# Recent Non-Surgical Advances in Management of Presbyopia

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**DOI: https://doi.org/10.51244/IJRSI.2026.1306000215**

**Received: 12 June 2026; Accepted: 17 June 2026; Published: 30 June 2026**

## ABSTRACT

Presbyopia is an age-related decrease in the eye's ability to focus on near objects, affecting nearly all individuals over 40 years of age. Increasing life expectancy and greater dependence on digital devices have increased their impact on quality of life. Recent non-surgical advances include improved multifocal optical correction and pharmacological therapies, such as pilocarpine and aceclidine-based eye drops, which enhance near vision by increasing the depth of focus. Emerging lens-softening therapies aimed at restoring accommodation are currently being investigated. However, no current treatment fully restores natural accommodation with long-term safety and efficacy. Future therapies are expected to focus on personalised, restorative treatment approaches to improve vision and quality of life in patients with presbyopia.

This review focuses on contemporary non-surgical approaches to presbyopia, highlighting recent developments in pharmacological eye-drop therapy and important considerations for patient selection and treatment initiation.

**Keywords**

Presbyopia, Loss of accommodation, Non-surgical, Pilocarpine, Contact lenses

## INTRODUCTION

Presbyopia is an age-related physiological decline in accommodation, in which the eyes gradually lose their ability to focus on near objects. It is characterised by an irreversible reduction in the accommodative amplitude of the eye, resulting in the progressive deterioration of near vision.[1]

Uncorrected presbyopia remains a significant contributor to visual impairment worldwide.[2] The term "presbyopia" is derived from the Greek words "presbys" and "ops", which mean "old eye". [3] The condition typically manifests between 40 and 45 years of age; however, its onset may vary depending on occupation, working distance, illumination, refractive status, and visual demand. In recent years, the extensive use of digital devices and prolonged near-work activities have contributed to the earlier presentation of presbyopic symptoms, with increasing reports among individuals in their early to late thirties. Uncorrected presbyopia remains highly prevalent in developing countries, affecting nearly half of all presbyopic individuals.[4] According to global estimates, the number of individuals affected by presbyopia is expected to reach approximately 2.1 billion by 2030, largely attributable to increasing life expectancy and an ageing population worldwide.[5] In India, approximately one-third of adults over 30 years of age are estimated to have uncorrected presbyopia, highlighting a substantial public health burden affecting nearly 180 million people.[6]

Along with decreased near vision, other common symptoms include eye strain, visual fatigue, double vision, tearing, and headaches.[7] Although presbyopia is not completely curable, vision can be effectively corrected using reading glasses, contact lenses, eye drops, or surgery. In this article, we emphasise non-surgical methods for correcting presbyopia.

## REVIEW

Presbyopia refers to the progressive age-related loss of accommodation, resulting in difficulty with near-vision activities and everyday functioning.[8,9] The Government of India, through its 2017-2020 strategic health

framework, highlighted the importance of presbyopia screening at public health centres and introduced revised norms for near-vision spectacle assistance.[10]

Conservative treatment modalities for presbyopia include spectacles, contact lenses, and topical pharmacological agents, whereas surgical approaches are more invasive.[11] The management of presbyopia remains challenging, as many patients are unwilling to wear spectacles for cosmetic and convenience-related reasons, and surgical correction may not be suitable or acceptable for all patients. Topical pharmacological therapies have therefore emerged as a promising intermediate approach, offering improvement in near vision with relatively minimal side effects.

The concept of Dysfunctional Lens Syndrome was introduced by George Waring IV, who summarised it as an age-related progressive deterioration of the crystalline lens characterised by loss of accommodation, reduced optical activity, and eventual cataract formation, representing a continuum from presbyopia to cataract.[12]

There are many non-surgical approaches to presbyopia, such as spectacle correction, contact lenses, pharmacological management, and lifestyle modifications.

The use of reading glasses, consisting of single-vision(monofocal) lenses designed for near tasks, remains the oldest, simplest, and most widely available method for correcting presbyopia. These lenses compensate for the diminished accommodative power of the eye by providing additional positive optical power for near vision.[11,13] Monofocal near-vision glasses are used for patients who have no significant distance correction. Bifocals, trifocals, and progressive addition lenses(PALs) are other types of spectacle corrections. Variable-lens systems are advantageous because they combine multiple optical prescriptions within a single lens, thereby enabling the correction of various viewing distances with a single pair of spectacles.[11,13] These are more expensive and have relatively restricted optical zones,[11] which may adversely affect subjective visual performance during driving and other occupational tasks.[14,15] Monovision is suitable for patients with distance prescriptions. In this technique, one eye is corrected for distance vision, and the other for near vision using glasses.

Presbyopia can be corrected with soft and rigid gas-permeable contact lenses.[11,16-18] It can be used in many ways, such as in combination with contact lenses aided by glasses. In this original method, the refractive error is corrected with contact lenses and glasses, which add a near prescription. Patients may remain dissatisfied due to the repeated need to put on and remove spectacles during near work.[18] Multifocal contact lenses are designed to accommodate multiple refractive prescriptions using a single lens. Successful fitting requires careful patient selection and thorough pre-fitting assessment, since visual outcomes and patient satisfaction are strongly influenced by lens centration, pupil size, ocular optics, and neural adaptation.[19,20] Monovision with contact lenses can be achieved, providing functional vision at both near and distance without the need for additional optical aids. A major limitation of monovision is reduced stereopsis and contrast sensitivity.[21-24]

Pharmacological management of presbyopia can be achieved through two mechanisms: increasing depth of focus by inducing miosis and creating a pinhole effect, and restoring lens flexibility to improve accommodation. There is also one group of drugs, which is a lens-softening agent, choline ester of lipoid acid

Topical pharmacological therapy for presbyopia offers a non-invasive, reversible, and cosmetically acceptable alternative that improves near vision, reduces dependence on spectacles, and serves as a potential bridge between optical correction and surgical interventions.

Vuity(pilocarpine HCl 1.25%) was the first US FDA-approved presbyopia-correcting eye drop in 2021.[25] A DCGI-approved Indian alternative is PresVu (1.25% pilocarpine hydrochloride ophthalmic solution), which is comparatively more affordable and has been formulated to enhance ocular penetration in the more heavily pigmented Indian eye. The dosing can be once or twice daily. Pilocarpine acts by stimulating muscarinic receptors, leading to elevated calcium concentrations in the pupillary sphincter and ciliary muscle contraction, thereby inducing miosis and improving accommodation.[26] The adverse effects most frequently associated with pilocarpine eye drops are headache, conjunctival congestion, and eye pain during drop administration. The GEMINI and VIRGO studies assessed the efficacy and adverse effects of 1.25% pilocarpine ophthalmic solution in the management of presbyopia.[27,28] In 2023, the US FDA approved Qlosi, a low-dose 0.4% Pilocarpine

hydrochloride ophthalmic solution developed to provide effective near-vision improvement in presbyopia while minimising the adverse effects commonly associated with higher pilocarpine concentrations.[29]

Aceclidine primarily acts on the nerve endings of the pupillary sphincter muscle while exerting minimal stimulatory effect on the ciliary muscle.[26,30,31] The CLARITY study demonstrated the therapeutic effectiveness and safety of aceclidine.[31-33] In July 2025, a 1.44% aceclidine ophthalmic formulation, marketed as VIZZ, received US FDA approval for the pharmacological management of presbyopia.[34] Following topical instillation, aceclidine acts rapidly, enhancing near visual acuity within 30 minutes, with effects sustained for up to 10 hours.[31]

Topical combination therapy with carbachol and brimonidine has been reported to provide more sustained near-vision improvement than pilocarpine.[35] This formulation, marketed as YUVEZZI and containing 2.75% carbachol and 0.1% brimonidine tartrate, subsequently received US FDA approval for the treatment of presbyopia.

Phentolamine acts by relaxing the pupillary dilator muscle, resulting in indirect miosis and an increased depth of focus, which may improve near visual acuity.[26] The VEGA studies confirmed the therapeutic efficacy and safety profile of 0.75% phentolamine ophthalmic solution in the management of presbyopia.[36,37] This drug is currently under clinical evaluation and is awaiting US FDA approval for the treatment of presbyopia.

UNR844 (EV06) is a lipoic acid choline ester ophthalmic formulation designed to restore lens elasticity by reducing disulfide bonds within crystalline lens proteins, thereby offering a potential disease-modifying approach to presbyopia management.[38] In 2023, Novartis terminated its US FDA clinical trial of this drug due to failure to meet the study's primary objective.[39]

Combination therapy with pilocarpine helps sustain the pharmacological effect of cholinergic agonists. The Benozzi method involves twice-daily instillation of a combination of Pilocarpine 1% and diclofenac 0.1% eye drops in emmetropic patients with presbyopia to improve near vision while maintaining distance visual acuity.[40] In 2012, Kaufman proposed a potential approach for presbyopia correction involving monocular administration of pilocarpine combined with brimonidine (Alphagan-P) to improve near vision.[41] It is not FDA-approved for the treatment of presbyopia. Renna et al. (2016) evaluated a patented topical combination therapy comprising pilocarpine 0.247%, phenylephrine 0.78%, polyethylene glycol 0.09%, nepafenac 0.023%, pheniramine 0.034%, and naphazoline 0.003% under the name FOV Tears for presbyopia management. The formulation was designed to induce accommodation and improve near vision while preserving physiological pupillary behaviour and minimising the adverse effects commonly associated with miotic therapy.[42]

In 2008, True Vision Treatment (TVT), developed by Yolia Health in Mexico, was a non-invasive presbyopia treatment involving a customised contact lens and a proprietary ophthalmic solution designed to promote corneal remodelling to enhance near vision in patients without distance refractive error. Based on corneal topography, individualised lenses are prescribed and worn for approximately 8 hours daily for 7 days, along with hourly instillation of the ophthalmic solution during treatment. Patients are subsequently evaluated on the eighth day to assess visual outcomes.[43]

There are many prerequisites for prescribing eye drops to treat presbyopia, including taking a detailed ocular history. Patient selection for presbyopia eye drops should include assessment of symptoms, severity, occupational visual requirements, prior ocular surgery or trauma, and coexisting ocular conditions such as glaucoma, uveitis, retinal pathology, and dry eye disease.[42] A detailed refractive assessment, including distance and near refraction, estimation of near add requirements, and detection of latent hyperopia or astigmatism, is essential before prescribing presbyopia eye drops. Mild-to-moderate presbyopia cases are better candidates for treatment, as topical agents are more effective in individuals with preserved residual accommodation function.[43] Assessment of visual acuity should include both uncorrected and corrected distance visual acuity, as well as near visual acuity under photopic and mesopic conditions. The GEMINI trial reported that nearly 75% of subjects receiving treatment experienced at least a 2-line gain in mesopic distance-corrected near visual acuity.[44] Ideal candidates for pharmacological therapy are individuals who maintain good distance vision but primarily experience difficulty with near tasks due to presbyopia.[43] Baseline pupil diameter should be assessed under both

photopic and mesopic conditions prior to initiating pharmacological therapy for presbyopia, as many topical agents improve near vision by inducing miosis and increasing depth of focus.[26] Individuals with relatively larger baseline photopic pupil diameters (> 3 mm) are generally considered more suitable candidates and may experience better therapeutic outcomes with miotic therapy.[45] Accommodation and binocular vision testing, including amplitude of accommodation, ocular dominance, binocular function, and stereopsis, is important before initiating pharmacological therapy. The standard recommendation is to identify the dominant eye and correct it preferentially for distance vision.[46] A detailed anterior segment examination is essential for assessing ocular surface disorders, detecting any early lenticular opacities, and ruling out active inflammatory conditions before prescribing presbyopia eye drops. This is done because prolonged administration of pilocarpine has been associated with stimulation of the uveal tract, which can produce ocular inflammatory reactions.[47] IOP measurement is particularly important in patients receiving miotic agents, as pilocarpine lowers intraocular pressure by enhancing trabecular aqueous outflow.[48] A comprehensive posterior segment examination is essential to assess macular status and exclude pre-existing retinal pathology before prescribing presbyopia eye drops. Miotic agents such as Pilocarpine increase accommodative activity and alter vitreoretinal traction, which may predispose susceptible individuals with abnormal vitreoretinal adhesions to retinal tears or retinal detachment.[26] Pharmacological agents used for Presbyopia should be prescribed with caution or avoided when appropriate in patients with narrow-angle glaucoma, significant cataract, severe dry eye disease, active ocular inflammation, or increased risk of retinal detachment, as well as in individuals who are heavily dependent on nighttime driving.[49] Patient counselling is of the utmost priority to inform the patient about the temporary nature of the effect, the need for repeated instillation, and possible side effects such as headache, brow ache, dim vision, and hyperemia.[27,28,50] The patient should also be informed about variable responses among individuals and should have realistic expectations.

Lifestyle modifications such as limiting exposure to prolonged UV radiation by wearing sunglasses when going out. UV radiation may promote oxidative changes in the crystalline lens, leading to increased lenticular rigidity.[51] Smoking and alcohol consumption may contribute to the premature onset of presbyopia.[52] Systemic conditions, including diabetes mellitus and cardiovascular disease, may influence accommodative function through microvascular alterations that affect the crystalline lens and ciliary body.[53] Decreased antioxidant activity in the crystalline lens may contribute to the onset of presbyopia.[54] Experimental studies suggest that hesperidin, a citrus-derived flavonoid antioxidant, may preserve lens elasticity and delay lenticular ageing, thereby potentially slowing the onset of presbyopia.[54,55] Yoga has been explored as a supportive lifestyle approach to improve visual comfort and reduce eye strain in individuals with presbyopia. One such study proposed in India is expected to provide valuable evidence on the potential role of Yoga (Trataka Kriya) as a supportive intervention for patients with presbyopia.[56] Reducing digital eye strain through regular visual breaks and maintaining adequate illumination during near work may help improve visual comfort and reduce accommodative stress in individuals dealing with presbyopia and delay its onset. However, scientific evidence for this remains limited.

Optimal candidates for pharmacological treatment are typically younger presbyopes with mild-to-moderate disease, good distance vision, healthy ocular surfaces, normal retinal status, and realistic expectations. Individualised assessment of age, refractive status, ocular comorbidities, visual demands, and lifestyle factors is essential to maximise treatment efficacy while minimising adverse effects and patient dissatisfaction.

Pharmacological treatment of presbyopia should be used cautiously or avoided in patients with narrow-angle glaucoma, retinal detachment risk factors, active ocular inflammation, significant cataract, severe ocular surface disease, retinal pathology, advanced glaucoma, or conditions in which pharmacologically induced miosis may adversely affect visual function.

## CONCLUSION

The non-surgical management of presbyopia has evolved considerably in response to increasing life expectancy, growing digital dependence, and rising patient expectations for spectacle independence. With an expanding middle-aged population spending prolonged hours on near-vision tasks, such as mobile phone use, computer work, and reading, presbyopia has become an important visual and quality-of-life concern worldwide. In

addition, presbyopia represents an early stage of age-related lenticular dysfunction and may progress toward cataract formation as the crystalline lens undergoes progressive sclerosis and loss of elasticity with age.

Although cataract-related visual impairment ultimately requires surgical intervention, many presbyopic individuals prefer non-surgical treatment options in the early stages of lenticular ageing. Consequently, there has been increasing interest in conservative approaches to improve near vision while delaying or reducing the need for invasive procedures, and many patients prefer non-surgical options for their safety, reversibility, affordability, and minimal invasiveness.

Conventional optical correction with spectacles and contact lenses remains the cornerstone of presbyopia management because of its safety, accessibility, and effectiveness. However, recent advances in pharmacological therapy have significantly expanded the range of non-surgical treatment options. The US FDA approval of Vuity represents a major milestone in presbyopia management, introducing the first approved topical therapy for improving near vision through pharmacologically induced miosis. Similarly, the introduction of PresVu in India reflects the growing acceptance of pharmacological approaches tailored to the needs of Indian patients.

In addition to pharmacotherapy, lifestyle modifications, visual ergonomics, ocular surface optimisation, and complementary measures such as yoga-based eye exercises may help improve visual comfort and reduce digital eye strain. Nevertheless, appropriate patient selection, comprehensive ocular evaluation, and awareness of potential adverse effects are essential for achieving optimal outcomes.

Future advances in pharmacological and regenerative therapies hold the potential to revolutionise non-surgical presbyopia treatment while delaying the progression of cataract-associated visual disability.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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