

Peer-Reviewed Literature:

# Surgical Correction of Presbyopia



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Surgical options for the correction of presbyopia have generated considerable ophthalmic interest for centuries. A myriad of surgical options exists primarily because the etiology of presbyopia is not well understood. Hermann von Helmholtz theorized that accommodation results from elastic properties of the lens, which add to the lens' anterior and posterior dimensions and increase its power when zonular tension is relieved during ciliary muscle contraction. Thus, Helmholtz believed that presbyopia is caused by nuclear sclerosis of the lens, which becomes unable to change shape with age. This theory has been challenged by Ronald Schachar, MD, who suggests the longitudinal fibers of the ciliary muscle contract during accommodation, thereby placing more tension on the equatorial zonules while relaxing the anterior and posterior zonules. This tension difference causes an enlargement in the equatorial diameter that increased the central lenticular volume and, thus, the power of the lens.<sup>1</sup>

Methods of presbyopic surgical correction include monovision, anterior ciliary sclerostomy, scleral expansion bands, and lens implantation.

The following articles were reviewed for this discussion:

1. Hamilton DR, Davidorf JM, Maloney RK. Anterior ciliary sclerostomy for treatment of presbyopia: a prospective controlled study. *Ophthalmology*. 2002;109:1970-1977.
2. Jain S, Ou R, Azar DT. Monovision outcomes in presbyopic individuals after refractive surgery. *Ophthalmology*. 2001;108:1430-1433.
3. Malecaze FJ, Gazagne CS, Tarroux MC, Gorrard JM. Scleral expansion bands for presbyopia. *Ophthalmology*. 2001;108:2165-2171.
4. Jacobi PC, Dietlein TS, Lüke C, Jacobi FK. Multifocal intraocular lens implantation in prepresbyopic patients with unilateral cataract. *Ophthalmology*. 2002;109:680-686.
5. Küchle M, Seitz B, Langenbucher A, et al. Comparison of 6-month results of implantation of the 1CU accommodative intraocular lens with conventional intraocular lenses. *Ophthalmology*. 2004;111:318-324.
6. Cumming JS, Slade SG, Chayet A, AT-45 Study Group. Clinical evaluation of the model AT-45 silicone accommodating intraocular lens: results of feasibility and the initial phase of a FDA clinical trial. *Ophthalmology*. 2001;108:2005-2010.
7. Baikoff G, Matach G, Fontaine A, et al. Correction of presbyopia with refractive multifocal phakic intraocular lenses. *J Cataract Refract Surg*. 2004;30:1454-1460.

## MONOVISION

Monovision is a simple method used to mask presbyopia. Typically, the patient's dominant eye is corrected for distance, and his nondominant eye is corrected for near tasks (-1.00- to -2.00-D endpoint). This correction can be achieved with corneal treatments such as LASIK, conductive keratoplasty, and PRK, as well as with monofocal lens implantation.

Jain et al<sup>2</sup> reported outcomes in 144 monovision patients following refractive surgery. Thirty-five patients (24%) had bilateral distance correction postoperatively, and 42 (29%) had anisometropia of less than -3.50D (monovision). Twenty-one percent of patients had more than 3.50D of anisometropia and were not evaluated in this study. Although 10 monovision patients underwent a monovision trial prior to surgery, two patients in this group requested correction, due to blurry vision and residual astigmatism. The overall monovision subjective satisfaction rate was 88%, slightly higher than the mean success rate of 76% found in the literature.

## ANTERIOR CILIARY SCLEROSTOMY

Anterior ciliary sclerostomy employs radial cuts in the sclera overlying the ciliary body to allow the sclera to extend, which can increase the space between the crystalline lens and the ciliary body. Researchers<sup>1</sup> reported the results of the procedure in nine eyes. However, the study was discontinued after two significant complications occurred: an anterior chamber perforation and sectoral iris akinesis. The investigators reported that the procedure failed to yield a statistically significant improvement in either accommodative amplitude or near vision through best-corrected distance vision compared with controls.

## SCLERAL EXPANSION BANDS

Scleral expansion bands are four arcuate segments inserted into scleral loops located in four quadrants. This procedure is based on Schachar's theory of accommodation. Malecaze et al<sup>3</sup> investigated scleral expansion bands in six subjects (four monocular and two bilateral implantations). The investigators found no increase in near visual acuity (40cm) or in accommodative amplitude 1 year postoperatively compared with preoperative values. Three patients requested removal of the segments due to a lack of beneficial effect.

## IOLs

IOLs have been used in refractive lensectomy or in conjunction with cataract extraction to correct presbyopia. Jacobi et al<sup>4</sup> evaluated multifocal IOL implantation (Array multifocal lens; Advanced Medical Optics, Inc.,

Santa Ana, CA) in patients with unilateral cataracts. Fifty-four patients received monocular implants, and 41 received multifocal lenses. No difference in dependency on the distance spectacle correction was noted postoperatively, and 81% of the multifocal patients believed they could function at near compared with 49% of monofocal subjects. This study was not blind, however; subjects' preoperative education regarding the limits of the type of lens implanted may have influenced the results. Additionally, four lenses became dislocated during the study; three were multifocal.

Küchle et al<sup>5</sup> reported the results of an accommodative PCIOL (Akkommodative 1CU; Humanoptics AG, Erlangen, Germany) implanted in 20 eyes compared to a monofocal PCIOL implanted in 20 eyes. The 1CU is intended to allow the patient to accommodate by means of anterior movement of the lens haptic as the ciliary muscle contracts. The amount of pseudophakic accommodation produced was limited—less than 1.25D for all methods of accommodation tested (defocus, near point, and retinoscopy).

Cummings et al<sup>6</sup> evaluated the AT-45 pseudophakic accommodating IOL (Crystalens; Eyeonics Inc., Aliso Viejo, CA) in 75 eyes of 62 patients. This lens is designed to allow horizontal movement along the visual axis of the eye using the natural physiology of the intact ciliary muscles. Uncorrected distance visual acuity was 20/40 or better in 90% of patients, and 97% of patients (60/62) had uncorrected near visual acuity of 20/30 or better. No complications or adverse events were reported.

Baikoff et al<sup>7</sup> evaluated multifocal anterior chamber phakic lenses (Vivarte presbyopic phakic refractive lens; Ioltech Laboratories, La Rochelle, France) implanted in 55 eyes of 33 patients. Eighty-four percent of patients had UCVA of 20/33 at distance and near UCVA of J2 or better. Ten percent of eyes developed pupil ovalization in bright light conditions secondary to the implantation of a large lens. No endothelial cell loss was noted. Eighteen percent of patients reported seeing halos, although only two of 33 eyes experienced vision difficulty that interfered with patients' nighttime driving. The authors suggested that demanding patients and those whose professions require significant night driving be considered noncandidates for phakic bifocal lens implantation.

## THE BOTTOM LINE

Nearly all studies reviewed commented that proper patient selection and extensive education are crucial to the success of presbyopic correction. However, no treatment modality yields nearly 100% success in visual performance and comfort. The simplest technique to mask presbyopia is monovision, which is extremely successful

in patients who have previously worn monovision contact lenses. Further studies may determine if the benefit of presbyopic correction is worth the surgical risk. ■

### Reviewers

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