Article • Lockdown in Hong Kong Promotes Myopia Progression in Schoolchildren: A Case Report

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ABSTRACT

Background: We describe two cases of monocular orthokeratology with rapid myopia progression in the contralateral untreated eye during a time that children stopped attending school due to COVID-19 and switched to an online mode of learning.

Case Reports: An 11-year-old female unilateral myopic anisometrope was fitted with an orthokeratology lens only in her left eye. The right eye (non-treated eye) showed myopic progression and axial length elongation, while the left eye (orthokeratology treated eye) showed no change in refractive error or axial length from Jan 2020 to Jun 2020, which was the class suspension period. The change in myopia (spherical equivalent) was -0.50 D in the right eye (non-treated eye) but remained unchanged in the left eye (orthokeratology treated eye). The change in axial length was 0.14 mm in the right eye (non-treated eye) and -0.1 mm in the left eye (orthokeratology treated eye) at around 5 months.

A 13-year-old female unilateral myopic anisometrope was fitted with an orthokeratology lens in her left eye. The refractive error of each eye was stable before the class suspension, but myopic progression was demonstrated in both eyes during class suspension. The change in myopia (spherical equivalent) was -0.75 D and -0.50 D in the right eye (non-treated eye) and the left eye (orthokeratology treated eye), respectively. The non-treated eye showed -0.25 D more myopic change than the treated eye in a 4-month interval.

Conclusions: Myopia progressed 2 to 5 times faster during lockdown; thus, the change of learning mode and lifestyle under the COVID-19 pandemic are possible risk factors for myopia progression. Protective behaviors and myopia control intervention should be publicized and implemented as promptly as possible.

Keywords: anisometropia, COVID-19, myopia control, myopia progression, orthokeratology

Introduction

A new coronavirus caused an outbreak of pneumonia in Wuhan of Hubei Province, China in December 2019. This coronavirus disease was officially named COVID-19 by the World Health

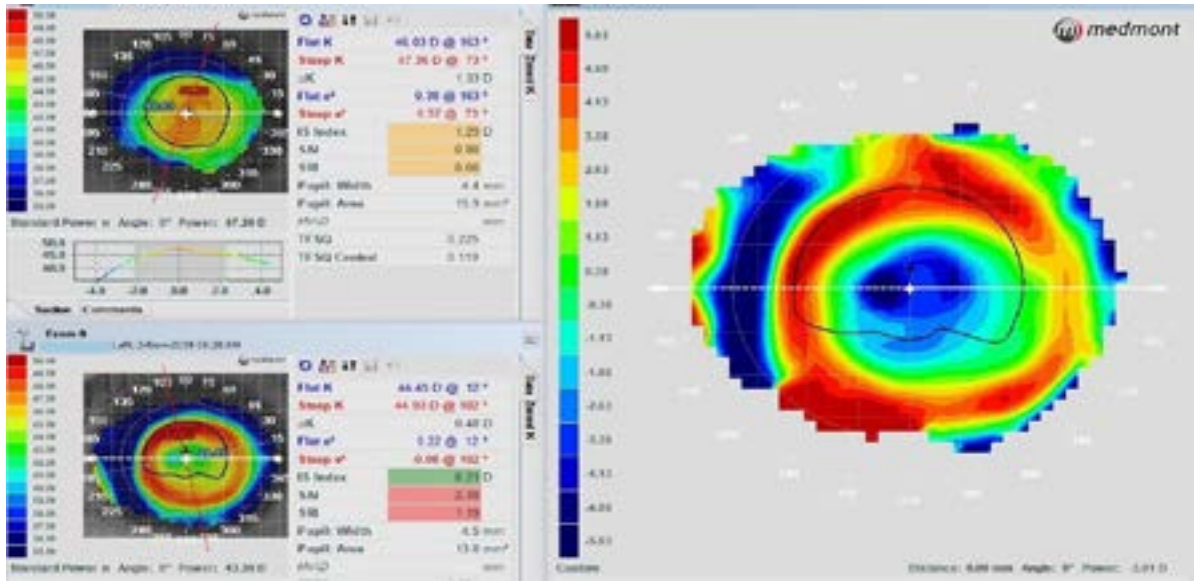

Figure 1. *Topography after one night of wear for patient 1*

Table 1. Horizontal Visible Iris Diameter (HVID), Keratometric Readings, and e-Value of the of the Flattest Meridian

	Eye	HVID	K-reading	e-Value
Case 1	Right eye	11.0 mm	46.00@002	0.64@002
	Left eye	11.0 mm	46.03@163	0.62@163
Case 2	Right eye	Nil	43.16@166	0.27@166
	Left eye	Nil	42.77@006	0.49@006

HVID=horizontal visible iris diameter, K-reading=keratometric reading

Organization (WHO) on February 11, 2020.[1] Since the first case of COVID-19 in Hong Kong was confirmed on January 23, 2020,[2] the government of Hong Kong has implemented a range of public health measures to suppress local transmission. One of the public health measures was school closure. The Hong Kong Government postponed class resumption for kindergarten to secondary schools several times and implemented class suspension in tutorial centers. In the light of the local outbreak of COVID-19 in early May, class resumption started from May 20th in several phases.[3] Most of the classes in secondary and primary schools resumed in early June of 2020. During the school closures, from late January to mid-June, schoolchildren in Hong Kong stopped attending class for at least 4 months. To maintain teaching and learning, many schools and tutorial centers began adapting online teaching during this period. Schools provided online lessons via videoconferencing, with schedules similar to those of usual schooldays. In addition, schools provided online assignments to students; students did not only use electronic devices for lessons, but also for completing online assignments, causing a dramatic increase in screen time. Besides changing children's learning mode, the outbreak also hinders schoolchildren from spending time outdoors, as people preferred staying at home as much as possible.[4] Near work and lack of outdoor activity are risk factors of myopia.[5-9] This paper describes two children with anisometropia who were fitted with orthokeratology in one eye for myopia control who presented with rapid myopic progression in the non-treated eye during the class suspension period.

Case Reports

Case 1

In July 2019, an 11-year-old girl was brought to the Optometry Clinic of The Hong Kong Polytechnic University by her parents for a routine eye examination. Unaided visual acuity of the right and left eyes was 6/7.6 and 6/30, respectively. The refractive error was plano-0.25x180 (6/6) right eye and -1.25-0.25x170 (6/6) left eye, tested by subjective refraction. The axial length (IOLMaster Ocular Biometer, Zeiss) was 22.55 mm and 22.90 mm in the right and left eyes, respectively. The intraocular pressure was normal, and external and internal ocular health examinations were unremarkable. There was no contraindication for overnight orthokeratology lens wear. Different myopia control measures were explained to the parents, and overnight orthokeratology was chosen.

The orthokeratology fitting session was scheduled in September of 2019; subjective refractive correction was -0.25-0.25x180 (6/6$^+$) right eye and -1.50-0.50x175 (6/6$^+$) left eye. Measurements of the horizontal visible iris diameter, keratometric reading, and e-value of the flattest meridian by corneal topography (Medmont E-300) are shown in Table 1. The corneal apex of each eye was found to be decentered down and temporal.

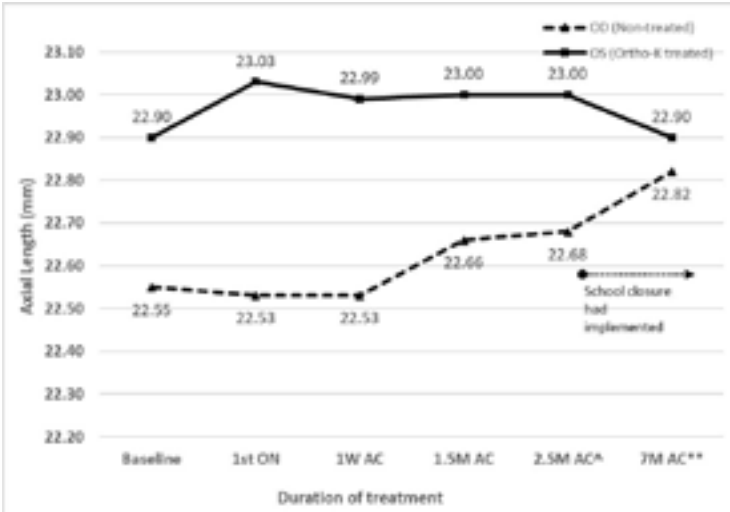

Figure 2. *Axial length changes for patient 1*

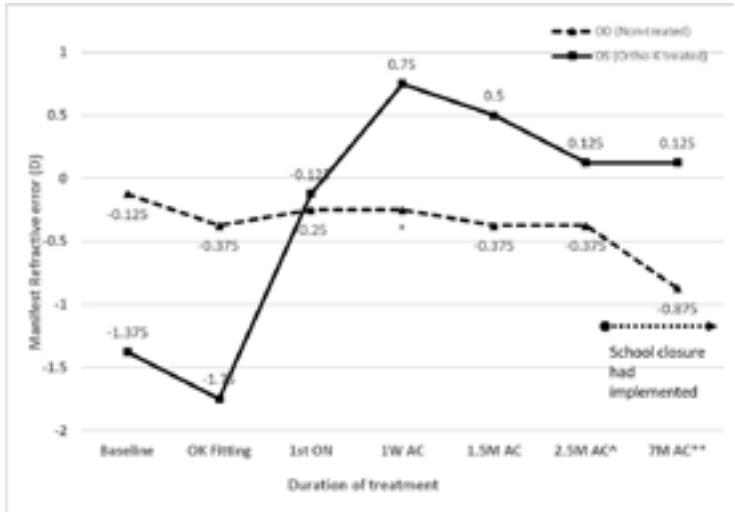

Figure 3. *Manifest refractive error changes for patient 1*

The patient was fitted with a Paragon CRT lens (Paragon Vision Sciences) in the left eye only. After instruction on lens insertion, removal, and lens handling and care, trial lens CRT 7.8-550-33 (base curve-return zone depth-landing zone angle) was dispensed. She returned to the clinic the next morning after 8 hours of overnight lens wear. Left eye unaided visual acuity was $6/7.6^{+2}$, and manifest refractive correction was +0.25-0.75x010 ($6/6^{-}$). Follow-up was scheduled for a week later, and slit lamp biomicroscopy revealed good corneal integrity. Subtractive topographical plots showed a bull's-eye pattern but excessive flattening of the cornea (Figure 1a). Left eye unaided visual acuity was $6/9.5^{+3}$, and the manifest refractive correction was +1.00-0.50x130 ($6/6^{-1}$). The patient also reported that her near vision was not as clear in the left eye. Therefore, another CRT lens (7.7-550-33) was ordered. She was advised to keep wearing the orthokeratology lens on alternate nights while waiting for the new lens. At the follow-up visit a few weeks later, she had worn the new lens for 3 consecutive nights. Unaided visual acuity was $6/6^{-2}$ and 6/6 in the right and left eyes, respectively. The manifest refractive correction was -0.25-0.25x010 ($6/6^{+2}$) and +0.50 (6/6). Axial length was 22.66 mm and 23.00 mm in the right and left eyes, respectively. External ocular health was unremarkable. She was instructed to wear the orthokeratology lens nightly. At a follow-up appointment scheduled a month later in January of 2020, the clinical findings were similar to the last visit; a follow-up was planned a month later and then every three months. However, to avoid crowded places during the local outbreak of COVID-19, the patient missed the February follow-up. She returned in June, which was almost 5 months from the last visit, but she consistently wore the overnight lens. Unaided visual acuity was $6/9.6^{-2}$ and 6/6 in the right and left eyes, respectively. Manifest refractive correction was -0.75-0.25x180 (6/6) and +0.25-0.25x090 ($6/6^{+}$). Axial length was 22.82 mm and 22.90 mm. External ocular health was unremarkable. As there was remarkable increase in axial length and myopia in right eye, orthokeratology treatment was also advised for the right eye. The measurements of axial length and manifest refractive error (spherical equivalent) from September 2019 to June 2020 are presented in Figure 2 and Figure 3, respectively.

Case 2

In April 2018, a 13-year-old girl was brought to a private practitioner for an eye examination. The subjective refractive correction was +0.25-0.25x165 (6/6) and -1.75-0.25x180 (6/6) in the right and left eyes, respectively. The intraocular pressure of each eye was normal, and external and internal ocular health examinations were unremarkable. There was no contraindication for overnight orthokeratology lens wear. Orthokeratology for the left eye was suggested, and fitting was done a week later. Measurements of the keratometric readings and e-value by corneal topography (Keratron Scout) are shown in Table 1.

The patient was fitted with E-lens (E&E Optics) in the left eye only. After instruction on lens insertion, removal, and lens care, the E-lens 43.00/10.6/-2.00/Boston XO (Flat K/lens diameter/target power/lens material) was dispensed. She returned to the clinic in the morning after overnight wear for two nights. Left eye unaided visual acuity was 6/6, and the manifest refractive correction was plano-0.25x180 (6/6). No corneal staining was found. At the follow-up visit one month later, the unaided visual acuity of each eye was 6/6, and the manifest refractive correction of the

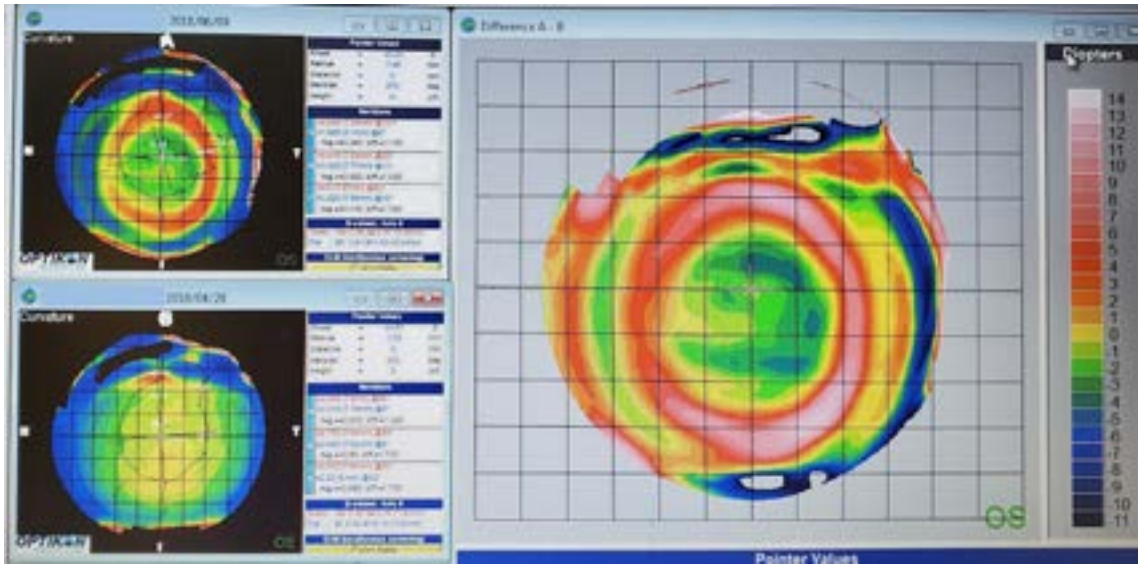

Figure 4. *Topography after one month of wear for patient 2*

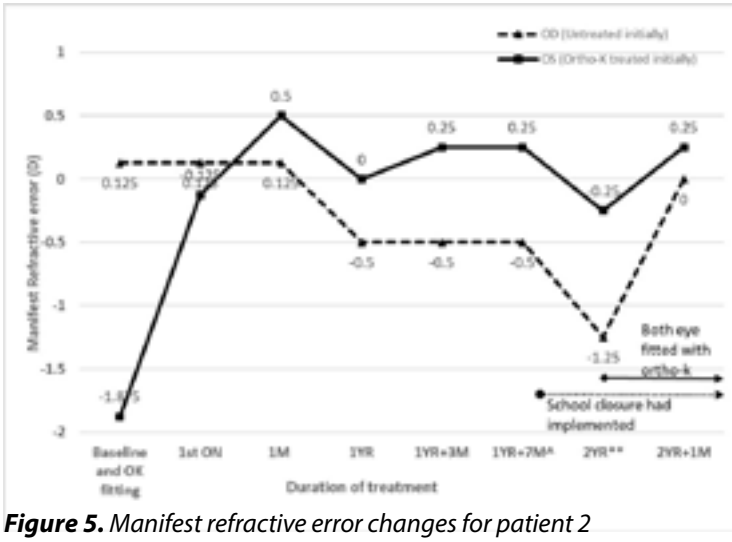

Figure 5. *Manifest refractive error changes for patient 2*

left eye was +0.50 D (6/6). Subtractive topographical plots showed a bull's-eye pattern (Figure 4). External ocular health was unremarkable. She was advised to wear the lens on alternate nights and to have regular follow-ups every three months. The manifest refractive correction was -0.50 D (6/6) and plano (6/6) in the right and left eyes, respectively, at the follow-up visit in May 2019. No lens use was advised for the right eye at that visit. The manifest refractive correction was -0.50 D (6/6) and +0.25 D (6/6) for the right and left eyes, respectively, at the follow-up visits in September 2019 and January 2020. At the follow-up visit in May 2020, the parents shared their concern about myopic progression, as the girl had spent more than ten hours per day on the computer and smart phone for distance learning since the school closure in early February 2020. Unaided visual acuity was 6/15 and 6/7.5^{+} in the right and left eyes, respectively. The manifest refractive correction was -1.00-0.50x170 (6/6) and -0.25 D (6/6). External ocular health was unremarkable. Orthokeratology fitting was now done for both eyes. Her right eye and left eye were fitted with E-lens 43.00/10.6/-1.50/Boston XO and E-lens 43.00/10.6/-2.00/Boston XO, respectively. Her unaided visual acuity was 6/6 in each eye, the manifest refractive correction was plano (6/6) and +0.25 D (6/6), and the external ocular health was unremarkable. She was advised to have regular follow-ups every three months. The measurements of manifest refractive correction (spherical equivalent) from April 2018 to June 2020 are presented in Figure 5.

Discussion

We presented two cases of monocular orthokeratology showing rapid myopic progression in the non-treated eye during the class suspension period (starting from late January 2020).

In the first case, referring to Figure 3, the refractive correction of the right eye (non-treated eye) was relatively stable before the class suspension. The right eye (non-treated eye) showed remarkable myopic progression and axial length elongation, while the left eye (orthokeratology treated eye) showed no change in refractive error and axial length from January 2020 to June 2020 (almost 5 months). The change in myopia (spherical equivalent) was -0.50 D in the right eye (non-treated eye), but there was no change in the left eye (orthokeratology treated eye). The change in axial length was 0.14 mm in the right eye (non-treated eye) and -0.1 mm in the left eye (orthokeratology treated eye).

In the second case, referring to Figure 5, the refractive correction of each eye was stable before the class suspension, but myopic progression was shown in both eyes during class suspension (January 2020 to May 2020, 4 months). The change in myopia (spherical equivalent) was -0.75 D and -0.50 D in the right eye (non-treated eye) and the left eye (orthokeratology treated eye), respectively. The non-treated eye showed -0.25 D more myopic change than the treated eye in the 4-month interval.

Several studies report that orthokeratology decreases the interocular difference in axial length in anisometropia.[10-14] A retrospective study by Long et al.[10] showed that orthokeratology slowed progression of axial elongation in the more myopic eye in both unilateral myopic anisometropes and bilateral myopic anisometropes, compared with anisometropes treated with spectacles, resulting in less difference in axial length between the eyes after one year of orthokeratology treatment. Another retrospective study by Fu et al.[11] showed that a reduction of interocular difference in axial length occurred in unilateral myopic anisometropes only. The two cases reported were unilateral myopes fitted with orthokeratology in one eye who showed reduction in the interocular difference in axial length, similar to the studies discussed here. However, both of the cases had started the orthokeratology treatment prior to class suspension (February 2020); the myopic progression in the contralateral untreated eye was faster after class suspension was implemented. Tsai et al.[12] found that the axial length difference between eyes in a low-anisometropia group (less than -2.50 D between eyes) decreased from 0.6 mm to 0.4 mm in 2 years. In case 1, the axial length difference between the eyes decreased from 0.32 mm to 0.08 mm in 5 months; the rate of change was much faster than demonstrated in the study.[12] We suggest that the remarkable reduction of axial length difference between the eyes was not only due to the retardation of axial elongation of the more myopic eye by orthokeratology, but also due to the more rapid myopic progression in the contralateral eye.

The rate of progression of the spherical equivalent refraction of myopic children in Hong Kong is about -0.033 D to -0.043 D per month, while the rate of progression of the axial length is about 0.015 mm to 0.02 mm per month.[15,16] The spherical equivalent refraction of the untreated eye changed -0.11 D/month and -0.18 D/month in the first and second cases, respectively, from January 2020. The axial length of the untreated eye increased 0.031 mm/month in the first case from January 2020. The myopia in terms of spherical equivalent refraction and the axial length of the untreated eyes escalated 2 – 5 times and 2 times, respectively, compared to the general progression in age-matched children in Hong Kong during class suspension.

We suggest that a change of lifestyle is associated with the rapid myopic progression in these cases. To suppress the local transmission of COVID-19, class suspension in school and tutorial centers was implemented from late January to early June 2020. Schoolchildren in Hong Kong stopped attending class for at least 4 months. To maintain teaching and learning, many schools and tutorial centers have been adopting online teaching during this period. Schoolchildren spent significant time attending online lessons, approximately 6 hours per day,[17] plus doing online assignments and playing games via different kinds of electronic devices, such as computers, tablets, or smart phones, leading to a remarkable increase in screen time. A meta-analysis found that more time spent on near-work activities was associated with higher odds of myopia and that the odds of myopia increased by 2% for every one diopter-hour more of near work per week.[5] The Beijing Childhood Eye Study,[7] a population-based cross-sectional study of 15,066 children aged seven to eighteen years, showed that myopia was associated with longer daily studying duration. A recent longitudinal population-based study found a significantly lower prevalence of myopia in Taiwan children aged 9-11 years with near-work distance >30 cm, discontinuing near work every 30 minutes, and more time outdoors during recess. The authors suggested that proper near work behaviors could be helpful in myopia prevention.[8] Besides changing the learning mode, school closure may also hinder the children being able to spend time outdoors, as children often engaged in outdoor activities during recess. Moreover, parents avoided allowing the children to go outside, since people preferred staying at home as much as possible during the COVID-19 pandemic,[4] further reducing their time spent outdoors. A meta-analysis found a significant negative association between time spent outdoors and the prevalence of myopia; the odds of myopia decreased by 2% for every one hour more spent outdoors per week.[6] A school-based intervention study also showed a significantly lower incidence rate of myopia and a lower rate of myopia progression in children spending their time on outdoor activities during recess.[9] We believe that the change of learning mode, leading to intensive near work, and

the reduction of outdoor activity are associated with the rapid myopia progression in the non-treated eye of these two cases during the COVID-19 pandemic. These case reports do not only reflect the important role of environmental risk factors on myopia, but they also raise awareness of the importance of myopia control, especially during lockdown. The number of confirmed cases of COVID-19 in Hong Kong rose again in early July 2020, and school closure was implemented again; school closures have been implemented in over 100 countries due to the pandemic.[18] Eye care practitioners should promote visual hygiene to schoolchildren and their parents and provide interventions to slow myopia progression as promptly as possible to better ensure the highest quality care.

Conclusion

Myopia progressed faster during lockdown in the presented cases. Visual hygiene and myopia control intervention should be publicized and implemented as promptly as possible.

Acknowledgements

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