Management of Presbyopia - A Review

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Presbyopia is not a refractive error but a condition of physiological insufficiency of accommodation due to reduced amplitude leading to a progressive fall in near vision(1).Though not incapacitating if corrected, presbyopia without optical correction results in an inability to perform once-effortless near tasks at a customary working distance without experiencing visual symptoms. Presbyopia has been described as "an irreversible optical failure, an unexplained evolutionary blunder that comes as a psychologic shock'(2).

Although there are a number of approaches for managing the visual disability associated with presbyopia, all of the available modalities are compensatory rather than corrective.

Presbyopia can be classified by type (2,7)

1. ***Incipient Presbyopia***
2. ***Functional Presbyopia***
3. ***Absolute Presbyopia***
4. ***Premature Presbyopia***
5. ***Nocturnal Presbyopia***
6. ***Prandial presbyopia***

PATHOPHYSIOLOGY OF PRESBYOPIA(1)-

1. Age related changes in lens :
   - Decrease in elasticity of lens capsule
   - Progressive increase in size and hardness of lens substance
2. Age related decline in ciliary muscle power

CLINICAL FEATURES OF PRESBYOPIA(1,2,4)-

- Difficulty seeing fine objects or small print
- Headaches, tired or sore eyes when reading
- The need to hold reading material further away
- The need to increase lighting for close work
- Intermittent diplopia

Management of Presbyopia -

The condition cannot be cured , only supportive care can be given.

Optical Correction with Spectacle Lenses -

Single vision lenses (unifocal lenses) -

The use of spectacles containing single vision lenses is an appropriate option for some patients with presbyopia. Typical candidates for this treatment are patients with emmetropia, patients with a low degree of ametropia (who do not require distance correction), and patients with uncorrected myopia whose uncorrected vision meets their near task needs (who may either remove their glasses for near tasks or use "reverse half-eye" glasses). Some patients who experience significant difficulty using multifocal lenses may prefer to use separate pairs of glasses for seeing at distance and near(1 , 2,).

Single vision spectacles with the near correction provide a wide field of view unmatched by any other form of spectacle correction for presbyopia, but they cause blurring of distance vision(1, 2). The distance blur should be demonstrated to the patient before prescribing single vision spectacles to use at near only. One option for patients without significant refractive error is traditional half-eye spectacles that allow them to look over the near vision lens and view distant objects clearly.

Bifocal lenses. These lenses incorporate the distance vision and the near vision prescriptions into a single spectacle lens. In the typical design, the majority of the lens area contains the distance vision correction while the near vision correction is confined to a smaller segment in the lower portion of the lens(2, 5). This configuration allows the patient to alternate between lens segments, according to the visual tasks at hand. A variety of designs and sizes of bifocal lenses are available (e.g., flat-top, curve-top, executive, round, Ultrex, blended) and should be selected on the basis of the characteristics and needs of the specific patient(5)

Flat-Top Lenses **-** Also known as the "D" style multi-focal lens, this type of lens has an a magnifying area in the lower part of the lens that resembles a letter D turned on its side, with the flat side up. This is among the easiest of multi-focal lenses to adapt to. It is also an available lens design and can be produced in any lens material. The flat top of the lens provides a definite transition between reading and distance vision(5).

Kryptok Lenses **-** Also referred to as a round lens, the magnifying area in the lower part of the lens is a complete circle. The lens can restrict viewing up top, due to the round shape. There is less significant transition between reading and distance vision(5).

Curved Top Lenses **-** Also known as the C-style, the magnification area is similar to the "D" style lens. However, the top of the area is slightly curved upward. The rounded corners on the segment are often marketed as enhancing peripheral(5)

Franklin Lenses - This lens most closely resembles the original bifocal lenses invented by Benjamin Franklin and are also known as executive, dual and full-segment lenses(5). This lens is often used as an occupational lens for those who do a lot of reading. Because the magnification area is so large, this style of lens offers the widest reading range of any bifocal.

Ultex Lenses **-** The ultex lens, also called the baseball segment, is similar to the executive lens, but with a curved rather than a straight transition. The wide segment makes ultex lenses an excellent choice for an occupational lens that offers a wider reading range(5)

Blended Lenses **-** Blended bifocal lenses are also referred to as the invisible or seamless bifocal. This lens is designed to conceal the transition from the magnification segment to the distance segment. This is accomplished by placing a blended range of 1mm to 2mm between the segments. This range can distort perspective at times that some may not adapt to easily(5)

Vocational Lenses **-** Vocational lenses have multiple magnifying segments in each lens above and below the midline of the lens. Double D, double Franklin and double-circle lenses are common configurations(5).

Trifocal Lenses - These multifocal lenses incorporate distance, intermediate, and near lens prescriptions, which is often important for patients who have advanced or absolute presbyopia. Trifocal lenses are manufactured in a variety of types and sizes, including flat-top, curve-top, executive, and round. The option of a greaterthan- standard vertical dimension of the intermediate segment of these lenses may improve vision for the patient who is frequently involved in intermediate distance tasks. The prescription for trifocal lenses should be tailored to the patient's specific vocational or avocational needs(5).

Specialty Lenses - These lenses can combine the benefits of different lens configurations to best improve the vision of the user.

Computer Lenses- These lenses separate the magnification powers into three progressive fields. Intermediate viewing is at the top of the lens, while near vision is at the bottom, with distance in the middle. This lens can help reduce the stress experienced when viewing computer monitors for long periods of time(5).

Progressive Lenses **-** Progressive lenses are true multi-focal lenses that more closely mimic the natural vision. The top portion of the lens is for distance vision. The center of the lens provides intermediate viewing, and the bottom allows for close reading. The transitions from one segment to another are smooth and seamless(5).

Optical Correction with Contact Lenses -

Both rigid and soft lens designs can be used for contact lens correction of presbyopia. When fitting contact lenses for presbyopia, the clinician should consider the patient's refraction, appropriate lens design, and ocular physiology. Evaluation of ocular physiology is important to ascertain which patients cannot tolerate contact lens wear (e.g., the patient with dry eye or corneal dystrophy). Other factors, such as the patient's motivation and understanding, vocational and avocational activities, support system, manual dexterity, personal hygiene, and financial situation are also important(2).

Contact lenses are of two types -

1. Monovision lenses
2. Bifocal contact lenses -
   (a) Alternating vision bifocal contact lenses
   (b) Simultaneous vision contact lenses

Monovision lenses. A common contact lens management for presbyopia is the monovision option, which uses a single vision contact lens in each eye or, when no distance correction is required, a lens in only one eye. The dominant eye is generally corrected for distance viewing; the fellow eye, for near. Modest decreases in contrast sensitivity and in stereopsis occur and sometimes affect the patient's driving and on-the-job performance. Some patients have difficulty with even a mild loss of stereopsis and report spatial disorientation and difficulty performing critical distance vision tasks(2,5)

Bifocal contact lenses. The correction of presbyopic vision with bifocal contact lenses is theoretically similar to that with multifocal spectacle lenses. Bifocal contact lenses may be made of either rigid or soft lens materials. Two basic design strategies are "alternating" vision and "simultaneous" vision

Alternating vision bifocal contact lenses. Whether of rigid or soft lens materials, bifocal contact lenses may be designed to facilitate an alternating (translating) vision process. Typically,when the patient looks straight ahead, the distance portion of the contact lens occupies a position in front of the pupil. Upon downgaze, the action of the lower eyelid causes the lens to move upward on the cornea so that the near vision segment is raised to a position in front of the pupil. To facilitate this action, the bifocal contact lens may incorporate prism ballast or truncation. Both of these features minimize lens rotation that could otherwise degrade vision. Pupil coverage by the distance and the near portions of the contact lens varies in the dynamic process of continual lens movement.

Simultaneous vision contact lenses. By design, the simultaneous vision contact lens simultaneously positions the distance and near portions of the lens over different parts of the pupil, producing two images of the object of regard, one superimposed on the other. When the object is at a distance that is appropriately focused by either the distance portion or the near portion of the lens, the image will be in sharp focus on the retina. Overlying it will be the out-of-focus image formed by the other portion of the lens. The net effect is that, even though the contrast will be somewhat reduced, there will be a rather sharp image of the object of regard. Sometimes patients report "ghosting" or shadows around images, and they may notice reduced contrast and reduced visual acuity(2, 5).

Combination of Contact and Spectacle Lenses

Many contact lens wearers gain some advantage by combining the use of spectacles with their contact lenses. One common example is the patient who uses contact lenses for distance viewing and adds glasses over the contact lenses for reading. A second example is the patient who has critical near vision tasks for most of the day and chooses to wear contact lenses for near, adding glasses for distance tasks. A third example is the monovision contact lens wearer who sometimes wears glasses to improve binocular vision for the performance of specific tasks. Some contact lens wearers use spectacles to correct residual astigmatism when performing more critical visual tasks(2, 3)

Refractive Surgery-

Patients should be informed of the range of possible side effects of refractive surgery (e.g.,overcorrection, undercorrection, induced astigmatism, regression, delayed epithelial healing, stromal haze, diplopia, ocular tenderness). Patients need to understand fully that, unlike treatment with ophthalmic lenses, refractive surgery is irreversible. Presbyopia patients contemplating refractive surgery should be informed of the likelihood of postsurgical need for reading spectacles to achieve clear vision for near tasks.

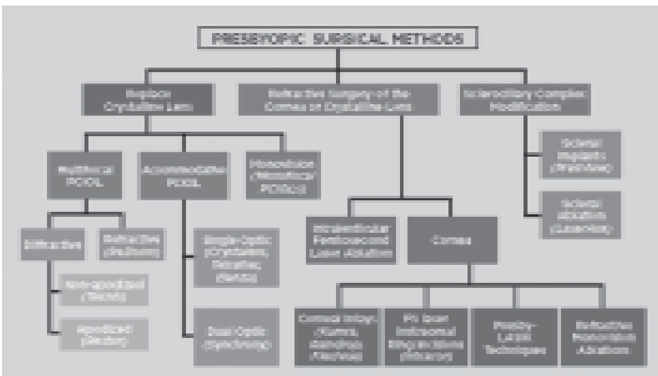

Table | Surgical treatment of presbyopia

Cornea

Monovision

- Laser in situ keratomileusis
- Photorefractive keratectomy

Presbyopic LASIK (multifocal laser ablation)

Conductive keratoplasty

Intractor femtosecond laser

Corneal inlay

Lens

Monovision (monofocal IOL)

Multifocal IOL

Accommodative IOL

Sclera

Anterior ciliary sclerotomy

Abbreviations : LASIK, Laser-Assisted in situ keratomileusis; intraocular lens.

Monovision LASIK and Photorefractive Keratectomy - (2, 3, 5)

Patient age has been considered as an important variable affecting the outcomes of various corneal refractive producers, such as LASIK and PRK. Younger patients tend to have a more aggressive healing response, which may contribute to some regression of the effect of treatment. Monovision has been used as a strategy to compensate for presbyopia by optically correcting one eye for distance vision and the other eye for near vision. However, this strategy induces anisometropia with a consequent reduction in binocular acuity and stereopsis. Although older patients may be symptomatic from presbyopia and thus more willing to accept monovision, several studies have not shown any correlation between age and monovision success. Women selected monovision slightly more often than men did on refractive laser correction range from 72% to 92.6%.Factors related to better results include good interocular blur suppression posttreatment of anisometropia of less than 2.50 diopters (D), successful distance correction of the dominant eye, good stereoacuity, lack of esophoric shift, and the willingness and motivation to adapt to this visual system. Since certain limitations and complications still persist in excimer laser correction, it is imperative to proceed with a complete ophthalmologic examination, including visual acuity assessment, refraction, intraocular pressure, and fundoscopic examination, as well as corneal thickness and corneal topography assessment. Assessment of biomechanical properties of cornea may be helpful but it is still under investigation. Thin cornea and/or abnormalities on topography, such as keratoconus, may prevent the refractive error correction. Complications such as haze and postoperative pain in PRK, as well as complications regarding the flap, diffuse lamellar keratite, corneal ectasia and dry eye in LASIK correction may occur. LASIK and PRK for myopia and hyperopia have shown reasonable safety, efficacy, and predictability profiles in the presbyopic age group

Presbyopic LASIK (multifocal laser ablation) -

The different strategies implemented to create a bifocal fit - in particular, the strategy to create a central steeper area - resulted in a potentially safer and more consistent outcome. The use of LASIK as a more controllable technique for corneal multifocality, avoiding the plastic compensatory effect of the growing epithelium reactive to surface ablation profiles, seems to be more adequate for presbyopia correction. ***In peripheral presbyLASIK, the central cornea is treated for distance, whereas in the periphery a negative asphericity is created to increase the depth of field. In central presbyLASIK, a hyperpositive area is created for the near vision at the center, whereas the periphery is left for far vision.*** Central presby LASIK, patients have reduced contrast sensitivity at higher spatial frequencies, a finding probably related to change in corneal aberration in coma and the changes in the retinal point-spread function. Moreover, some patients had night halos and loss of two lines in distance BSCVA.

Evidence from optic geometrical analysis of corneal surface suggests presbyopic correction up to 4 D might preserve good quality of vision. Most probably, presbyLASIK will offer a valid alternative for the correction of presbyopia, but scientific evidence is still necessary to support its widespread use today.

Conductive keratoplasty - (1, 2, 3)

CK is a nonablative, radiofrequency-based, collagen-shrinking procedure that has been approved by the Food and Drug Administration for the temporary correction of mild to moderate spherical hyperopia (+0.75 D to +3.00 D) in people over the age of 40 years. Radiofrequency energy is delivered through a fine tip inserted into the peripheral corneal stroma in a ring pattern outside of the visual axis. When a series of eight to 32 treatment spots are placed in up to three rings in the corneal periphery (6-, 7-, and 8-mm optical zones), striae form between the spots and create a band of tightening, resulting in a steepening of the central cornea, correction of hyperopic refractive error and improvement in near vision. CK avoids LASIK-related complications.CK can be performed in the office setting under topical anesthesia and involves the use of a portable unit that is much less expensive than most other refractive surgery platforms. After correction for near vision in one eye with CK, a phenomenon called "blended vision" has been observed. Different from monovision, in CK presbyopic correction appears to result in less compromise of distance vision binocularly, contrast sensitivity, or depth perception. Patients should be informed that this refractive procedure may not be permanent. Patient selection and education plays a vital role in CK surgery. Previous corneal surgery, epithelial or endothelial disease, keratoconus, pellucid degeneration, and significant dry eye are not considered good candidates. In conclusion, evidence suggests conductive keratoplasty acts as a temporary treatment of low to moderate hyperopia

Intracor femtosecond laser (2, 3) -

The Intracor procedure is performed using the femtosecond laser system, which delivers a completely intrastromal customized pattern of laser pulses into the cornea to induce a local reorganization of the biomechanical forces and change in corneal shape. The basic pattern for presbyopia correction is a series of femto-disruptive cylindrical rings that are delivered within the posterior stroma, at a variable distance from Descemet's membrane, and extending anteriorly through the mid-stroma to an anterior location at a predetermined fixed distance beneath Bowman's layer. The pattern of laser delivery is entirely intrastromal, without impacting either the endothelium, Descemet's membrane, Bowman's layer, or epithelium at any point throughout the procedure. The net effect is a central steepening of the anterior corneal surface, not in the shape of a steep central island, but rather as a multifocal hyperprolate, corneal shape with an ideal, pupil-dependent aberration pattern. The potential advantages of such a procedure are intrastromal delivery without breaking the epithelium, avoidance of pain and inflammation from the exposed ocular surface, speed of recovery due to the absence of surface wound healing, and stability of refractive outcome by preserving the strongest, anterior corneal fibers.

The side effects seen to date are minimal, with a slight disturbance of visual acuity during the early postoperative hours due to the cavitation gas bubbles located in the cornea, dissatisfaction with the hyperprolate aberration depth pattern, diffractive effects from the paracentral laser pulse delivery, high dependability on proper centration and alignment, and progression or loss of effect over time due to changes in the biomechanical corneal forces.

Corneal inlay - (2, 3) currently being investigated for the treatment of near-plano and plano presbyopia. This corneal inlay is designed to increase the of field using the principle of small-aperture optics to restore near and intermediate visual acuity without significantly affecting distance vision. A carbon pigment makes the inlay opaque. Sixteen hundred holes (25 mm diameter) arranged in a randomized pattern allow nutritional flow through the implant into the anterior stromal tissue to prevent corneal melting. Femtosecond laser is used to create a superior hinged flap in the nondominant eye. The intended depth from the corneal surface is 170 ?m, and with the patient fixating on the excimer laser microscope's single light source, the corneal inlay is centered on the stromal bed, with the first Purkinje reflex in the center of the inner diameter of the inlay. One great advantage of the corneal inlay procedure is its potential reversibility because no ablation is performed over the optical axis. The inlay, however, like other refractive procedures, causes a small loss of contrast sensitivity.

Lens approaches - (3)

As modern technology advances and expectations increase, cataract surgery is no longer purely a visual restoration procedure. The refractive component, including management of presbyopia, has become more important. At present, there is no single perfect solution for managing presbyopia. The lens approach is becoming popular day by day. The lens that can be used are monofocal, multifocal ,accommodative and pseudoaccomodative.

Pseudoaccommodative Intraocular lens implantation

Pseudoaccommodative intraocular lenses offer a potential forward-backward movement in the eye, thus changing the focal point. This is achieved by new, flexible haptic designs that allow the lens to move while forces interact with the capsular bag. These lenses are undergoing investigational trials(2)

Accommodative intraocular lenses

The accommodative IOL uses ciliary muscle contraction to change the dioptric power of the IOL. Current accommodative IOL approaches are based on the "focus shift" principle: through an essentially hypothetical mechanism, contraction of the ciliary muscle would move the optic anteriorly, thereby increasing the dioptric power of the eye. Cimberle reported on Moedas's results of 21 patients who received the AT-45 accommodative lens and emphasized the importance of immersion biometry to accurately measure axial length prior to implantation.

Posterior capsule opacification may be an important complication of these new lens and haptic designs, and long-term studies are required to prove the biocompatibility of such lenses. Also, the long-term ability and stability of the lenses, especially after neodymium:YAG capsulotomy, need to be evaluated and the designs optimized.(2 , 3)

In accommodative IOLs depth perception is problematic but glare and halos seems to be lesser than multifocal IOLs.

Lens Refilling - Lens refilling is another technique that attempts to replace the crystalline lens with artificial accommodative IOLs. Wesendahl et al proposed using a hydrogel lens and Nishi et al suggested silicone material(2, 3) but it needs further studies and modifications

Multifocal Defractive and Refractive IOLs (2, 3)

These lenses have multiple concentric rings of varying optical power and provide full distance visual acuity and a sufficient near visual acuity . Multifocal lenses are preferably implanted in cataract patients or are a procedure of choice in conjunction with clear lens extraction

The lenses have different distributions of light on the pathway from the lens to the retina and can be divided into two groups:

- o Diffractive multifocals belong to the first generation of multifocal intraocular lenses. They separate the incoming light into two different focal points, one for near objects and one for distance objects, which means they are effectively bifocal lenses.
- o Refractive IOLs, on the other hand, have a refracting surface, and 100% of the light reaches the retina, in contrast to the diffractive lenses.

Excellent clinical outcomes have been reported; however, patient dissatisfaction and secondary procedures, including IOL exchange, can also be significant. Multifocal IOLs provided better uncorrected near acuity. Nevertheless, multifocal IOLs reduced contrast sensitivity and caused more glare and halos. These optical effects can be so disturbing that secondary intervention and IOL removal after the original surgery might be required.

As with all intraocular lenses, posterior capsular opacification (PCO) is a problem that should be addressed with modern PCO-reducing IOL designs, such as sharp edges and foldable materials. Selection and education of patients are very important to optimize patients' visual outcome and satisfaction following multifocal IOL implantation. These multifocal IOL prototypes will undoubtedly advance to multifocal phakic IOL designs in the near future.

Monovision Procedures- In monovision procedures, one eye is optically corrected for distance vision and the other eye for near vision. This can be achieved with contact lenses, corneal refractive procedures (eg, RK, PRK, LASIK, LTK, CK), or IOLs. Not every patient is a candidate for this procedure, however, and the binocular visual function is decreased. In all monovision procedures the image quality in one eye will be blurred at a given distance, while the other eye is in focus. Thus, the patient should be able to suppress the blurred vision in one eye in favor of the clear image seen with the other eye.

Anterior ciliary sclerotomy (2, 3)

Anterior ciliary sclerotomy involves making radial incisions in the sclera overlying the ciliary muscle. Based on Schachar's theory, this may allow expansion of the sclera overlying the ciliary body, increasing the space between the lens equator and ciliary body. This may place more resting tension on the equatorial zonules, allowing for increased tension to develop during ciliary muscle contraction. The procedure is hypothesized to restore accommodative amplitude in presbyopic subjects. The effect of surgery gradually disappeared,due to healing of the sclera.

An alternative technique for scleral expansion uses polymethyl methacrylate bands placed in tunneled partial-scleral thickness incisions overlying the ciliary body in each of the four quadrants. This technique is called scleral expansion segment surgery.

Evidence suggests that anterior ciliary sclerotomy or any other scleral surgical technique is not an appropriate treatment for the correction of presbyopia. Better-controlled studies are needed before widespread adoption of these techniques.

Conclusion

The treatment of presbyopia started with unifocal spectacles and now it has landed at many surgical approach which try to correct the accommodation insufficiency.the total transition duration has seen bifocals , contact lenses , corneal surgeries , lens surgeries and sclerociliary procedures.to delay presbyopic onset accommodative exercises have been proposed.After an extensive review of the techniques and results of treatments aimed at correcting both distance and near vision in the presbyopic population, we noted that a unique and ideal solution is still not available. In fact the search for the restoration of true accommodation remains a challenge. In most of the procedures, near vision is achieved at the expense of far vision and/or quality of image. Technological advancements in terms of surgical instruments, biomaterials, and engineering and surgical capabilities have certainly moved surgical restoration of accommodation from a theoretical concept more into real ophthalmic practice, but much work still remains. Another major point is that neuroadaptive responses in presbyopia have not been adequately studied. Understanding which patients have neuroadaptive abilities may aid in patient selection. The ophthalmologist should decide which surgical management is the best choice for each patient. The most important recommendation is to help patients to set realistic expectations, and together with the subject evaluation, predict the effectiveness of surgery

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