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ORIGINAL ARTICLE

# ADVANCES IN THE DIAGNOSIS AND CLINICAL MANAGEMENT OF MYOPIA: FROM REFRACTION ASSESSMENT TO PERSONALIZED MYOPIA CONTROL

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## Abstract

Myopia is a common ocular condition characterized by blurred distance vision and abnormal ocular growth, particularly excessive elongation of the axial length. The increasing prevalence of myopia has created a need for more accurate diagnostic approaches and individualized management strategies. Traditional eye care has primarily focused on correcting refractive error with spectacles or contact lenses, whereas contemporary clinical practice increasingly emphasizes the identification of progression risk and prevention of excessive axial elongation. Accurate diagnosis is the foundation of effective management because the severity and progression of myopia vary considerably among patients. Modern assessment may include visual acuity testing, cycloplegic refraction, corneal evaluation, binocular vision assessment, ocular health examination, and measurement of axial length. These methods provide complementary information and allow clinicians to distinguish stable refractive error from progressive myopia. Current management includes conventional optical correction as well as myopia-control spectacle lenses, specialized contact lenses, orthokeratology, and pharmacological treatment with low-concentration atropine. The selection of treatment should be based on age, refractive status, progression rate, ocular characteristics, family history, lifestyle, treatment adherence, and patient preferences. Regular monitoring is essential because treatment effectiveness can vary between individuals and progression may continue despite intervention. This article examines modern diagnostic principles and clinical management strategies for myopia and highlights the importance of personalized, long-term care in protecting visual health.

Keywords: myopia, diagnosis, refraction, cycloplegia, axial length, ophthalmology, myopia control, atropine, orthokeratology, spectacle lenses, contact lenses, personalized treatment.

## 1. Introduction

Myopia is one of the most frequently encountered refractive conditions in ophthalmic practice. It occurs when the optical system of the eye focuses incoming light in front of the retina rather than directly on the retinal surface when accommodation is relaxed. As a result, distant objects appear blurred, while near objects can often be seen relatively clearly. The condition may be mild and remain stable or may progressively increase during childhood and adolescence.

The clinical importance of myopia has changed considerably in recent decades. In the past, the main objective of treatment was to restore clear distance vision. Spectacles and contact lenses remain highly effective for this purpose, but current knowledge demonstrates that progressive myopia may involve structural changes in the eye that cannot be addressed simply by improving visual acuity. Excessive axial elongation can increase the likelihood of retinal, macular, and optic nerve complications, particularly when high myopia develops.

The expansion of myopia-control research has therefore introduced a broader concept of management. Clinicians increasingly assess not only the current refractive error but also the likelihood of future progression. This approach is particularly important in children because ocular growth remains active and myopia can change substantially over several years.

Accurate diagnosis is essential for determining the appropriate management strategy. An apparently small refractive change may represent the beginning of progressive myopia in a young child, while a similar refractive value in an older adolescent may remain relatively stable. For this reason, age, previous measurements, family history, axial length, lifestyle, and rate of change should all be considered.

Modern diagnostic technologies have improved the ability of clinicians to characterize the eye. In addition to standard visual acuity and refraction, axial length measurement provides a direct structural indicator of ocular growth. Optical biometry and other imaging technologies can help monitor changes over time. These developments have made longitudinal assessment an increasingly important part of myopia care.

## 2. Materials and Methods

The present article was prepared as a narrative scientific review based on contemporary ophthalmological literature concerning the diagnosis and management of myopia. Scientific publications addressing refractive assessment, axial length measurement, clinical monitoring, optical interventions, orthokeratology, pharmacological treatment, and individualized myopia control were analyzed.

The literature review emphasized peer-reviewed clinical studies, systematic reviews, randomized controlled trials, and professional consensus documents. Particular attention was given to studies involving children and adolescents because these groups represent the population in which progressive myopia is most frequently observed.

For diagnostic analysis, the main clinical indicators considered were uncorrected visual acuity, best-corrected visual acuity, spherical equivalent refraction, cycloplegic refraction, axial length, corneal parameters, and ocular health findings. The value of repeated measurements was also considered because a single examination cannot always determine whether a refractive error is stable or progressive.

For therapeutic analysis, interventions were classified into conventional optical correction, specialized optical myopia-control methods, orthokeratology, pharmacological treatment, and combined approaches. The assessment considered treatment effectiveness, safety, adherence, practical accessibility, and the necessity of long-term monitoring.

The interpretation of available evidence was performed with consideration of differences among patient populations, treatment protocols, follow-up periods, and outcome measures. Because myopia is a heterogeneous condition, the analysis emphasized individualized treatment rather than assuming that one intervention is equally effective for all patients.

## 3. Results

The analysis demonstrates that modern myopia diagnosis requires more than a simple measurement of visual acuity. Visual acuity determines the functional consequence of refractive error, but it does not explain the structural characteristics of the eye or indicate whether myopia is likely to progress. A complete examination therefore begins with visual acuity assessment and continues with objective and subjective refraction.

Cycloplegic refraction is particularly important in pediatric patients. Children possess strong accommodative ability, and active accommodation can temporarily shift the measured refraction toward a more myopic value. Cycloplegia reduces this influence and allows a more accurate estimation of the underlying refractive state. This is especially useful when evaluating children with

suspected myopia or when previous measurements show inconsistent results.
Axial length measurement has become increasingly important in contemporary myopia management. The axial length represents the distance from the anterior surface of the eye to the retina and provides information about the physical growth of the globe. Progressive myopia is frequently accompanied by axial elongation. Monitoring axial length over time can therefore complement refractive measurements and provide evidence about the biological response to treatment.
Another important diagnostic component is evaluation of ocular health. Patients with significant myopia may require careful examination of the retina and other posterior structures. This becomes increasingly important with higher degrees of myopia because structural changes can predispose patients to retinal tears, retinal detachment, myopic macular pathology, and other complications.
The results show that conventional spectacles continue to represent one of the safest and most accessible methods for correcting myopia. Properly prescribed spectacles provide clear vision and are particularly important for children's educational and social functioning. However, standard single-vision spectacles are primarily corrective rather than specifically designed to slow axial growth.
Specialized spectacle lenses have expanded the range of treatment options. Modern lens designs can alter the peripheral retinal image profile and are intended to provide a myopia-control signal while maintaining functional central vision. Clinical studies have reported reductions in myopia progression with several specialized lens designs, although effectiveness may vary according to lens technology and patient characteristics.
Contact-lens-based approaches provide another category of myopia management. Multifocal and specially designed soft contact lenses can simultaneously provide clear vision and optical signals intended to influence ocular growth. These approaches may be useful for selected children and adolescents who can safely handle contact lenses and maintain appropriate hygiene.
Orthokeratology represents a different optical strategy. Special rigid gas-permeable lenses are worn during sleep and temporarily reshape the corneal surface. This can provide functional daytime vision without conventional spectacles or daytime contact lenses. Research indicates that orthokeratology can also slow axial elongation in many children. Nevertheless, overnight lens wear requires careful patient selection, strict hygiene, professional fitting, and regular follow-up.
Pharmacological therapy with low-concentration atropine has become an important component of modern myopia management. Atropine influences ocular growth through mechanisms that are not fully explained by accommodation alone. Clinical trials have demonstrated that low concentrations can reduce the rate of myopia progression in children, although effectiveness varies according to concentration and individual response.
Treatment monitoring is essential for evaluating whether a selected intervention is producing the desired effect. Refractive measurements should be compared over time, and axial length can provide an additional structural outcome. If progression remains rapid despite treatment, the clinician may need to reconsider adherence, treatment choice, dosage, or the possibility of combining interventions.
The results also indicate that personalized management is increasingly important. Children of the same age with the same baseline refractive error may have very different progression risks. A younger patient with rapidly increasing myopia and a strong family history may require more intensive management than an older patient with stable refraction.

## 4. Discussion

The transition from conventional refractive correction to active myopia management represents a major development in ophthalmology. The central concept of this transition is that visual acuity and ocular health are related but distinct clinical outcomes. A patient can achieve excellent visual acuity with spectacles while still experiencing progressive axial elongation. Consequently, treatment success should not be judged solely by how clearly the patient can see after correction.
The diagnostic process should be adapted to the patient's age. In younger children, cycloplegic refraction is particularly valuable because accommodation can complicate measurements. In older patients, repeated non-cycloplegic measurements may sometimes provide useful information, although clinical circumstances determine the most appropriate method.
Axial length has special importance in modern practice because it provides a structural measure of ocular growth. A change in spherical equivalent refraction may be influenced by several optical factors, whereas axial elongation directly reflects enlargement of the globe. However, axial length should not be interpreted in isolation. Different individuals have different normal anatomical

dimensions, and clinical interpretation requires consideration of age, sex, refractive status, and previous measurements.

The increasing number of myopia-control interventions creates both opportunities and challenges. Having multiple treatment options allows clinicians to individualize care, but it also makes decision-making more complex. Families may find it difficult to understand the differences between specialized spectacles, contact lenses, orthokeratology, and atropine. Clear communication is therefore essential.

Treatment adherence is a critical determinant of real-world effectiveness. A child may fail to wear prescribed lenses consistently, forget medication, or experience difficulties with contact-lens hygiene. Such factors can reduce treatment effectiveness even when the intervention itself has strong scientific support. Clinicians should therefore evaluate not only which treatment is theoretically most effective but also which treatment is practical for the individual child and family.

Low-concentration atropine demonstrates the importance of balancing effectiveness and tolerability. Higher concentrations may produce stronger effects but can also increase photophobia, pupil dilation, and accommodative difficulties. Lower concentrations generally have fewer ocular side effects, but their ability to control progression may differ. Current evidence supports an individualized approach rather than a universal concentration for every patient.

Orthokeratology also illustrates the importance of balancing benefits and risks. The possibility of slowing axial elongation and providing daytime freedom from spectacles can be attractive to families. However, overnight contact-lens wear requires strict hygiene and appropriate follow-up. The risk of microbial keratitis, although uncommon with proper care, means that patient education is essential.

Combination therapy may be considered when monotherapy does not adequately control progression. Studies investigating atropine combined with orthokeratology or other optical interventions suggest that additional control may be possible in selected patients. However, combination treatment can increase cost, complexity, and adherence demands. Therefore, it should be introduced based on clinical need rather than as a routine first-line approach for every child.

Another important aspect is communication with parents. Parents sometimes interpret increasing spectacle prescriptions as evidence that spectacles have weakened the child's eyes. This is incorrect. Spectacles correct the optical consequences of myopia; they do not cause the underlying axial elongation. Explaining this distinction can improve treatment acceptance and reduce misconceptions.

The clinical management of myopia should also include lifestyle counseling. Treatment should not replace healthy visual behavior. Regular outdoor activity, appropriate working distance, adequate illumination, and breaks during prolonged near tasks can complement clinical interventions. Such measures are especially attractive because they are relatively inexpensive and can be incorporated into daily routines.

Long-term follow-up is necessary because myopia progression can continue for several years. Even when progression slows, treatment should not automatically be discontinued without professional assessment. Some patients may experience renewed progression after treatment cessation, while others may achieve stability. Individual follow-up is therefore essential.

The future of myopia management is likely to involve increasingly personalized risk assessment. Advances in ocular imaging, biometric measurement, genetics, artificial intelligence, and longitudinal data analysis may eventually allow clinicians to estimate an individual's progression risk more precisely. Such tools could help determine which children require intervention and which can be monitored with less intensive treatment.

## 5. Conclusion

Modern myopia management has evolved from simple refractive correction toward a comprehensive strategy aimed at preserving long-term ocular health. Accurate diagnosis, identification of progression risk, and regular monitoring are essential components of this approach.

Cycloplegic refraction provides reliable information about refractive status in children, while axial length measurement offers valuable insight into structural ocular growth. Together with visual acuity testing and ocular health examination, these methods provide a more complete assessment than conventional refraction alone.

Current treatment options include standard spectacles, specialized myopia-control spectacle lenses, multifocal contact lenses, orthokeratology, and low-concentration atropine. Each method has advantages and limitations, and treatment should be selected according to the patient's age,

progression pattern, ocular characteristics, lifestyle, adherence, and family circumstances.
The most appropriate strategy is therefore not necessarily the same for every patient. Personalized treatment combined with regular follow-up can improve the likelihood of controlling progression and reducing the future burden of high myopia.
Ultimately, the objective of modern clinical management is not simply to help a patient see clearly today but also to protect the structural and functional health of the eye for the future. Continued research and wider access to evidence-based myopia management are essential as the global prevalence of myopia continues to increase.

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