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Contents

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Contents

Contents

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ORIGINAL ARTICLE

Case Control Study

Novel application of multispectral refraction topography in the observation of myopic control effect by orthokeratology lens in adolescents

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Author contributions: Ni NJ performed data analysis and wrote the manuscript; Wu XM designed the study and participated in data collection and served as the scientific advisor; Ma FY corrected the manuscript; Liu X, Zhang HY, Yu YF, Guo MC, and Zhu SY participated in data collection.

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Abstract

BACKGROUND

Myopia, as one of the common ocular diseases, often occurs in adolescence. In addition to the harm from itself, it may also lead to serious complications. Thus, prevention and control of myopia are attracting more and more attention. Previous research revealed that single-focal glasses and orthokeratology lenses (OK lenses) played an important part in slowing down myopia and preventing high myopia.

AIM

To compare the clinical effects of OK lenses and frame glasses against the increase of diopter in adolescent myopia and further explore the mechanism of the OK lens.

METHODS

Changes in diopter and axial length were collected among 70 adolescent myopia patients (124 eyes) wearing OK lenses for 1 year (group A) and 59 adolescent myopia patients (113 eyes) wearing frame glasses (group B). Refractive states of their retina were inspected through multispectral refraction topography. The obtained hyperopic defocus was analyzed for the mechanism of OK lenses on slowing down the increase of myopic diopter by delaying the increase of ocular axis length and reducing the near hyperopia defocus.

RESULTS

Teenagers in groups A and B were divided into low myopia (0D - -3.00 D) and moderate myopia (-3.25D - -6.00 D), without statistical differences among gender and age. After 1-year treatment, the increase of diopter and axis length and changes of retinal hyperopic defocus amount of group A were significantly less than those of group B. According to the multiple linear analysis, the retinal defocus in the upper, lower, nasal, and temporal directions had almost the same effect on the total defocus. The amount of peripheral retinal defocus (15°-53°) in group A was significantly lower than that in group B.

CONCLUSION

Multispectral refraction topography is progressive and instructive in clinical prevention and control of myopia.

Key Words: Multispectral refraction topography; Myopia; Retinal hyperopic defocus; Eye axis; Diopter; Orthokeratology lens; Frame glasses

Core Tip: Nowadays, against the increasingly serious myopia of juveniles, myopia prevention and control methods have attracted more attention. Among them, orthokeratology is highly valued because of its high efficiency and low side effects. In this study, the effect of orthokeratology on reducing diopter growth and eye axis length was proved again. Multispectral refraction topography was used to quantify the defocus state of the retina in the 53° field of view and present the defocus form using a visual topographic map. Thus more accurate and reliable evidence was provided on the association between the peripheral retina and myopia development.

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INTRODUCTION

Myopia has become a worldwide health problem. The myopia incidence in China is one of the highest globally and increases year by year[1]. Moreover, complications of high myopia, such as cataracts, glaucoma, retinal detachment, macular hemorrhage, and macular hole, occur frequently[2]. High myopia has become the leading cause of blindness and low vision in China. The World Health Organization has listed the prevention and control of myopia in the Global Blindness Prevention Plan[3].

Orthokeratology lenses (OK lenses), rigid contact lenses with a reverse geometric design, can reduce the refractive power and correct myopia by flattening the center of the cornea and steepening the periphery with the absorption of tear fluid during nights when eyelids are closed[4]. At present, the efficacy and safety of OK lenses in controlling adolescent myopia are generally recognized. Studies support it as a control of myopia, as it can reduce the hyperopic defocus in the periphery of the retina by changing diopter and even reverse the defocus of myopia, delaying the growth of the optic axis length[5-7].

The quantification of hyperopia defocus is the key to correcting myopia and preventing diopter increase in adolescents. The multi-spectral topographic map refers to a topographic map corresponding with values of the actual refractive power of each pixel, calculated and summarized through the in-depth development of computer algorithms. Different wavelengths of single-spectral light collect fundus images in multispectral refraction topography (MRT) sequentially. The lens-compensated multispectral images are analyzed for diopter values. Now Chinese self-developed multispectral fundus imaging system, combined with its honeycomb focusing system, can detect retinal refractive topography and quantify the retinal hyperopic defocus.

MATERIALS AND METHODS

Study design

This is the first study to apply MRT to research the inhibition of myopia by OK. By comparing the refractive power increases of patients, the myopia increase of patients treated with different methods can be quantified. Based on the speculation about the relationship between total retinal defocus values (TRDV) growth and peripheral retinal hyperopic defocus in recent years, corneal topographic measurements are used to quantify the patient's axial length growth and TRDV in order to verify the impact of TRDV.

Setting and participants

Measurements were performed on adolescent patients treated and regularly reviewed in our hospital's ophthalmology clinic from June 2019 to July 2020. Patients were divided into group A [70 adolescent myopia patients (124 eyes) wearing OK lenses for 1 year] and group B [59 myopia patients (113 eyes) wearing single-focal frame glasses]. The spherical lens diopter in groups A and B was within 0D - -6.00 D, and their corrected visual acuity of both eyes reached 1.0. Group A was composed of 45 males and 79 females, while group B included 51 males and 62 females (Table 1). The age ranges of both groups were 8-16 years (Table 2). Few statistically significant differences existed in genders and age composition ratio of both groups (gender composition ratio of patients with low myopia: P = 0.860; gender composition ratio of patients with moderate myopia: P = 0.030; age composition ratio between group A and B: P = 0.166; age composition ratio of patients with low myopia: P = 0.105; age composition ratio of patients with moderate myopia: P = 0.096).

Exclusion criteria: Patients whose corneal curvature was less than 40 D or more than 47 D, the corneal thickness was less than 480 um or greater than 600 um, original corneal curvature value was not restored after stopping treating for 1 mo, and whose parents had high heredity myopia, or who had irregular astigmatism, ophthalmological organic diseases, or became myopic due to trauma.

Myopia correction

OK lenses were provided by the same brand. All patients wore OK lens for 8-10 h overnight. Then their corneas were stained with fluorescein under the cobalt blue light of a slit lamp. No severe complications were shown in the cornea. The optical zone covered the pupil area; the motion range of the lens was 1-2 mm. The four arc zones were kept clear. Patients whose naked eye vision was 0.8-1.0 during the daytime were conducted follow-up inspections regularly. Patients of group B wore single focus frame glasses during the daytime.

Diopter measurement

In both eyes, 0.5% compound tropicamide was spotted every 5 min and five times in total for mydriasis. After complete anesthesia of ciliary muscle, the lowest diopter was measured through retinoscopy optometry combined with computer optometry and test strips to calculate the best-corrected visual acuity of the patients. Before their diopter changes (spherical lenses) were determined, patients of both groups received myopia correction for 1 year. Group A patients received mydriatic optometry 1 mo after stopping wearing OK lenses, and the apparent refraction was taken as a diopter.

Eye axis

The length of the eye axis was indicated with the average of three measurements with IOL-Master 500.

Multispectral topographic map

MRT was used to measure the retinal refractive values and the retinal hyperopic defocus of two groups after correction for 1 year. Pictures of the fundus were taken in

Table 1 Gender composition ratio of patients in groups A and B

Patients with	Group	Gender		Total	χ^2	*P* value[1]
		Male	Female			
Low myopia	Group A	16	25	41	0.031	0.860
	Group B	22	37	59		
Moderate myopia	Group A	29	54	83	4.718	0.030
	Group B	29	25	54		

[1]Statistic analysis was performed with the χ^2 test. Group A: Myopia patients wearing orthokeratology lenses for 1 year; Group B: Myopia patients wearing frame glasses.

Table 2 Age composition ratio of patients in groups A and B

Patients with	Group	Number of eyes	Mean value of ages[1]	*Z*	*P* value[2]
Low myopia	Group A	41	10.95 ± 1.84	-1.620	0.105
	Group B	59	10.27 ± 2.15		
Moderate myopia	Group A	83	11.95 ± 2.48	-1.665	0.096
	Group B	54	11.22 ± 2.16		

[1]mean value ± SD.
[2]Statistic analysis was performed with non-parametric Mann-Whitney test. Group A: Myopia patients wearing orthokeratology lenses for 1 year; Group B: Myopia patients wearing frame glasses.

a dark room with a normal pupil and a 53° field of view, from which overexposed or poor-quality ones were removed. Total defocus values, defocus values of 15°/30°/45° (RDV15°/30°/45°) around the macula, and defocus values of the upper, nasal, lower, and temporal quadrants were measured and recorded separately.

Statistical methods

All statistical analyses were performed using SPSS 23.0. Normal distribution of data was substantiated through Shapiro-Wilk Test (Univariate Analysis and Normality Test Using SAS, Stata, and SPSS, HM Park, 2015) on raw data. Statistically significant differences were determined by the Student's test (*t*-test). Statistically significant differences of datasets, which did not meet the assumptions of normality, were determined by the Mann-Whitney *U* test. The count data was represented by *n* (%). Statistically significant differences were determined by the χ^2 test. The correlation between the independent and dependent variables of the groups was analyzed using multiple linear regression analysis.

RESULTS

Wearing orthokeratology can prevent the increase of diopter

As mentioned above, the effects of OK lens and frame glasses treatment on myopia were evaluated among patients with low or moderate myopia. The gender composition of groups A and B with moderate myopia showed a small difference (P = 0.030), which is expected to be revised in future data collection.

Diopter increase was compared between groups A and B through non-parametric Mann-Whitney *U* test with non-normal distributed data; no significant difference existed between original diopter values of two groups (low myopia group: Z = -0.949, P = 0.343; moderate myopia group: Z = -1.758, P = 0.079). Among patients with low or moderate myopia, the growth rate of diopter showed significant differences between the two groups. The degree of myopia in patients wearing OK increased significantly, slower than that of patients wearing traditional frame glasses (low myopia group: Z = -7.103, P < 0.001; moderate myopia group: Z = -8.925, P < 0.001), indicating the effect of OK lenses on delaying myopia growth (Figure 1). In addition, no correlation between

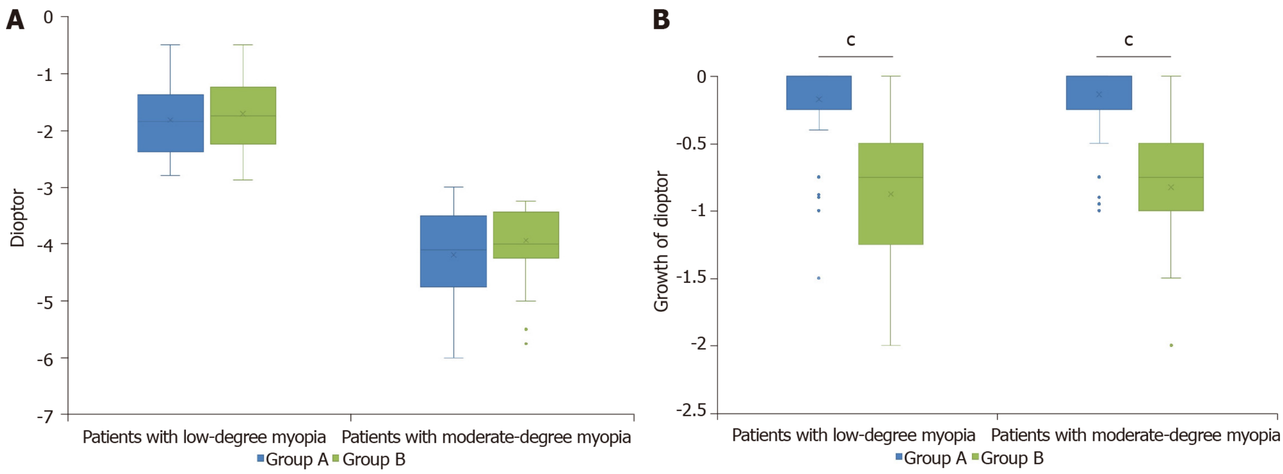


Figure 1 Original diopter values and diopter increase in the two groups. A: Original diopter values. Of patients with low-degree myopia: Group A: n = 41, mean ± standard deviation (SD) = -1.82 ± 0.71; Group B: n = 59, mean ± SD = -1.71 ± 0.64. Of patients with moderate-degree myopia: Group A: n = 83, mean ± SD = -4.19 ± 0.82; Group B: n = 54, mean ± SD = -3.94 ± 0.62; B: Growth of diopter. Of patients with low-degree myopia: Group A: mean ± SD = -0.17 ± 0.34; Group B: mean ± SD = -0.88 ± 0.39. Of patients with moderate-degree myopia: Group A: mean ± SD = -0.13 ± 0.22; Group B: mean ± SD = -0.82 ± 0.37. N was the number of eyes. Boxes indicate the 1st, 2nd, and 3rd quartile, whiskers represent the maximum and minimum value, and x indicates mean value. Statistically significant differences between patients treated differently were determined by a Mann-Whitney test ($^cP \leq 0.001$). Group A: Myopia patients wearing orthokeratology lenses for 1 year; Group B: Myopia patients wearing frame glasses.

original diopter values and increase of diopter was observed in both groups; the growth rate of myopia in patients with low and moderate degrees showed no significant differences (group A: Correlation coefficient = 0.032, P = 0.728, Z = -0.395, P = 0.693; group B: Correlation coefficient = -0.071, P = 0.455, Z = -0.522, P = 0.601).

Growth of eye axis and total defocus values can be controlled by wearing orthokeratology lenses

The axis length of groups A and B was measured separately before treatment (2019) and after wearing glasses for 1 year (2020) to identify the differences in axis changes caused by the two treatments. Low and moderate myopia patients were separately analyzed because of the length difference in the original eye axis. Despite no significant difference between the original length of eye axis of groups A and B (low myopia group: F = 0.004, P = 0.061, Figure 2A; moderate myopia group: F = 2.553, P = 0.253, Figure 2B), patients wearing OK showed significantly fewer changes of axis length than those wearing frame glasses (low myopia group: Z = -4.504, P < 0.001, Figure 2; moderate myopia group: Z = -6.625, P < 0.001, Figure 2). Correlation between the original axis length and axis growth was only proved in group A (group A: Correlation coefficient = -0.214, P = 0.040; group B: Correlation coefficient = -0.128, P = 0.200). Similarly, the effect of original defocus values on axis growth was also observed in group A (group A: Z = -2.178, P = 0.029; group B: Z = -1.198, P = 0.231). Surprisingly, the therapeutic effect of OK lenses was more significant in the moderate myopia group; eye axis length changed significantly slower in the group of moderate myopia [low myopia patients in group A: mean ± standard deviation (SD) = 0.25 ± 0.15 (mm); low myopia patients in group B: mean ± SD = 0.45 ± 0.19 (mm); moderate myopia patients in group A: mean ± SD = 0.18 ± 0.11 (mm); moderate myopia patients in group B: mean ± SD = 0.39 ± 0.14 (mm)].

In addition to the increase of diopter and eye axis, OK was also detected to impact the TRDV of these adolescent patients. TRDV was unaffected by original defocus value (group A: Correlation coefficient = -0.008, P = 0.934, Z = -1.439, P = 0.150; group B: Correlation coefficient = -0.010, P = 0.916, Z =-0.463, P = 0.644). Besides, TRDV had a tiny influence on increase of defocus values (group A: Correlation coefficient = 0.064, P = 0.483; group B: Correlation coefficient = -0.166, P = 0.080). In low and moderate myopia groups, TRDV of patients wearing OK lenses was significantly lower than that of patients wearing frame glasses (low myopia group: Z = -3.879, P < 0.001, Figure 3; moderate myopia group: Z = -3.821, P < 0.001, Figure 3). The significantly lower hyperopia defocus value in group A revealed the effect of OK lenses on delaying the eye axis growth and improving eye fundus environment, thereby the myopia growth prevention was verified again.

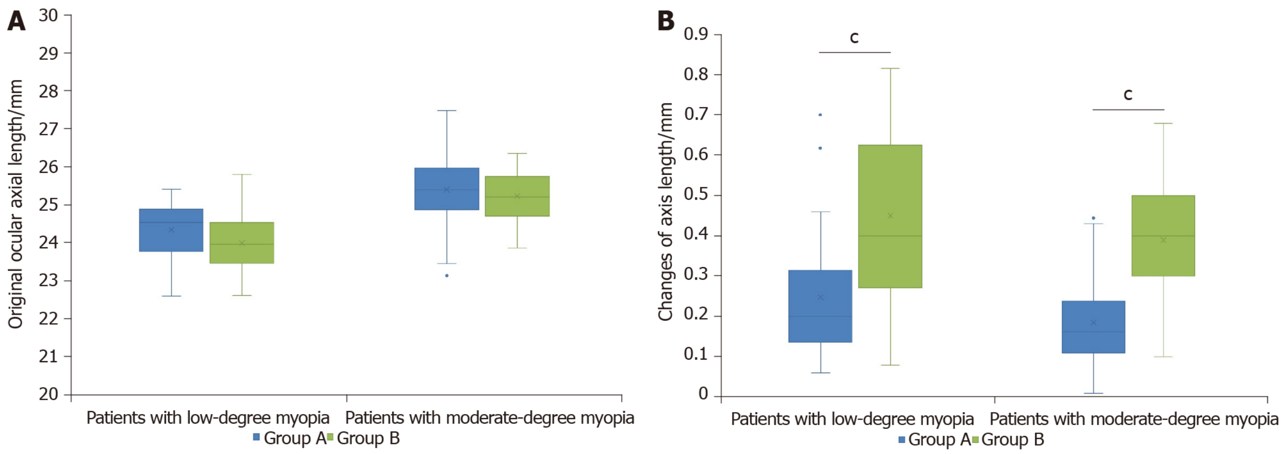


Figure 2 Axis length and its change after 1-year treatment in the groups. A: Original ocular axial length. No significant differences between two groups were verified by a Student test ($P \geq 0.05$). Of patients with low-degree myopia: Group A: n = 28, mean ± standard deviation (SD) = 24.33 ± 0.70 (mm); Group B: n = 54, mean ± SD = 24.01 ± 0.76 (mm). Of patients with moderate-degree myopia: Group A: n = 64, mean ± SD = 25.40 ± 0.90 (mm); Group B: n = 48, mean ± SD = 25.23 ± 0.65 (mm); B: Changes of axis length. Statistically significant differences between patients treated by different ways were determined by a Mann-Whitney test ($^cP \leq 0.001$). In low myopia groups: Group A: n = 28, mean ± SD = 0.25 ± 0.15 (mm); Group B: n = 54, mean ± SD = 0.45 ± 0.19 (mm). In moderate myopia groups: Group A: n = 64, mean ± SD = 0.18 ± 0.11 (mm); Group B: n = 48, mean ± SD = 0.39 ± 0.14 (mm). N was the number of eyes. Boxes indicate the 1st, 2nd, and 3rd quartile, whiskers represent the maximum and minimum value, and x indicates mean value. Group A: Myopia patients wearing orthokeratology lenses for 1 year; Group B: Myopia patients wearing frame glasses.

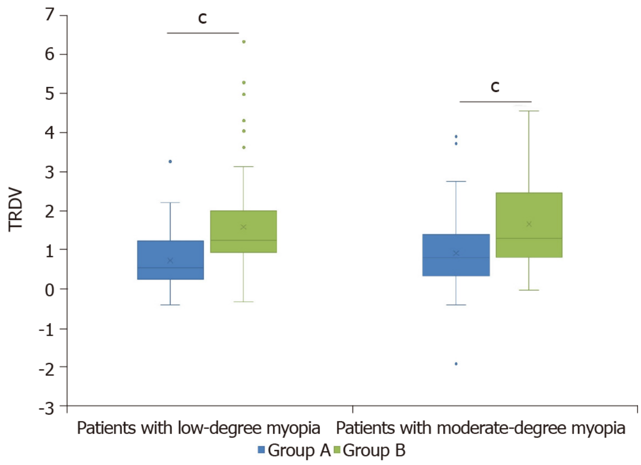


Figure 3 Comparison of total retinal defocus value in the two groups. Patients with low-degree myopia: Group A: n = 41, mean ± SD = 0.73 ± 0.75; Group B: n = 59, mean ± SD = 1.58 ± 1.31. Patients with moderate -degree myopia: Group A: n = 83, mean ± SD = 0.91 ± 0.89; Group B: n = 54, mean ± SD = 1.66 ± 1.15. Boxes indicate the 1st, 2nd, and 3rd quartile, respectively, whiskers represent the maximum and minimum value, and x indicate mean value. Statistically significant differences between patients treated differently were determined by a Mann-Whitney test ($^cP \leq 0.001$). TRDV: Total retinal defocus value; Group A: Myopia patients wearing orthokeratology lenses for 1 year; Group B: Myopia patients wearing frame glasses.

Orthokeratology lens reduces the peripheral retinal hyperopic defocus

With previous studies and evidence above, the OK lens delays the progression of myopia by inhibiting the posterior growth of the eye axis and reducing the defocus of the peripheral retinal hyperopia. Although this theory is generally recognized, details of the mechanism are still not clear. For the influence of OK on areas of the peripheral retina, relationships between defocus values of four sides of the peripheral retina and TRDV were analyzed through multiple linear regression.

Undoubtedly, peripheral hyperopic defocus (15°-53°) showed a strong correlation with TRDV (patients with low myopia in group A: Correlation coefficient = 0.944, P < 0.001; patients with low myopia in group B: Correlation coefficient = 0.787, P < 0.001; patients with moderate myopia in group A: Correlation coefficient = 0.809, P < 0.001; patients with moderate myopia in group B: Correlation coefficient = 0.745, P < 0.001; correlation test was performed through Spearman test with non-normally distributed data; Figure 4). Peripheral hyperopic defocus (15°-53°) were also affected by treatment with OK lens, significantly lower among patients in group A (patients with low

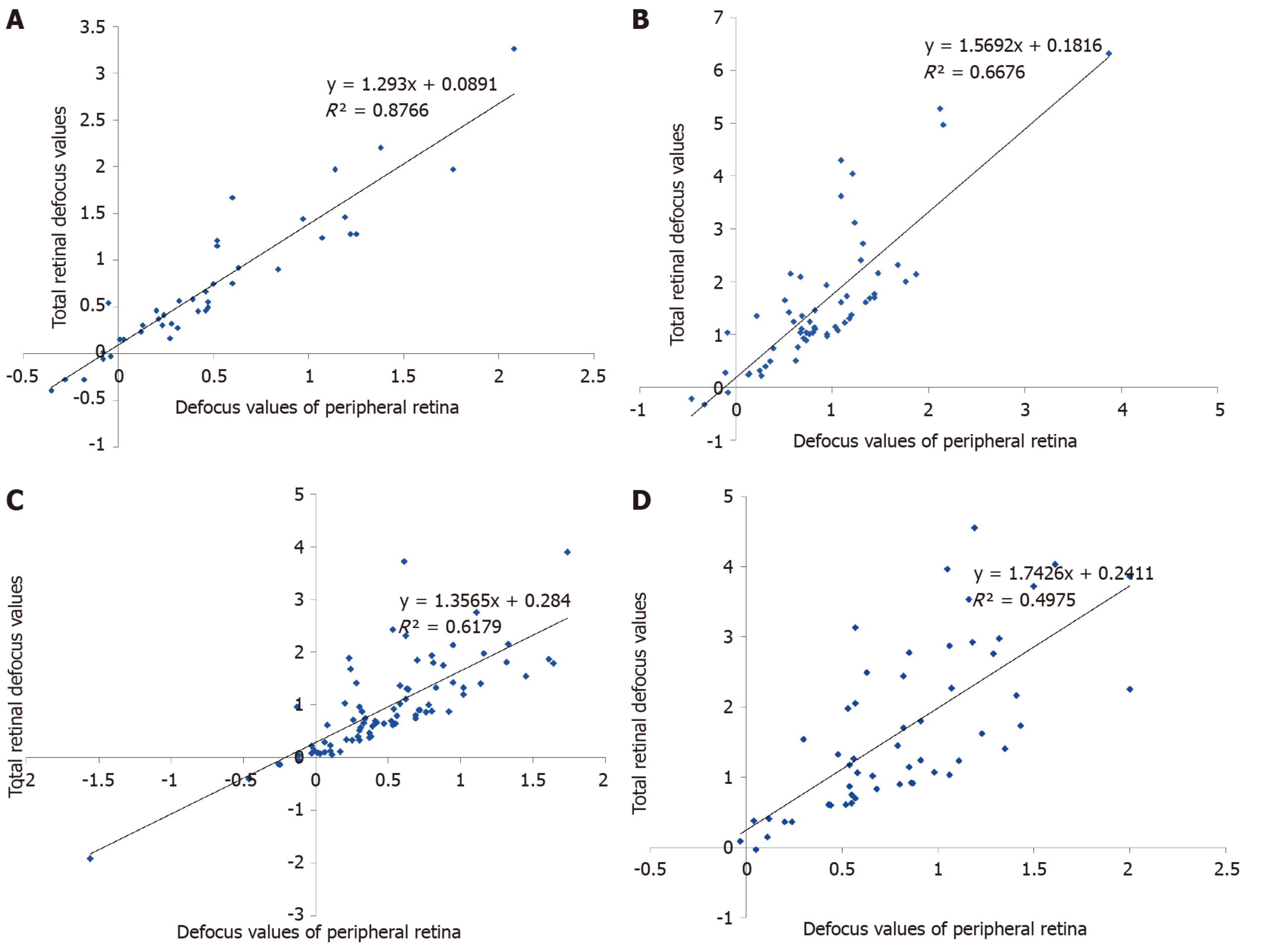


Figure 4 Scatterplots showing the relationship between total retinal defocus value and defocus values of peripheral retina. A: Showing retinal defocus values (RDVs) of patients with low-degree myopia in group A (R^2 = 0.877); B: Showing RDVs of patients with low-degree myopia in group B (R^2 = 0.668); C: Showing RDVs of patients with moderate-degree myopia in group A (R^2 = 0.618); D: Showing RDVs of patients with moderate-degree myopia in group B (R^2 = 0.498).

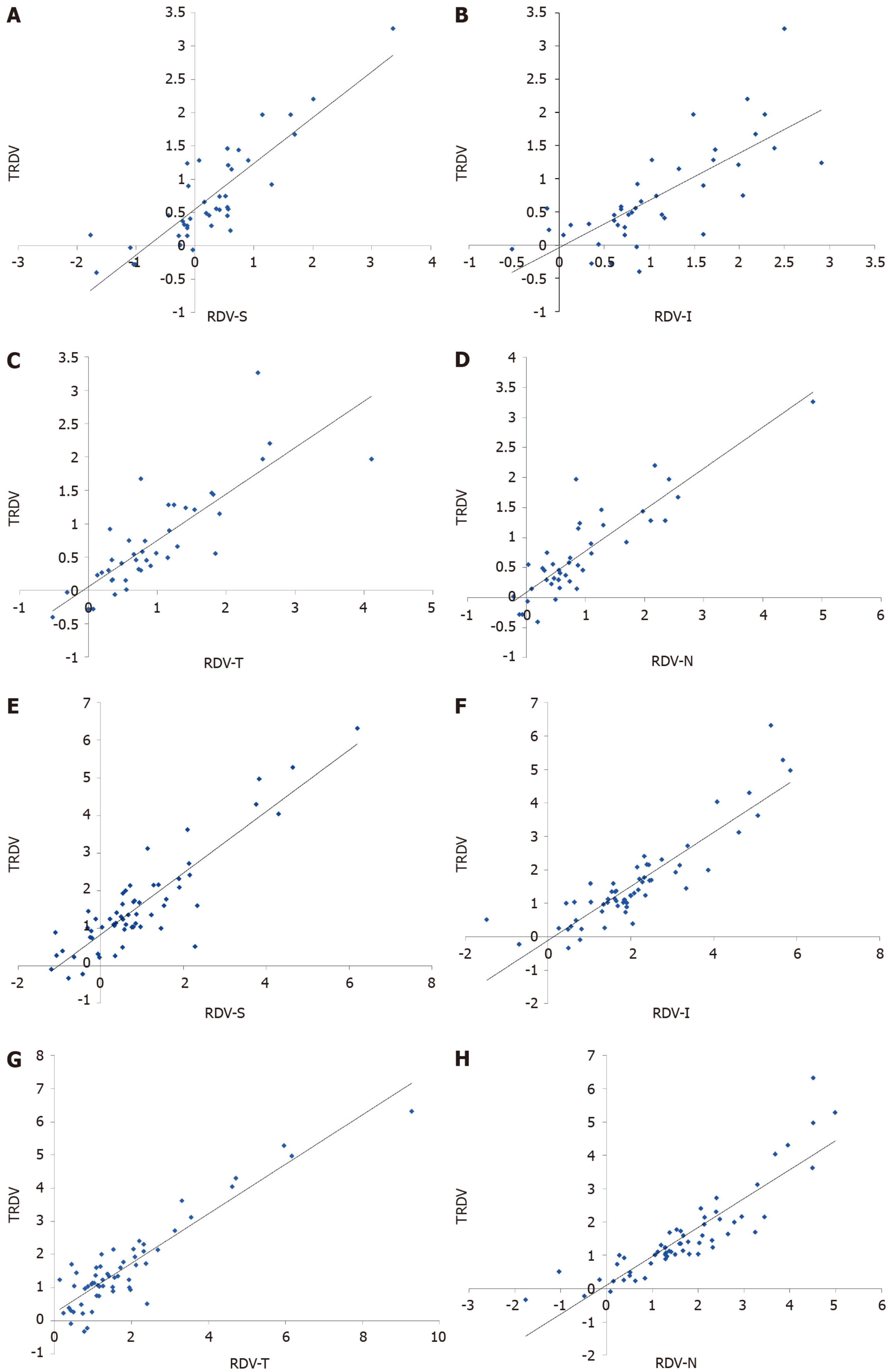
myopia: Z = -3.403, P < 0.001; patients with moderate myopia: Z = -3.905, P < 0.001; correlation test was performed through Mann-Whitney U test with non-normally distributed data).

In addition, a certain degree of linearity between TRDV and defocus of the upper, lower, nasal, and temporal sides of the retina (Figure 5) existed for patients with low or moderate myopia treated with OK lenses or single-focal frame glasses. According to the multiple linear regression equation obtained, the predicted TRDV had a good linear relationship with the actual measured value (Regression equation: patients with low myopia in group A: TRDV = 0.265 × N + 0.270 × T + 0.233 × I + 0.237 × S - 0.094, R^2 = 0.996; patients with low myopia in group B: TRDV = 0.241 × N + 0.250 × T + 0.256 × I + 0.252 × S - 0.043, R^2 = 0.998; patients with moderate myopia in group A: TRDV = 0.262 × N + 0.274 × T + 0.239 × I + 0.224 × S - 0.091, R^2 = 0.997; patients with moderate myopia in group B: TRDV = 0.248 × N + 0.250 × T + 0.249 × I + 0.255 × S - 0.046, R^2 = 0.999, Figure 6).

To sum up, OK lenses control myopia development, delaying the growth rate of diopter and axis length through improving peripheral retinal defocus. Changes of TRDV appear equally on the four sides peripheral retina.

DISCUSSION

Myopia is an eye disease resulting from multiple factors, among which genetic and environmental factors play a major role[8]. With heavier study and academic pressure and the popularization of electronic products, the incidence of myopia in adolescents is increasing year by year. Moreover, complications of high myopia such as cataracts, glaucoma, and retinal detachment have increased significantly.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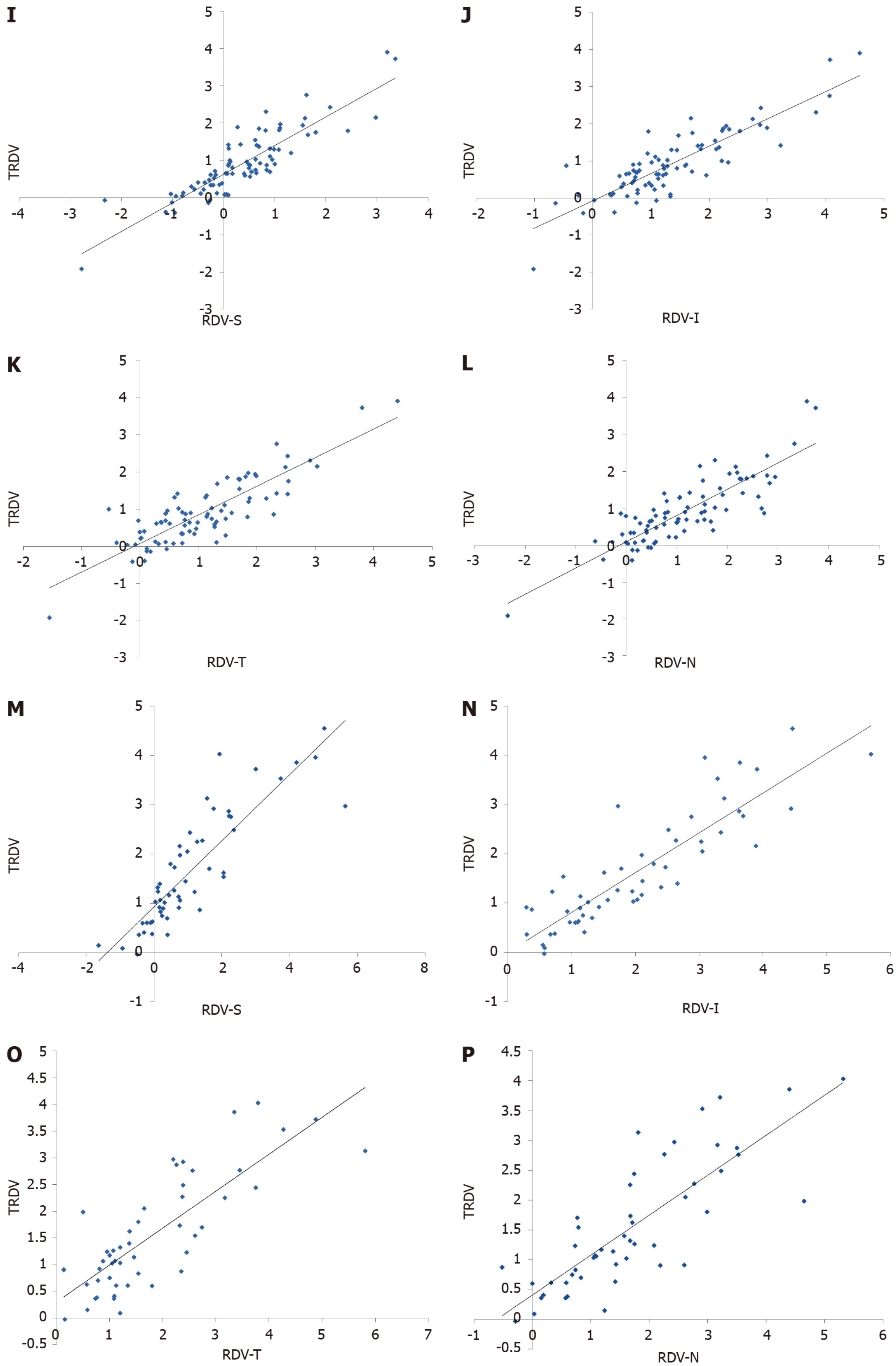

Figure 5 Scatterplots showing the relationship between total retinal defocus value and retinal defocus value of the nasal side of the retina of patients with moderate-degree myopia in group B. A, E, I, and M: Retinal defocus value of the upper; B, F, J, and N: Retinal defocus value of

lower; C, G, K, and O: Retinal defocus value of temporal; D, H, L, and P: Retinal defocus value of nasal. TRDV: Total retinal defocus value; RDV: Retinal defocus value; RDV-S: Retinal defocus value of the upper; RDV-I: Retinal defocus value of lower; RDV-T: Retinal defocus value of temporal; RDV-N: Retinal defocus value of nasal.

Currently, the most effective myopia prevention and control methods are: (1) Longer outdoor activities time, at least 2 h a day; (2) Effective optical correction, like OK; and (3) Drug treatments, such as low-concentration atropine eye drops[9,10]. Because of the side effects of atropine, the optically corrected OK lens is attracting people's attention[9,11-13].

Undoubtedly, the current focus is myopia control and high myopia rate reduction. OK is highly valued for its effect on low- and moderate-myopia control. OK lenses are generally recognized to delay myopia growth now. It is reversible to correct myopia by temporary diopter reduction. Big data research shows that OK lenses can slow down the eye axis growth by approximately 0.15 mm/year and control refractive power increase (0.25-0.50 D/year)[14,15]. In a 2-year study by Santodomingo-Rubido *et al*[16] in patients aged 6-12 years, the axial length of patients wearing OK lenses increased by 0.47 mm, less than 0.69 mm in the group wearing frame glasses. The same conclusion was reached by the teams of Lau *et al*[17] and Na *et al*[18].

Currently, different opinions exist about the mechanism of myopia incidence. In recent years, a new concept has been proposed that signals from the periphery of the retina play a significant role in controlling myopia[19]. Smith[20] proved that the eye axis growth was accelerated through induced hyperopia defocus in the peripheral retina of young monkeys. After the removing inducement, the eye axis growth gradually slowed down and even returned to normal levels. Animal model research also revealed that not the central retina but the peripheral retina defocus mainly controlled the myopia progression[19]. Studies have shown that the peripheral retina has a more regulatory effect on the eye axis growth and myopia development than the fovea. Hyperopia defocus can be adjusted in the peripheral retina to delay myopia progression[21,22]. In addition to OK lenses, defocus soft lenses, defocus frame lenses, and multifocal soft lenses also represented their effects on reducing hyperopic defocus around the retina and delaying myopia development[11,23,24].

Depth estimation is a critical field of computer vision research. Generally, depth information is automatically extracted from one or a plurality of images of a scene[25-27]. The design of MRT is based on the depth estimation method of focus distance measurement. Thus, this classic method is creatively applied to the fundus depth estimation and further transformed into the refractive information of human eyes.

In this study, comparing patients of low or moderate myopia wearing OK and frame glasses for 1 year, the former showed significantly slower refractive power and eye axis growth, indicating the efficiency of OK lenses on delaying myopia development.

This study also confirmed that the initial defocus values and axis length could affect the following length growth after wearing OK lenses for 1-year[28,29]. After 1 year of treatment, the retinal hyperopic defocus were measured through MRT. In groups with low or moderate myopia, patients wearing OK lenses showed significantly lower TRDV than those wearing frame glasses. Eyeball growth backward was weakened by OK lenses, corresponding to lower TRD values; thus, the eye axis of those patients grew slower, and their refractive power of myopia increased less.

In addition, the 15°-53° (peripheral) hyperopic defocus values of the retina in the OK lens group were significantly lower than in the frame glasses group. In conclusion, OK lenses can reduce the peripheral retina hyperopia defocus values and delay the eye axis growth, thereby controlling myopia progression. This theory also has guiding significance for other myopia preventing and control methods, such as defocus soft lenses, defocus frame lenses, and multifocal soft lenses[30-32]. In this study, MRT was used to quantify the change in the peripheral retinal defocus, the delay of the eye axis growth, and the refractive power increase in the peripheral retina of the OK lens group. The final results were consistent with many studies at home and abroad[33-36].

CONCLUSION

With the popularity of electronic products, myopia incidence remains high in adolescents, seriously affecting the physical and mental health of children. Thus, this problem needs close attention.

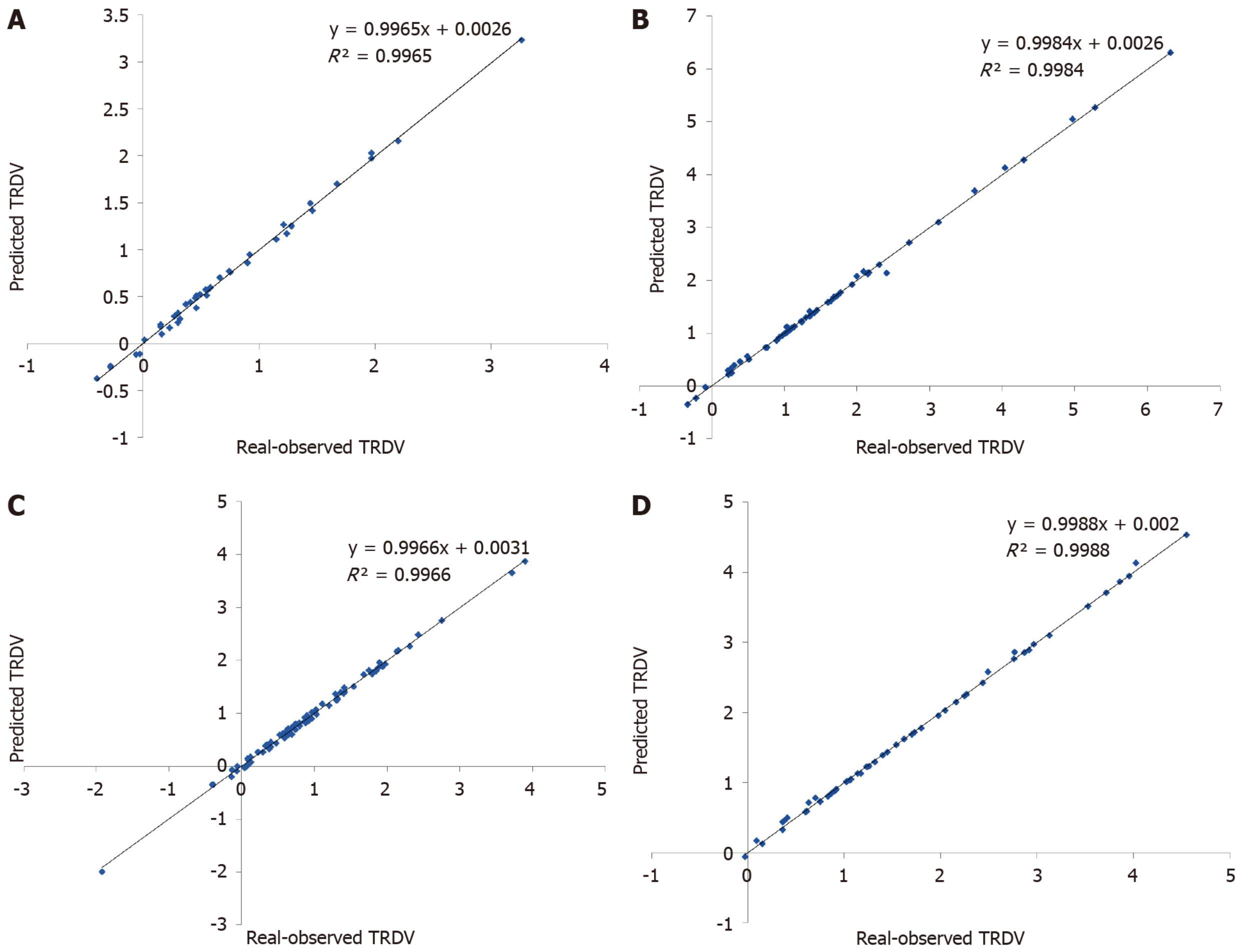

Figure 6 Scatterplots showing the relationship between the predicted value and real-observed total retinal defocus value. A: Linear regression between predicted total retinal defocus value (TRDV) and observed value low-degree myopia patients of Group A; B: Linear regression between predicted TRDV and observed value low-degree myopia patients of Group B; C: Linear regression between predicted TRDV and observed value moderate-degree myopia patients of Group A; D: Linear regression between predicted TRDV and observed value moderate-degree myopia patients of Group B. TRDV: Total retinal defocus value.

MRT was used to detect the corneal state to obtain accurate diopter values. It has been proved that, whether wearing frame glasses or OK lenses, patients with moderate myopia showed higher retinal hyperopic defocus than those with low myopia. More samples and study time are necessary to study whether the retinal hyperopic defocus of patients is related to the aspheric shape of the cornea and the eye axis length. So far, MRT is the only advanced instrument to reproduce the amount of retinal defocus accurately. The data is accurate and reliable, having clinical applicability. It is advanced and instructive in clinical myopia prevention and control[37]. MRT can also be used to predict initial eye axis growth and myopia progression.

ARTICLE HIGHLIGHTS

Research background

Myopia is a common eye disease often occurring among adolescents. Although the study-and-play surrounding of teenagers has been greatly improved in recent years, myopia incidence in China and some other developing countries is still quite high. As for myopia pathogenesis, a new hypothesis shows that myopia is controlled by signals from the retina's periphery. To some extent, it explains how rigid gas-permeable contact lenses, like orthokeratology lens (OK lens) and single-focal glasses, testified effective in myopia control, slow down the growth rate of myopia degree. Based on computer depth estimation, multispectral refraction topography (MRT) technology can provide more accurate data containing more refractive information, especially the peripheral retina counterpart.

Research motivation

This study focused on the theory supporting OK lenses in myopia control. The treatment efficiency comparison between OK lenses and single-focal glasses revealed the effect of OK lenses in delaying diopter development, reducing the growth rate of the eye axis, and controlling total retinal defocus values (TRDV). Meanwhile, the effect of periphery retina on myopia progression was proved on another side. The myopia control mechanism of OK lenses provides guides for technical improvement of OK lenses and new possibilities for more effective myopia control.

Research objectives

In this study, MRT was involved in predicting myopia development and guiding myopia control. It provides more accurate data on myopia progression than traditional optometry methods. It is a new attempt, showing a further use of MRT in myopia prevention and control.

Research methods

In this study, MRT was creatively combined with myopia treatment to explore the mechanism of OK lenses in preventing myopia growth. MRT was used to accurately quantify the retina hyperopia defocus, confirming that reducing the defocus of peripheral hyperopia can delay the eye axis growth and increase diopter.

Research results

Statistically significant differences were detected in diopter increase between patients treated with OK lenses and single-focal glasses. Regardless of low- or moderate myopia in the initial period, OK lenses were more effective than frame glasses. Similarly, when no significant difference existed in the original ocular axial length between the two groups, growth of eye axis was delayed more distinctly in groups wearing OK lenses. OK lenses were also more effective in TRDV control, which was certificated to be linearly associated with hyperopic defocus values of the peripheral retina (15°-53°). Improvement of TRDV occurred evenly on four sides of the retina.

Research conclusions

The effects of OK lenses on controlling myopia development, reducing diopter growth rate and ocular axial length, and improving patients' TRDV were certificated again in this study. More evidence that OK lenses affected myopia development through working on the peripheral retina was given by the strong relationship between TRDV and peripheral hyperopic defocus values. Those data were very valuably detected by MRT with high correctness and accuracy.

Research perspectives

This study provided new evidence for old theories and hypotheses and proved the high value of MRT in ocular research, especially myopia-associated ones. Thus, it has been planned to expand the study size for more accurate and reliable data. This data may provide a new angle about how myopia developed and further how to prevent and control myopia.

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