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Analysis of the Reasons for the Discontinuation of Orthokeratology Lens Use: A 4-Year Retrospective Study

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Purpose: Although orthokeratology has a positive effect on myopia control, some patients discontinue orthokeratology lens use. This study analyzed the data of all patients who had been fitted with an orthokeratology lens in the past 4 years and the reasons for discontinued lens use, with the aim of improving the prevention and control of myopia.

Methods: This retrospective study analyzed the data of patients, aged 8 to 18 years, fitted with orthokeratology lenses from 2017 to 2020. The ametropic spherical lens powers ranged from −6.00 D to −0.75 D, and the cylindrical lens powers were all more than −1.50 D. The reasons for discontinuation of lens wear were analyzed and compared. The period of lens wear (median [range]) was 24 (13.5–34.5) months.

Results: A total of 2,499 patients' files were retrieved. The duration of lens wear was 24 (13.5–34.5) months. A total of 50 patients discontinued lens use, including 25 patients (50.0%) who could not adhere to lens use for various reasons, nine patients (18.0%) with a short sleep time, eight patients (16.0%) with economic difficulties, and five patients (10.0%) who experienced a poor effect after wearing the lenses. Corneal infiltrates affected lens use in three patients (6.0%). In addition, 30 patients underwent surgical correction when they reached adulthood.

Conclusion: Although orthokeratology lenses are effective and safe, there are still a small number of patients who discontinued lens use for various reasons. Adherence and precautions should be emphasized during the process.

Key Words: Myopia control—Orthokeratology—Contact lens—Side effects.

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The prevalence of myopia has been increasing annually, with an accelerating trend, especially after the coronavirus disease 2019 (COVID-19) epidemic. Because of significantly decreased time spent outdoors and increased screen time at home, the prevalence of myopia has increased.[1,2] According to the results of the survey conducted by the Ministry of Education in mainland China in June 2020, compared with that at the end of 2019, the prevalence of myopia in primary and secondary school students increased by 11.7% in half a year; the prevalence of myopia in primary school students increased by 15.2%.[3] Myopia is a leading factor of vision loss, so the prevention and control of myopia, especially in teenagers, have become a major global public health problem.[4] In China, a recent epidemiological survey on school students showed that the prevalence rate of myopia was as high as 59.35%.[5] Therefore, in mainland China, the issue of myopia prevention and control is serious and has attracted the attention of government officials at all levels, including the national strategic level.[6]

For the prevention and control of myopia in adolescents, orthokeratology (OK) therapy has attracted increasing attention from ophthalmologists and myopia patients because of its good corrective effects and ability to control the progression of myopia.[7,8] Orthokeratology lenses have a much flatter central base curve than the secondary curve, thus creating positive pressure that pushes against the central cornea and negative pressure that pulls against the midperipheral cornea, flattening the central cornea by thinning the epithelial layer to change the refractive power and correct myopic ametropia.[9] Meanwhile, light would be refracted simultaneously onto the midperipheral retina and macula through plateau-shaped cornea, leaving the peripheral retina with relative myopic defocus. This peripheral myopia defocus is hypothesized to stabilize eye growth and reduce myopia progression.[8,10] After more than 30 years of clinical application, the effectiveness for myopia control of the OK lens has been confirmed.[11] Because the lenses are worn at night and preserve good vision during the day, OK therapy has been recognized by many patients and their families. However, in clinical work, the authors found that some patients who wore OK lenses for various reasons ultimately chose to discontinue wearing the lenses and changed to other methods of visual correction. Therefore, this study analyzed the data of patients who had been fitted for OK lenses in the past 4 years and the specific reasons for the discontinuation of OK therapy to improve patient services and ensure myopia prevention and control.

METHODS

Subjects

In this retrospective study, data were retrieved from the files of 2,799 patients who had demonstrated adaption to OK lens wear between January 2017 and December 2020 and were treated at

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Hanyang Aier Eye Hospital (Luoqi Road, 12# Hanyang District, Wuhan 430050, Hubei Province, China). The inclusion criteria included the following: age at commencement of ortho-k treatment 8 to 18 years old, refractive error between −6.00 D and −0.75 D, refractive astigmatism of −1.50 D or more, and best-corrected visual acuity (BCVA) better than 0.00 logMAR. This study was approved by the ethics committee of Aier Eye Hospital of Wuhan University (HYEYE2020IRB01).

Exclusion criteria included baseline age greater than 18 years, ortho-k not for the purpose of myopia control, switched to another hospital for lens replacement, and ocular and health issues (such as retinopathy, premature birth, and history of genetic diseases) that may affect myopia progression.

Clinical Pathway

All patients had received a comprehensive examination to assess uncorrected visual acuity (UCVA), BCVA, and extraocular movements. The pre-ortho-k examination also included corneal light reflection tests, intraocular pressure measurements, slitlamp examination, fluorescein staining, corneal endothelial cell density analysis, axial length measurements, mydriatic fundus examination, corneal topography analysis, and tear meniscus height measurements. According to the corneal curvature, topography data, diopters (D), and corneal diameter, trial lenses were selected. After the tear film stabilized (approximately 20 min), adaptation assessments (dynamic assessment and static assessment) were performed. If the effect of the trial lens was inappropriate, such as poor lens center positioning, insufficient contact area with the cornea, and so on, the lenses were fine adjustment according to the parameters of the trial lens to improve the fit. The reasons for discontinuation during the adaptation period were mostly that the patients could not tolerate contact lens discomfort and the parents were still on the fence. After commencement of lens wear, 1 day, 1 week, 1 month, and every 3 months, thereafter, regular follow-up examinations were conducted. Follow-up examinations included history taking; UCVA; BCVA; intraocular pressure measurements; fundus examination; slitlamp examination of the cornea, conjunctiva, and tear film; lens integrity; and corneal topography assessment. Corneal endothelium and axial lengths were examined every 6 months.

Statistical Analysis

The number of patients who discontinued lens use during the 4-year study period was determined from patients who satisfied the inclusion criteria, and the reasons were analyzed. The Fisher exact test was used to compare the reasons for discontinuation in sex and age groups. Cox regression was used to analyze the factors affecting the discontinuation. Statistical significance was defined as a P value<0.05. All statistical analyses were performed using SPSS software version 23.0 (IBM Corporation, Chicago, IL).

RESULTS

A total of 2,499 data were retrieved from patients' files. In the baseline, the median age (range) was 11(10–13) years, and the average lens power was −3.14 D±−1.38 D. The median duration of lens wear was 24 (13.5–34.5) months. Thirty patients, aged 18 (18–20) years, had completed the myopia control treatment and had switched to refractive surgery to correct their refraction.

A total of 50 patients (2%) discontinued OK therapy, including 25 females and 25 males, aged 10 to 17 years, with a median age of 13.5±1.73 years when they discontinued OK therapy (Table 1). Pre-ortho-k myopia who could not adhere to lens use for different reasons was an average of −2.10 D±−1.06 D, whereas that of other patients who discontinued lens use was −3.10 D±−1.35 D; the difference was statistically significant (t=4.08, $P<0.001$).

There was no significant difference in the reasons for discontinuation between the sexes ($P=0.79$).

The reasons for lens discontinuation were compared by the age group. In the younger age group (<14 years old), the primary cause was inability to lens use for various reasons (60.0%). In the older age group (≥14 years old), "inability to lens use for various reasons" was also the primary cause (40.0%). There were no significant differences among the various causes within different age groups ($P>0.05$), as shown in Table 2. Further comparison revealed that although more people discontinued lens use in the older age group than in the younger age group because of a short sleep time, the results were not statistically significant; there were no significant differences in corneal infiltrates, economic factors, or poor control.

Correlation analysis of the 50 patients who discontinued lens use with the duration time of wearing lens was performed. The results showed that with the increase in the duration of wearing lenses, the number of patients who discontinued lens use decreased, and the results showed a significant negative correlation (rs=−0.88, $P<0.05$) (Fig. 1).

Multivariate Cox regression model was constructed by incorporating sex, baseline age, baseline myopia, and OK brand variables. The results showed that refractive errors had a significant effect on the discontinuation (Hazard Ratio=2.28, 95% Confidence Interval 1.23–4.21, $P=0.008$). The influence of other variables on the discontinuation was not statistically significant ($P>0.05$) (Fig. 2).

DISCUSSION AND CONCLUSION

In the process of OK lens fitting, a few patients discontinued the lens use during the adaptation period. The reasons were mostly that the patients could not tolerate contact lens discomfort and the parents were still on the fence. These patients were not included in our analysis. A total of 2,499 patients had demonstrated adaption

TABLE 1. *Demographics of the Observational Study Subjects*

Variable	n(%)
No. of patients	50
Sex	
Male	25(50.0)
Female	25(50.0)
Age	
<14 years	25(50.0)
≥14 years	25(50.0)
[a]Unable to adhere	25(50.0)
Corneal infiltrates	3(6.0)
Economic factors	8(16.0)
Short sleep time	9(18.0)
[b]Poor results	5(10.0)

[a]Could not adhere to lens use for different reasons, such as foreign-body feelings.

[b]The axial elongation increased by more than 0.2 mm in half a year after OK treatment.

TABLE 2. *Various Reasons for Discontinuation by the Age Group [n(%)]*

Age	Unable to Adhere	Corneal Infiltrates	Economic Factors	Short Sleep Time	Poor Results	Fisher	*P*
<14	15(60.0)	2(8.0)	4(16.0)	1(4.0)	3(12.0)	7.15	0.11
≥14	10(40.0)	1(4.0)	4(16.0)	8(32.0)	2(8.0)		

to OK lens wear in the data statistics for 4 consecutive years. The discontinuation rate for OK was 2%. The literature reports that 10%–50% of wearers dropout of soft contact lens wear within 3 years of commencement, the most common reason cited being contact lens discomfort (CLD),[12] so the discontinuation rate for OK lens is significantly lower than that for soft corneal contact lens, and the reasons are different. In addition, 30 patients discontinued OK lens use because of reaching adulthood, accounting for 1% of 2,499 patients, and these patients have good myopia control by wearing OK. Therefore, they chose to undergo refractive surgery after stop wearing for more than 3 months on reaching adulthood. An increasing number of patients choose OK and excimer surgery, which highlight patients' desires to stop progression and control and treat myopia.

In this study, the proportion of patients who could not adhere to lens use was relatively high, and this was the most common reason for discontinuation. There are different reasons for nonadherence. It has been reported in the literature that OK lenses have a certain impact on high-order aberrations.[13,14] Some patients experience problems such as glare or ghosting in dim light after wearing the lenses. However, these issues gradually improve 1 to 4 weeks. In this study, none of the patients reported nonadherence to lens use because of affected visual quality, and there was no difference between the sexes. Interestingly, the myopia of patients who failed to adhere was relatively low, mostly more than -3.00 D, with an average of −2.10 D±−1.06 D, whereas that of other patients who discontinued lens use was −3.10 D±−1.35 D. In addition, the regression model also showed that the higher the baseline myopia was, the fewer patients discontinued lens use. This may be because patients with high myopia have a stronger desire to control the growth of myopia. The patients and their guardians were further asked whether the patient wore the lenses regularly in the early stage. With the extension of lens wear time, the patients found that even if they did not wear the lenses all the time, they still had clear vision during the day; therefore, they gradually stopped wearing the lenses. After a period, the corrective effect of the lenses decreased, and the patients began to use the lenses again. Consequently, these patients experienced discomfort, such as foreign-body feelings. After several attempts at lens use, the patients were unwilling to wear them. The results of this study also indicate that the number of patients discontinuing lens use decreases significantly with the extension of use time. Therefore, it is necessary to explain to patients and guardians that adhering to use is important to ensure a corrective effect and myopia control effect.

Microbial keratitis (MK) remains the most serious and sight-threatening complication of OK. Some studies[15] have reported no association with the baseline level of myopia, sex, or the specific brand of OK lenses. In a retrospective analysis of a large sample, the incidence of corneal infection was approximately 7.7 per 10,000 years of lens use.[16] In this study, corneal infiltrates occurred in three patients, with an incidence of 0.1%. The three patients were 10, 14, and 16 years old. Only one case was bacterial keratitis, which resulted in turbidity in the corneal stroma after treatment; the other two cases were simple corneal infiltrates. After anti-inflammatory treatment, the condition was controlled, but irreversible scars were left on the cornea. An analysis of these three patients found that wearing the lenses for too long (>10 hr/night) was a common risk factor. In addition, MK development is often closely related to the cognition and compliance of the lens

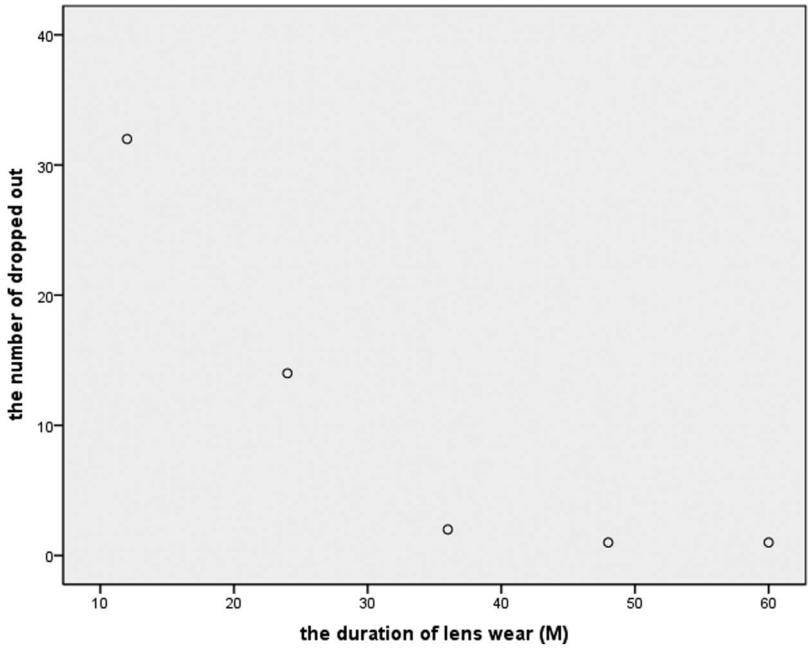

FIG. 1. Scatter diagram of the correlation between the number of patients who discontinued lens use and duration of wearing lenses (Spearman rank correlation, n=50 [excluded adults]): scatter plot of the number of patients who discontinued lens use and the duration of wearing lenses.

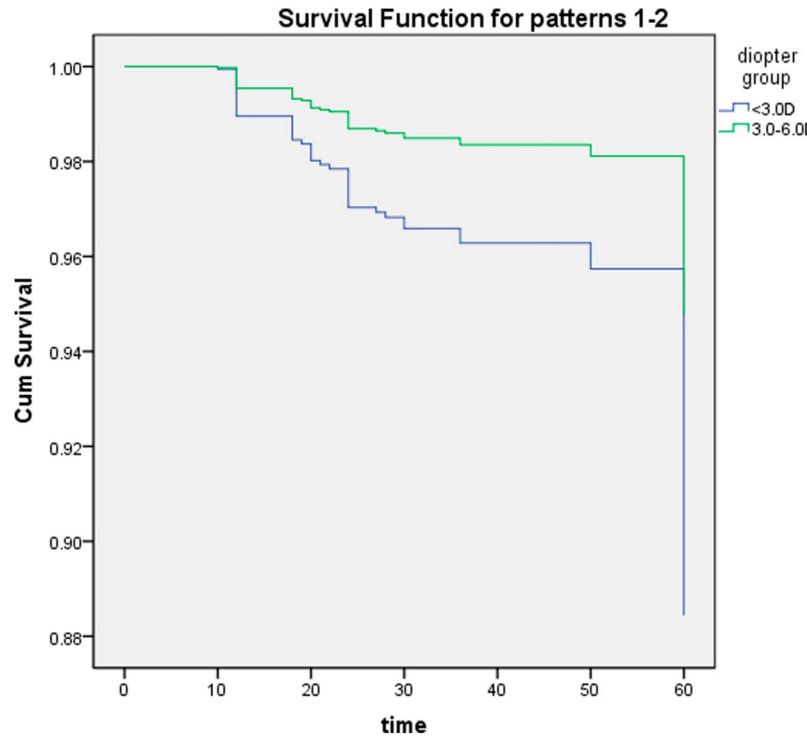

FIG. 2. Graphs of survival functions of patients by degree: the influence of different myopia on discontinued lens use: The discontinuation rate in the more –3.0 D group was higher than that in the –6.0 to –3.0 D group.

wearer. Patients should stop wearing immediately if they have pain or red eyes and go to the hospital for examination in time. The examinations included slitlamp examination of the cornea, conjunctiva, and tear film; lens adaptation assessment; and lens cleanliness, staining, protein deposit, and deformity assessment. These tests can help patients identify the cause of symptoms and treat them in time to avoid serious consequences. However, all three patients continued to wear the lenses, despite eye discomfort.

However, the positive effect of OK lenses on myopia control has been confirmed by many scholars.[17,18] In this study, five patients discontinued lens use because the effect of controlling the development of myopia was poor, accounting for 10% of the number of patients who discontinued lens use and 0.2% of all patients who were fitted for lenses during the 4-year study period. Although this proportion was relatively low, there are still many patients with myopia among China's very large population. For these patients, it is necessary to use other methods of treatment to control myopia.

The patients were divided into a younger age group and an older age group, with 14 years old as the cutoff. The study found that in the older age group, the number of patients who discontinued lens use because of a short sleep time was higher than that in the younger age group. However, the numbers were probably too small to be statistically significant; this indicated that the burden of school for the patients gradually increased with increasing age. For a long time, the heavy learning burden and high pressure of schoolwork on children and adolescents in China have been important factors in the occurrence and development of myopia. It has been reported that 73% of Chinese students do not achieve the recommended number of sleep hours every day.[3] The time spent on homework after class and time of continually viewing objects up close are too long. Sleep duration is closely related to the development of myopia.[19–21] Therefore, relevant departments should make adjustments at the institutional level by accelerating reforms from examination-oriented education to quality education; moreover, they should focus on the overall development of students' morality, intelligence, health, physical appearance, and labor and implement strategies to promote a "burden reduction."

Some lens wearers discontinue lens use because of economic problems. In addition, some patients' families change practices because of price factors. Orthokeratology lenses need to be replaced regularly according to the patient's situation and lens replacement once every 12 to 18 months according to the standard[22] results in a large expenditure for the patient and his or her family. Therefore, more enterprises should be encouraged to contribute to the development of OK lenses to reduce costs, reduce economic burdens on myopia patients, and promote collaborative participation in myopia prevention and control.

Although OK lenses play a protective role in the development of myopia, compliance and schoolwork pressure that caused insufficient wear time and other reasons affect lens use and reduce the effectiveness of OK therapy. This study analyzed the factors that caused patients to discontinue lens use over 4 years, which is a short time. If the study period is extended, more reasons for discontinuing lens use may be discovered.

To strengthen public awareness of myopia prevention and control strategies, students, parents, and fitting institutions should work together, and society should pay attention to and participate in myopia prevention and control.

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