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# *Research progress of prevention and treatment of myopia in teenagers by modern medicine*

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***Abstract:*** China is one of the countries with the highest incidence of myopia in the world, among which the prevalence of myopia in children and adolescents is increasing year by year, and the trend of younger age. Studies have shown that the younger the age of myopia, the more likely it is to develop into high myopia in adulthood. With the increase of myopia degree and the gradual extension of the eyeball, the probability of eye diseases (high myopia macular degeneration, open Angle glaucoma) also increases correspondingly, and refractory complications eventually lead to low vision and even blindness. If the current incidence of myopia can not be effectively prevented and controlled, it will become an important disease factor affecting the quality of life of the public in the future, and it will also become a problem for the prevention and control of eye diseases in the future. Therefore, preventing and controlling the formation of myopia in children and adolescents and (or) delaying the deepening of myopia degree is a common topic in the current research of traditional Chinese and Western medicine. The following is a summary of the relevant research on the prevention and control of children and adolescents in recent years in the modern medicine, hoping to provide references for the clinical prevention and control of myopia in children and adolescents, and provide possibilities for more in-depth, scientific and comprehensive prevention and control of myopia in adolescents in the future.

## 1. Introduction

Myopia is the distant light of the outside world, after the eye dioptric system, can only be imaged in front of the retina, often accompanied by the growth of the eye axis, also known as axial myopia, easy to cause visual fatigue. Myopia is measured by diopter (D), another measure closely related to the refractive state of the eye is axial length, which is the length of the eyeball from the front pole to the back pole. Therefore, myopia can be divided into refractive myopia and axial myopia according to refractive system classification. The axial length of the adult metropia (without ametropia) in the East Asian population is generally 22 to 25 mm. Many Chinese adults have an axial length of 23.3 mm. High myopia is usually defined as a myopia refraction greater than -6.0 D(600 "degrees") or an axial length of > 26 mm, high myopia can cause vitreous liquefaction, turbidity, complicated with cataracts and consciousness of the dark shadow floating in front of the eyes, seriously affecting the physical and mental health of patients, and has become one of the main reasons for vision loss.

The main pathological mechanism of myopia is still unclear. At present, the modern medical research believes that the occurrence of myopia is the result of the comprehensive effect of genetic factors and environmental factors. The prevalence of myopia is higher in individuals with both myopic parents, suggesting that genetic factors are clearly involved in the development of myopia [1]. Although genetic background influences the phenotype of myopia to a certain extent, the sudden increase in incidence cannot be explained by genetics alone, and lifestyle changes that lead to dramatic changes in the light environment are also important factors in the onset and development of myopia. The intensity, wavelength of modern electronic lighting equipment and the unscientific use method of electronic products lead to the difference between indoor and outdoor light environments, which may be one of the environmental factors for myopia control [2], air pollution, trace element deficiency, malnutrition, insufficient daily outdoor activities and other factors have an impact, but they are secondary factors. At the same time, population studies have shown that the development of myopia is associated with educational stress and increased proximity work time. [3]

At present, the situation of myopia in Chinese teenagers is serious. In 2020, the overall myopia rate of children and adolescents in China will be 52.7%, and the prevention and control of myopia among adolescents has become a key work of school health. Therefore, understanding the current common clinical myopia prevention and control methods, and making clear that various myopia prevention and control measures are suitable for the population, has positive significance for guiding clinical work in the future. In this paper, we will review the research on the prevention and control of myopia in young people in recent years, especially the middle and low degree myopia.

## 2. Research on the progress of modern medicine in the treatment of juvenile mild myopia

For the treatment of mild myopia in adolescents, modern medicine is mainly symptomatic treatment, including the following aspects.

### 2.1 Drug therapy

1) Atropine: Atropine is a non-specific muscarinic acetylcholine receptor antagonist, and atropine eye drops are now widely used by ophthalmologists to dilate the pupil and refractive ciliary body. The study found that atropine can significantly inhibit the progression of myopia in the single eye of adolescents. Cui Youxin [4] selected 105 patients with myopia aged 7 to 13 years old, compared 1% atropine group, 0.01% atropine group and optometry group, and found that 1% atropine group patients had photophobia symptoms. It is concluded that 0.01% atropine eye drops have good clinical effect and can effectively delay the diopter and axial growth of adolescent myopia patients. However, poor binding of atropine to M3 receptors can lead to serious eye side effects such as stes and ciliary paralysis [5].

2) Pirenzepine: Pirenzepine is a troponin antagonist [6]. Compared with atropine, pirenzepine can also inhibit the growth of the ocular axis and control the development of myopia, and is selective to M1 receptors [7,8], which is not easy to cause stene and ciliary paralysis. According to a safety and tolerability trial [9,10], Pirenzepine is considered an ideal drug for the treatment of myopia. However, as a hydrophilic compound, pirenzepine has low penetration and poor eye bioavailability, which reduces its effect on myopia development.

3) Topicamide (pyridylmethy): Topicamide is also an M cholinergic receptor antagonist, is a synthetic rapid cycloplegic agent. The function of controlling myopia development is achieved by relaxing the ciliary muscle and relaxing regulation. However, because the curative effect is short, there are defects that require repeated medication to achieve persistent regulation of paralysis, and there are few clinical applications.

4) Raceanisodamine: Raceanisodamine is a weak peripheral M-cholinergic receptor blocker. It has

a similar effect to atropine. 0.5% racanisodamine drops can relieve smooth muscle spasm, dilate ocular microvessels and effectively improve visual acuity. It has fewer side effects and higher safety and tolerability.

5) 7-Methylxanthine: 7-methylxanthine is a non-selective adenosine receptor antagonist that has been shown in animal models to alleviate axial myopia caused by faropic detachment [11]. Clinical experiments have found that it can increase the diameter and content of collagen fibers in the posterior sclera, thus increasing the scleral thickness [12]. However, due to the lack of relevant clinical data in China, its efficacy and safety are still unclear.

## 2.2 Optical Correction

Most number line myopia is caused by the long front and rear diameter of the eye, causing parallel light rays from distant objects to focus in front of the retina, and then the light begins to disperse and form a diffusion point when it reaches the retina, causing the object to blur. At present, optical correction mainly includes frame glasses, corneal contact lens and scleroscope. Mainly by adding a concave lens with a certain focal degree in front of the eye, the parallel light rays entering the eye are properly diffused, so that the focusing position can be moved to the retina. Nowadays, optical correction mainly includes frame glasses and contact lenses. Contact lenses include soft and hard lenses. Soft contact lenses include single focal point, double focal point, multi-focal point and peripheral defocus. Rigid contact lenses include rigid permeable contact lenses and orthokeratology lenses.

Frame glasses are convenient, economical and safe to wear. However, it affects the appearance and is more suitable for mild to moderate myopia. In addition, overcorrection, undercorrection or lens wear can accelerate the development of myopia. Compared with frame glasses, SCL is more widely used, because it is comfortable to wear, good hydrophilic, and does not affect the appearance, and is favored by young people. However, SCL prevents the contact between ocular surface and oxygen, and long-term wear may thin the central cornea and cause dry eye symptoms [13]. Constant oxygen supply is crucial for normal ocular surface tissue metabolism [14]. Compared with frame glasses and SCL, RGP is more suitable for developing adolescent myopia patients, and studies have found that RGP can effectively control the growth of myopia [15,16]. It provides better visual acuity and contrast sensitivity [17]. By comparing the central corneal thickness, corneal endothelial cell density, proportion of hexagon cells and coefficient of variation of endothelial cells before and after long-term wearing of SCL and PDSCL, Junlutan [18] concluded that RGPCL has no significant effect on corneal morphology and function in adolescents with mild myopia, and is more suitable for long-term wearing.

## 2.3 Therapeutic Instruments

It has been found that light has a regular effect on axial myopia, and the regularity of axial changes caused by light has been used to induce or inhibit axial myopia. People can obtain light stimulation with different characteristics, which can be achieved by adjusting the light intensity, wavelength, strobe and light distribution characteristics of the light source [19,20]. In 2017, Gawne et al. [21] studied primate shrews and found that red light with wavelength of 626 nm could inhibit the growth of eye axis in tree shrews. In the same year, Gawne et al. also found that tree shrews exposed to 527-749 Lux and red light with a wavelength of 650nm showed increased choroidal thickness, slow growth of eye axis and hyperopia [22]. In 2018, Li-Fang Hung of the University of Houston in the United States found through experiments with rhesus monkeys that red light with a wavelength of 650nm could inhibit the elongation of the eye axis in rhesus monkeys [23]. A number of domestic scholars have carried out clinical studies on the prevention and control of myopia by red light: Xu Yuling et al. used semiconductor lasers with different energy parameters to irradiate rabbit eyes in different ways, and observed whether 650nm semiconductor laser would cause pathological damage to eye tissues, revealing that short-term irradiation of low-energy 650nm semiconductor laser had no damage to cornea and lens [24]. In 2019, Pan Hongbiao, director of the First Affiliated Hospital of the University of Science and Technology of China, published at the 20th National Ophthalmology Conference of the Chinese Medical Association, "Observation and Thinking on the Control of axis growth in Children and Adolescents with myopia", pointing out that 650nm red light exposure can control the progression of myopia in children and adolescents, and no obvious side effects were seen. Huang Yan et al. [25] added a 640 nm red stroboscopic therapy instrument and a combination program of adjusting ensemble training to control eye axis length in the clinical treatment of myopia patients to effectively improve clinical treatment efficiency. Professor He Mingguang, distinguished PI of the State Key Laboratory of Ophthalmology Center of Sun Yat-sen University, published "Prevention and Control of Myopia in Adolescents, from Research Evidence to Clinical Practice" at the Boao International Vision Forum in 2019, pointing out that multi-center clinical studies were carried out in Zhongshan Eye Center, Shenzhen Children's Hospital, Hunan Xiangya Hospital, etc., to confirm the safety and effectiveness of 650nm red light in myopia prevention and control. However, the existing instruments still have the following problems, which need to be further studied.

1) Large range of wavelength variation. According to literature [26], the wavelength is an important axis of the eye, and the 650nm red light has a definite effect on myopia prevention and control [27,28]. However, the wavelength of light source used by existing instruments varies widely from 625nm to 660nm, and the effect of different red light wavelengths on myopia prevention and control is unknown.

2) The therapeutic light power was the dose of amblyopia. Due to the prevention and control effect of the existing instruments on myopia, which came from the accidental discovery in the treatment of amblyopia, both devices use the light power in the treatment of amblyopia to treat patients, and there is no corresponding clinical study on whether there is a better treatment power.

3) Lack of follow-up, the changes of ocular axis and choroid thickness after stopping red light therapy and whether the diopter rebounds after stopping red light therapy need to be further studied;

4) The existing equipment lacks the intelligent dose control function, myopia needs a long period of 3-12 months of continuous treatment, how to determine each time the patient is an effective treatment, how to determine the patient's specific treatment time, control the safety risks caused by excessive and insufficient treatment and ineffective treatment, need to be further investigated.

## 3. Discuss

The threat of myopia to human vision is increasing. In the past hundred years, the global myopia population has been rising rapidly. In the United States, the percentage of adults with myopia increased from 25% in the 1970s to more than 40% in 2004. [29] In East Asia, the proportion of young people with myopia ranges from 80% to 90% [30]. In 2000, the number of nearsighted patients in the world was 1.4 billion, and in 2010 it reached 1.95 billion (28.3% of the global population), while it is predicted that the number of nearsighted people in the world will reach 2.62 billion by 2020, and the global nearsighted population will reach half of the world's total population (4.758 billion) by 2050. This includes 938 million people with high myopia [31]. Myopia has become a serious public health problem that affects public health and quality of life. The myopia rate of junior high school students has dropped to less than 60%, and that of senior high school students has dropped to less than 70%. It is a long way to go to prevent and control myopia. At present, modern medicine has a prominent prevention and control effect on adolescent myopia, especially mild and moderate myopia, and the prevention and control measures are becoming more and more perfect. Long-term clinical observation has found that the means that have a clear effect on the control of myopia progression mainly include atropine eye drops and plastic keratology glasses. However, almost every myopia prevention and control method has limitations and even complications to a certain extent and within a certain range [32]. Long-term efficacy and long-term effect accumulation need further observation and study. At the same time, there is still a lack of a set of standardized and complete efficacy evaluation system for the prevention and treatment of myopia in adolescents, and in the future, it is necessary to constantly summarize treatment experience in clinical practice to form a more scientific standard. The threat of myopia to human vision is increasing. In the past hundred years, the global myopia population has been rising rapidly. In the United States, the percentage of adults with myopia increased from 25% in the 1970s to more than 40% in 2004. [29] In East Asia, the proportion of young people with myopia ranges from 80% to 90% [30]. In 2000, the number of nearsighted patients in the world was 1.4 billion, and in 2010 it reached 1.95 billion (28.3% of the global population), while it is predicted that the number of nearsighted people in the world will reach 2.62 billion by 2020, and the global nearsighted population will reach half of the world's total population (4.758 billion) by 2050. This includes 938 million people with high myopia [31]. Myopia has become a serious public health problem that affects public health and quality of life. The myopia rate of junior high school students has dropped to less than 60%, and that of senior high school students has dropped to less than 70%. It is a long way to go to prevent and control myopia. At present, modern medicine has a prominent prevention and control effect on adolescent myopia, especially mild and moderate myopia, and the prevention and control measures are becoming more and more perfect. Long-term clinical observation has found that the means that have a clear effect on the control of myopia progression mainly include atropine eye drops and plastic keratology glasses. However, almost every myopia prevention and control method has limitations and even complications to a certain extent and within a certain range [32]. Long-term efficacy and long-term effect accumulation need further observation and study. At the same time, there is still a lack of a set of standardized and complete efficacy evaluation system for the prevention and treatment of myopia in adolescents, and in the future, it is necessary to constantly summarize treatment experience in clinical practice to form a more scientific standard.

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