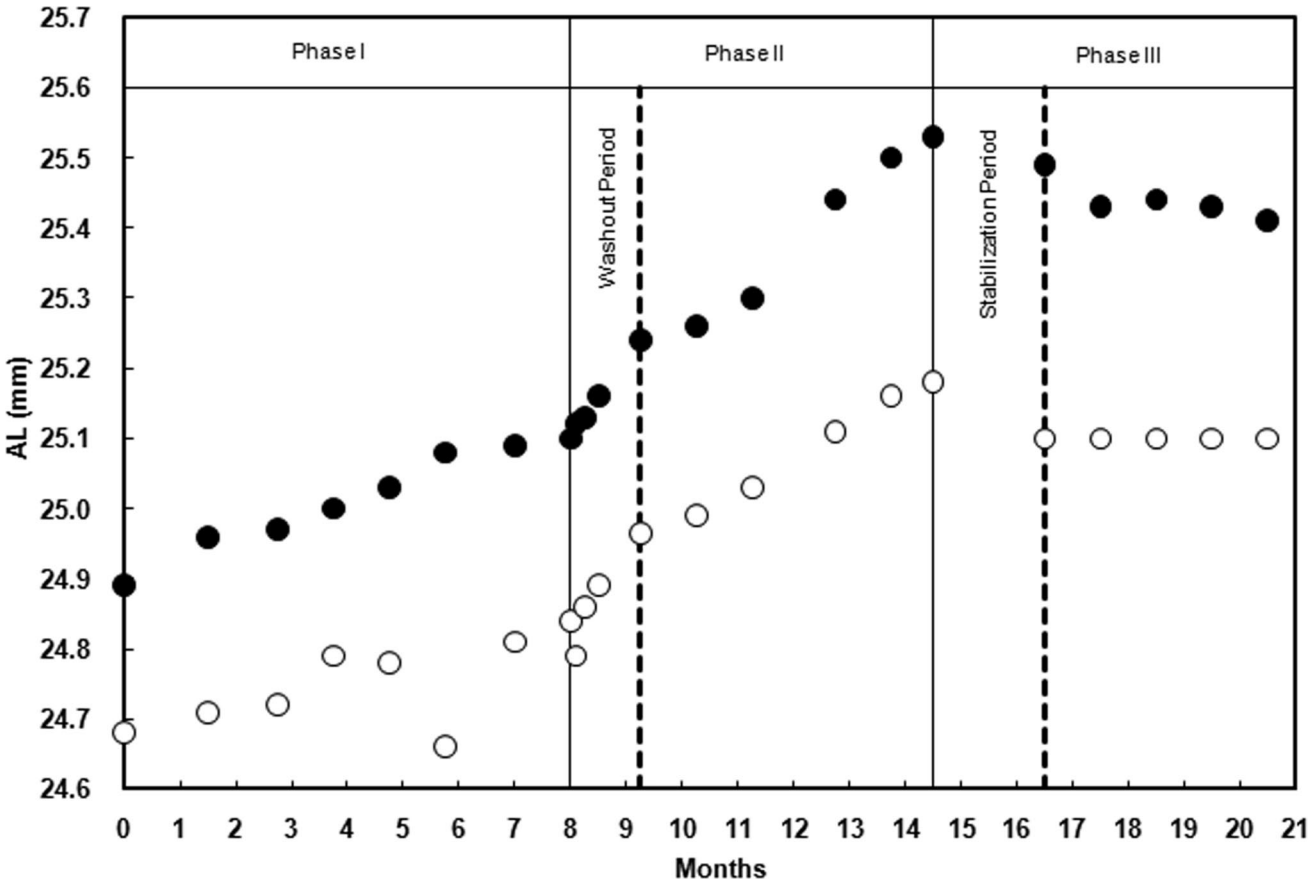

FIGURE 1.
AL elongations during different phases of the study: ○, OD; ●, OS.

writing this report, about 12 years old, and she is still wearing ortho-k lenses.

DISCUSSION

This case demonstrates that axial elongation was faster in a myopic child when wearing spectacles compared with when wearing ortho-k lenses. Edwards[7] monitored the refractive changes of 7 year olds over 5 years and showed that myopic progression was greatest between the ages of 9 and 11 years. However, Hyman et al.[8] monitored the myopic progression in 6- to 11-year-old myopic children and found that younger children had the highest myopic progression over 3 years. Saw et al.[9] also reported that the rate of axial elongation decreases with age in a group of 7- to 9-year-old myopic children in Singapore.

In the current case report, the child started the ortho-k lens wear when she was about 6 years old. She was only about 9 years old when ortho-k lens wear was temporarily ceased (phase I), and hence, myopic progression was expected to be still active. This was evidenced by the increases in AL and refractive errors when she stopped ortho-k lens wear. Comparing the changes in AL when the child was wearing ortho-k lenses to when she was wearing spectacles, the increase in AL was at least 50% slower when she was wearing ortho-k lenses. This was in agreement with the findings of the Longitudinal Orthokeratology Research in Children (LORIC)[2] and the Corneal Reshaping and Yearly Observation of Nearsightedness (CRAYON)[5] studies where the increase in axial elongation of the eyes of children wearing ortho-k lenses were about 50% less than those wearing spectacles (LORIC) or soft contact lenses (CRAYON).

Although AL increased significantly faster in phase II, nevertheless, axial elongation was not drastic. One month after ceasing ortho-k lens wear, her refractive errors were stabilized at OD $-3.00 - 1.50 \times 5$ and OS $-3.50 - 1.50 \times 170$. The spherical equivalent refractive errors were 0.50 D and 0.625 D more than the values in the OD and OS, respectively, at baseline (OD, $-2.75 - 1.00 \times 10$; and OS, $-3.25 - 0.75 \times 7$) before she commenced ortho-k treatment about 3 years ago. Unfortunately, we did not have her pre-ortho-k AL data for comparison. When she ceased ortho-k lens wear and returned to wearing spectacles, her AL started to increase at faster rates. At the end of the spectacle-wear period, her refractive errors were OD $-3.50 - 1.50 \times 175$ and OS $-4.50 - 1.50 \times 180$. The increases in myopia during the 6-month spectacle-wear period were 0.50 D (OD) and 1.00 D (OS). Fan et al.[10] reported the rate of myopic progression (spherical equivalent) in myopic children in Hong Kong to be 0.63 D per year, whereas a more recent study[11] reported the rate to be 0.90 D per year. The differences in the values reported may be because the former included children from 5 to 16 years old whereas the latter included only children from 6 to 12 years old. The increases noted in this case report in phase II were perhaps not unexpected as the child has a history of fast myopic progression before ortho-k treatment. We did not know the actual rate of myopic progression

before ortho-k treatment except that, as the parents reported, it was about 1.00 D per year. The corresponding increases in AL during this period were about double those measured during phase I when the girl was wearing ortho-k lenses [i.e., on average 0.06 mm per month in each eye vs. 0.02 (OD) mm and 0.03 mm (OS) per month during 8 months of treatment]. When the child resumed ortho-k lens wear (phase III), no further increases in AL were observed in either eye in the subsequent 6 months of lens wear. The child was about 10½ years old at the end of phase III.

A time period between two consecutive phases was necessary to allow the effect from the prior treatment (in the case of switching from ortho-k to spectacles) to wash out or the new treatment (in the case of switching from spectacles to ortho-k) to stabilize. A subtle increase in AL during the transition from phase I to phase II and a decrease in AL from phase II to phase III were observed. Additional studies will be needed to confirm whether a more rapid early rate of axial elongation, which suggests a small "rebound effect," is a repeatable characteristic of stopping ortho-k. There has not been any report investigating the short-term effect of ortho-k on AL. González-Méijome et al.[12] reported a short-term reduction of 9.08 μm in central corneal thickness after 3 h of ortho-k lens wear and a recovery of 5.33 μm 3 h after ortho-k lens removal. However, this net transient reduction of 3.75 μm in corneal thickness cannot explain the rapid rebound and the subtle decrease in AL observed when the girl stopped and resumed ortho-k lens wear, respectively, in the current case. Changes observed in this little girl may be particular to her only or may reflect changes that would be observed when switching between spectacle wear and ortho-k. Further work is still required to confirm how ortho-k effect myopic reduction and myopic control.

After resuming ortho-k treatment in phase III, AL did not show significant change in either eye. However, changes in AL in the two eyes were very different from what were observed during phase I. By phase III, the girl was 10 years old. It may be that myopic progression rate had naturally attenuated with increased age. This factor cannot be neglected, and a study with control of the age effect is warranted to further investigate the changes observed in this case report.

The results of this case, whilst providing a positive insight into what could happen after ceasing ortho-k treatment for myopic control, is nevertheless an anecdotal report on a single patient. Therefore, it is important that this case is not taken as a representing proof that myopia will not drastically increase or catch up with what they were expected to be if the eyes had never underwent ortho-k treatment. Additional research is required before a firm conclusion about the effects of ceasing ortho-k lens wear can be drawn.

CONCLUSIONS

When a myopic child who had been wearing ortho-k lenses for myopic control ceased lens wear and was switched to spectacles, small net amounts of axial elongation were observed. These took place at a faster rate relative to the ortho-k lens wear period. Ortho-k lens wear appeared to slow myopic progression for this child.

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