# Medical Coverage Policy

**Effective Date.....12/15/2024**
**Next Review Date.....11/15/2025**
**Coverage Policy Number..... 0141**

# Corneal Remodeling for Refractive Errors

## Table of Contents


Overview ..... 2
Coverage Policy..... 2
Health Equity Considerations..... 3
General Background ..... 3
Medicare Coverage Determinations ..... 14
Coding Information..... 14
References ..... 16
Revision Details ..... 21


## Related Coverage Resources

Intraocular Lens Implant

***INSTRUCTIONS FOR USE***

*The following Coverage Policy applies to health benefit plans administered by Cigna Companies. Certain Cigna Companies and/or lines of business only provide utilization review services to clients and do not make coverage determinations. References to standard benefit plan language and coverage determinations do not apply to those clients. Coverage Policies are intended to provide guidance in interpreting certain standard benefit plans administered by Cigna Companies. Please note, the terms of a customer's particular benefit plan document [Group Service Agreement, Evidence of Coverage, Certificate of Coverage, Summary Plan Description (SPD) or similar plan document] may differ significantly from the standard benefit plans upon which these Coverage Policies are based. For example, a customer's benefit plan document may contain a specific exclusion related to a topic addressed in a Coverage Policy. In the event of a conflict, a customer's benefit plan document always supersedes the information in the Coverage Policies. In the absence of a controlling federal or state coverage mandate, benefits are ultimately determined by the terms of the applicable benefit plan document. Coverage determinations in each specific instance require consideration of 1) the terms of the applicable benefit plan document in effect on the date of service; 2) any applicable laws/regulations; 3) any relevant collateral source materials including Coverage Policies and; 4) the specific facts of the particular situation. Each coverage request should be reviewed on its own merits. Medical directors are expected to exercise clinical judgment where appropriate and have discretion in making individual coverage determinations. Where coverage for care or services does not depend on specific circumstances, reimbursement will only be provided if a requested service(s) is submitted in accordance with the relevant criteria outlined in the applicable Coverage Policy, including covered diagnosis and/or procedure code(s). Reimbursement is not allowed for services when billed for conditions or diagnoses that are not covered under this Coverage Policy (see "Coding Information" below). When billing, providers must use the most appropriate codes as of the effective date of the submission. Claims submitted for services that are not accompanied by covered code(s) under the applicable Coverage Policy*

*will be denied as not covered. Coverage Policies relate exclusively to the administration of health benefit plans. Coverage Policies are not recommendations for treatment and should never be used as treatment guidelines. In certain markets, delegated vendor guidelines may be used to support medical necessity and other coverage determinations.*

## Overview

This Coverage Policy addresses procedures used specifically for the correction of refractive errors (i.e., myopia [nearsightedness], hyperopia [farsightedness], presbyopia [loss of near vision with age], and astigmatism).

This policy is not intended to address corneal procedures, including corneal transplantation, performed for the treatment of eye diseases.

## Coverage Policy

**Coverage for services for or related to routine refraction and the surgical treatment of refractive errors varies across plans. Please refer to the customer's benefit plan document for coverage details.**

**If coverage is available for services for or related to routine refraction and the surgical treatment of refractive errors, the following conditions of coverage apply.**

**Corneal Relaxing Incisions**

**Correction of surgically-induced astigmatism 3.00 diopters (D) or greater with a corneal relaxing incision (CPT® code 65772) post-cataract or post-corneal transplant surgery is considered medically necessary in an individual who is intolerant of glasses or contact lenses.**

**Corneal relaxing incision (CPT® code 65772) is considered not medically necessary for any other indication.**

**Intrastromal Corneal Ring Segments**

**The insertion of intrastromal corneal ring segments (CPT® code 65785) (i.e., INTACS® prescription inserts) is considered medically necessary when provided in accordance with the Humanitarian Device Exemption (HDE) specifications of the U.S. Food and Drug Administration (FDA) for the treatment of myopia and astigmatism in individuals with keratoconus who meet ALL of the following criteria:**

- progressive deterioration in vision, such that adequate functional vision on a daily basis with contact lenses or spectacles can no longer be achieved
- age 21 years of age or older
- clear central corneas
- corneal thickness of 450 microns or greater at the proposed incision site
- corneal transplantation is the only other remaining option for improving functional vision

**Intrastromal corneal ring segments (CPT® code 65785) (e.g., INTACS® prescription inserts) are considered not medically necessary for any other indication.**

**Other Procedures**

**Each of the following procedures is considered not medically necessary when performed solely for the treatment of refractive errors:**

- conductive keratoplasty (CPT® code 66999)
- lamellar keratoplasty (non-penetrating keratoplasty) (CPT® codes 65710; 66999)
- laser thermokeratoplasty (LTK) (CPT® code 66999)
- limbal relaxing incisions for non-surgically induced astigmatism (CPT® code 66999)
- penetrating keratoplasty (PK) (corneal transplantation, perforating keratoplasty) (CPT® code 66999)

**Each of the following refractive procedures is considered experimental, investigational or unproven:**

- automated lamellar keratomileusis (ALK) (i.e. standard keratomileusis) (CPT® code 65760)
- corneal allogenic intrastromal ring segments (CAIRS) (CPT® code 65785)
- corneal inlay (CPT® code 66999)
- corneal tissue addition keratoplasty (CTAK) (CPT® code 65710)
- hexagonal keratotomy (CPT® code 66999)
- keratophakia (CPT® code 65765)
- laser epithelial keratomileusis (LASEK) (CPT® code 66999)
- minimally-invasive radial keratotomy (mini-RK) (CPT® code 66999)
- orthokeratology (HCPCS code V2599)
- scleral expansion surgery (CPT® code 66999)

## Health Equity Considerations

Health equity is the highest level of health for all people; health inequity is the avoidable difference in health status or distribution of health resources due to the social conditions in which people are born, grow, live, work, and age.

Social determinants of health are the conditions in the environment that affect a wide range of health, functioning, and quality of life outcomes and risks. Examples include safe housing, transportation, and neighborhoods; racism, discrimination and violence; education, job opportunities and income; access to nutritious foods and physical activity opportunities; access to clean air and water; and language and literacy skills.

By 2050, it is estimated that the majority of total visual impairment will be due to uncorrected refractive error. Undiagnosed and uncorrected refractive errors contribute to the developmental, academic and social challenges in children, and, in some cases, vision loss. The presence and type of uncorrected refractive error varies by race and ethnicity. For example, Black and Hispanic children are more likely to be myopic than white children, while white and Hispanic children are more likely to be hyperopic than Black children. Racial and ethnic differences exist for astigmatism as well. The Multi-Ethnic Pediatric Eye Disease Study found a higher prevalence of presenting refractive error–related visual impairment in both Black children and Hispanic children than in either Asian American or non-Hispanic white children (Elam, et al., 2022).

## General Background

In the normal eye, both the cornea and lens function to refract or bend light rays and focus them on the retina to produce clear images. Refractive error (ametropia) is present when parallel rays

of light entering the non-accommodating eye do not focus on the retina. The errors are defects in the functioning power of the eye due to an imperfectly shaped eyeball, cornea or lens, so that viewed objects are focused either in front of or behind the retina, resulting in blurred vision. Refractive errors include myopia, or nearsightedness; hyperopia, or farsightedness; astigmatism, in which an uneven curvature of the cornea blurs vision for both near and far objects; and presbyopia, which is associated with aging and loss of flexibility of the lens, limiting the ability of the eye to change its point of focus from far to near.

Corneal ectasia, also known as keratectasia or iatrogenic keratoconus, is caused by irregularities in the cornea that lead to disturbances of vision as a result of astigmatism. The term corneal ectasia can refer to a group of conditions, most notably keratoconus, but can also be related to irregular astigmatism that can develop after a patient undergoes refractive surgery (laser in situ keratomileusis [LASIK] or photorefractive keratectomy [PRK]). Corneal ectasia after laser refractive surgery is a keratoconus-like focal biomechanical disorder characterized by progressive distortion of the corneal shape and optical quality. The cornea can continue to bulge, leading to a worsening of vision (American Academy of Ophthalmology [AAO], 2023).

Keratoconus is a non-inflammatory degenerative condition in which collagen fibers within the cornea weaken and progressively thin. As a result, the thinning the fibers can no longer maintain the normal round shape of the cornea. Consequently, the cornea bulges outward, steepens and develops a progressive conical shape. This abnormality prevents light that is entering the eye from focusing directly on the retina, resulting in irregular astigmatism and progressive myopia or visual loss. In a 2016 study, Woodward et al. found that Black and Latino Americans had significantly higher odds of being diagnosed with keratoconus than white Americans (57% and 43%, respectively), while Asian Americans were 39% less likely to develop the condition than white individuals. Other factors which have been found to increase the risk of development of keratoconus include asthma, sleep apnea, Down syndrome, connective tissue disorders, allergic eye disease, a family history of keratoconus, and Leber congenital amaurosis (Oyeniran and Tauqeer, 2021; Woodward, et al., 2016; Gomes, et al., 2015).

**Surgical Treatment of Refractive Errors**
Refractive surgery refers to surgical procedures designed to correct refractive errors by reshaping the corneal surface, and to improve the focusing power of the eye, thus reducing or eliminating the need for corrective lenses. According to the AAO, refractive surgery is an elective procedure which may be considered by those who wish to become less dependent on spectacles or contact lenses or when there is an occupational or cosmetic reason to not wear spectacles (AAO, 2022a).

The need to correct refractive errors depends on the patient's symptoms and visual needs. Those with low refractive errors may not need correction. Small changes in refractive corrections in asymptomatic patients are usually not recommended. The major reasons for treating refractive errors are to improve visual acuity, function and comfort. Other reasons for treatment include enhancing binocular vision and decreasing strabismus. Patients with high refractive errors generally require correction to achieve satisfactory vision. Options for correcting refractive errors include spectacles, contact lenses or surgery. Spectacles should be considered before contact lenses or refractive surgery. The majority of adults can tolerate up to 3.0 D of difference in eyeglass refractive correction. Occasionally, individuals may tolerate more than 3.0 D of difference.

**Refractive Procedures**

**Corneal Relaxing Incisions/Corneal Wedge Resection (Arcuate Keratotomy [AK])**
Corneal relaxing incisions are a type of incisional treatment used in the management of astigmatism and include arcuate (or "astigmatic") keratotomy (AK) and limbal relaxing incisions

(LRIs). In AK, either transverse or arcuate incisions are made in the paracentral cornea to change its curvature in order to reduce or eliminate corneal astigmatism by allowing the cornea to become more rounded when it heals. AK is often performed for the correction of surgically-induced astigmatism and following medically indicated cataract removal or corneal transplant surgery. Variations of AK include the Ruiz procedure and the Troutman Wedge Resection also referred to as a corneal wedge resection. The wedge resection, often used with corneal relaxing incisions, effectively decreases astigmatism. However, clinical results have been reported to be unpredictable, therefore, the technique is typically reserved for the correction of post-keratoplasty astigmatism of high degree.

Limbal relaxing incisions (LRIs) or peripheral corneal relaxing incisions are also a variant of AK in which incisions are placed just on the far peripheral aspect of the cornea. The incisions are created with blades designed to achieve a consistent depth. Femtosecond lasers may also be used to create arcuate incisions. LRIs may be used to treat low to moderate degrees of astigmatism and have been performed alone or combined with cataract extraction and intraocular lens implantation to reduce preoperative corneal astigmatism (AAO, 2022a). The correction of iatrogenic astigmatism is generally supported, while the use of LRIs to treat astigmatism not resulting from a prior surgery (e.g., correction of pre-existing, non-surgically induced astigmatism during cataract surgery) is considered not medically necessary.

**Intrastromal Corneal Ring Segments (ICRS)**
This procedure involves inserting a flexible ring beneath the surface of the cornea to elevate the edge of the cornea to flatten the front of the eye, decreasing nearsightedness. Different size rings are used to correct different degrees of nearsightedness. Intrastromal corneal ring segments have been investigated for two indications—as a refractive procedure to correct mild myopia and as a treatment of keratoconus.

**U.S. Food and Drug Administration (FDA):** On April 9, 1999, INTACS™ (Keravision Inc., Fremont, CA) received premarket application (PMA) approval from the FDA for the treatment of adults with mild myopia (from -1.0 to -3.0 D) who have ≤ 1.0 D of astigmatism. Intrastromal corneal ring segments are considered not medically necessary for patients with mild myopia. They are considered investigational for children, for patients with moderate to severe myopia (greater than -3.0 D), for patients with more than 1.0 D of astigmatism, and for hyperopia.

On July 26, 2004, INTACS® prescription inserts for keratoconus (Addition Technology, Sunnyvale, CA) received humanitarian device exempt (HDE) approval from the FDA. A humanitarian use device (HUD) is exempt from the effectiveness requirements of a PMA. According to the FDA, INTACS prescription inserts are indicated for the reduction or elimination of myopia and astigmatism in a specific subset of patients with keratoconus who meet all of the following criteria:

- progressive deterioration in vision, such that adequate functional vision on a daily basis with contact lenses or spectacles can no longer be achieved
- 21 years of age or older
- clear central corneas
- corneal thickness of 450 microns or greater at the proposed incision site
- corneal transplantation is the only remaining option to improve functional vision

**Literature Review:** Case series and comparative trials have evaluated the safety and effectiveness of intrastromal corneal implants for keratoconus (Torquetti, et al., 2009; Kymionos, et al., 2007; Colin and Malet, 2007; Ertan and Bahadir, 2006; Colin, 2006; Kanellopoulos, et al., 2006; Siganos, et al., 2003; Boxer, et al., 2003; Colin, et al., 2001). Some studies have had limitations including retrospective design, small sample size, and short-term follow-up. However, results of the available evidence indicate that the use of intrastromal corneal implants for

individuals with keratoconus is associated with improved functional vision and can defer or possibly eliminate the need for corneal transplantation.

Intrastromal corneal ring segments have been investigated as a treatment for corneal ectasia after LASIK. According to the AAO, reported techniques vary in the size, number, and symmetry of the implants as well as the location of the incision. Although early results show potential, long-term efficacy for this procedure remains to be determined (AAO, 2022a). Treatment for post- LASIK ectasia is not an FDA-approved indication for intrastromal corneal ring segments.

**Laser in Situ Keratomileusis (LASIK)**
LASIK is a type of laser surgery of the cornea performed to correct refractive errors. A slice of the patient's cornea is removed, shaped to the desired curvature with an excimer laser, and then sewn back to the remaining cornea. In recent years, LASIK surgery has become the procedure of choice for treating moderate to high levels of myopia, with or without astigmatism. In 1995, the first refractive laser systems approved by the U.S. Food and Drug Administration (FDA) were the excimer lasers for use in photorefractive keratectomy (PRK) to treat myopia and, later, to treat astigmatism. Physicians then began using these lasers for LASIK surgery and to treat refractive disorders other than myopia. The laser emits an ultraviolet beam that is able to reshape the cornea. Refractive errors are minimized with the aid of a programmed computer that, using a patient’s refraction and corneal topography, controls the laser beam to precisely remove corneal tissue.

Residual refractive errors after penetrating keratoplasty are usually responsible for decreased visual acuity despite a clear graft. The mean amount of astigmatism that has been reported after penetrating keratoplasty for keratoconus is usually between 2 and 6 D. Correction with spectacles or contact lenses should be considered initially, followed by the possibility of incisional refractive surgery if the patient is intolerant to either of these alternatives. The goals of LASIK after penetrating keratoplasty are to decrease the degree of anisometropia and ametropia to levels at which correction with glasses or contact lenses can be tolerated (Sierra and Hardten, 2019). Anisometropia means that the two eyes have a different refractive power, so there is unequal focus between the two eyes. This is often due to one eye having a slightly different shape or size from the other causing asymmetric curvature (astigmatism), asymmetric far-sightedness (hyperopia), or asymmetric near-sightedness (myopia).

**Photorefractive Keratectomy (PRK)**
PRK involves the reshaping of the surface of the cornea with an excimer laser to correct mild-to-moderate myopia. The laser alters the anterior curvature to modify a particular refractive error by varying the ablation pattern. Photoastigmatic keratectomy (PARK or PRK-A) is a refractive surgical procedure used to correct myopia with astigmatism. Both procedures are considered not medically necessary for patients with hyperopia of up to 6.0 D, and myopia of up to -10.0 D, with or without astigmatism up to 4.0 D, because the refractive corrections achieved with PRK and PARK are less precise than that achieved by eyeglasses or contact lenses. PRK and PARK are considered investigational for patients with hyperopia greater than 6.0 D, myopia greater than -10.0 D, astigmatism greater than 4.0 D, and for all other refractive errors. This is based on the FDA-approved indications for PRK and PARK.

**Other Procedures**

**Conductive Keratoplasty (CK):** CK is the application of radiofrequency thermal energy to increase the curvature of the cornea and thereby reduce hyperopia. On April 11, 2002, ViewPoint CK System® (Refractec Inc., Irvine, CA) received premarket approval (PMA) from the FDA. Based on data submitted with the PMA application, the ViewPoint CK System® is approved for the treatment of patients who are at least 40 years of age, who have mild to moderate hyperopia

(0.75 D to 3.25 D), 0.75 D or less astigmatism, and whose eyesight has changed very little over the previous 12 months, as demonstrated by a change of less than 0.50 D in refraction. According to the FDA, CK improves distance vision in farsighted people, but the amount of farsightedness correction is not always permanent. Those who require very acute vision for work-related activities may still need glasses, and glasses will also be needed for reading.

Currently, there is insufficient evidence in the peer-reviewed literature to support the effectiveness of CK for the treatment of presbyopia. Studies are primarily in the form of case series with small sample sizes (n=10-27) and follow-ups of 1-3 years (Ye, et al., 2011; Stahl, 2007). A larger series by McDonald and colleagues (2004) reported preliminary results of a multicenter clinical trial supported by the FDA to evaluate the effectiveness of CK for the treatment of presbyopic symptoms of emmetropic and hyperopic eyes. A total of 143 patients with presbyopic symptoms were enrolled in this one-year study and treated to improve near vision in one eye (unilateral treatment). In addition, 33 fellow eyes were treated to improve distance vision (bilateral treatment). At six months follow-up, 77% of examined eyes had J3 or better monocular UCVA, and 85% of patients had binocular UCVA of 20/25 or better distance along with J3 or better near, a combination that represents functional acuity for a presbyopic individual. Of eyes treated with CK, 92% had an uncorrected binocular vision of 20/32 and J5, which also allows a high degree of uncorrected visual function. It was noted that follow-up was too short for meaningful determination of refractive stability; follow-up to three years and beyond is needed for accurate evaluation of stability.

According to the AAO (2022a) disadvantages of CK include early overcorrection, regression and induced astigmatism. The procedure is not frequently used today.

**Lamellar Keratoplasty (Non-Penetrating Keratoplasty):** This is a corneal transplant procedure in which a partial thickness of the cornea is removed. The diseased tissue is replaced with a partial-thickness donor cornea. There are two types of lamellar keratoplasty: anterior lamellar keratoplasty (including the subtype deep anterior lamellar keratoplasty [DALK]) and posterior lamellar keratoplasty (also referred to as endothelial keratoplasty). Lamellar keratoplasty may be indicated for a number of corneal diseases, including scarring, edema, thinning, distortion, dystrophies, degenerations and keratoconus. However, it is considered not medically necessary when performed solely to correct astigmatism and other refractive errors.

**Laser Thermokeratoplasty (LTK) (Other Than Conductive Keratoplasty):** LTK utilizes the following methods: superficial treatment of Gassett and Kaufman for keratoconus, holmium, YAG laser thermokeratoplasty, or the hot needle of Fyodorov. Based on review of the literature, all of these methods of thermokeratoplasty have been abandoned in current refractive surgery because the corneal wound-healing response produces postoperative scarring and instability.

**Limbal Relaxing Incisions (LRIs):** LRIs, or peripheral corneal relaxing incisions, are a variant of arcuate (astigmatic) keratotomy (AK) (see above) in which incisions are placed just on the far peripheral aspect of the cornea. LRIs may be used to treat low to moderate degrees of astigmatism and have been performed alone or combined with cataract extraction and intraocular lens implantation to reduce preoperative corneal astigmatism (AAO, 2022a). As such, the use of LRIs to treat astigmatism that is not surgically induced is considered not medically necessary.

**Penetrating Keratoplasty (PK) (Corneal Transplantation, Perforating Keratoplasty):** PK involves replacement of the full-thickness of the cornea with a donor cornea, but retains the peripheral cornea. As with lamellar keratoplasty, this procedure may be indicated for a number of corneal diseases. Most PKs are performed to improve poor visual acuity caused by an opaque cornea. PK has also been used to remove active corneal disease, such as persistent severe bacterial, fungal, or amebic inflammation of the cornea (keratitis) after appropriate antibiotic

therapy. The most common indications for PK are: bullous keratopathy, keratoconus, corneal scar with opacity, keratitis, corneal transplant rejection, Fuch's dystrophy, corneal degeneration, other corneal dystrophies, corneal edema, and herpes simplex keratitis. PK is considered not medically necessary when performed solely to correct astigmatism or other refractive errors. Surgically induced astigmatism is a potential complication of PK that may require refractive surgery.

**Automated Lamellar Keratoplasty (ALK):** ALK, also referred to as standard keratomileusis, is a technique that shapes the cornea with a microkeratome, an oscillating sharp blade used to incise the corneal stroma beneath the Bowman membrane, rather than with a laser. It is considered investigational for treatment of all refractive errors. The AAO Refractive Surgery Preferred Practice Pattern assessment stated that ALK had only fair predictability. Complications of ALK include irregular astigmatism, thin flaps, free or displaced caps, anterior chamber perforation, interface opacities, infectious keratitis, and epithelial ingrowth. The AAO has further stated that ALK has been largely abandoned due to the advent of laser-in-situ keratomileusis (LASIK) (AAO, 2022a).

**Corneal Allogenic Intrastromal Ring Segments (CAIRS):** The CAIRS technique uses allogenic tissue as a spacer graft to produce effects similar to synthetic intrastromal corneal ring segments (i.e., INTACS). In this procedure, a deepithelialized and deendothelialized donor cornea is cut into two semicircles, and the segments are then inserted into intrastromal channels which are typically created via femtosecond laser. Corneal collagen cross linking may then be performed. CAIRS has been proposed for the treatment of corneal ectatic disorders, including keratoconus (Patel and Jacob, 2023).

**Literature Review:** There is insufficient evidence in the published, peer-reviewed literature to support the long-term safety and efficacy of CAIRS for the treatment of keratoconus or any other condition. The evidence consists primarily of case reports and small prospective and retrospective case series with small patient populations and short term follow-ups (Bteich, et al., 2024; Coscarelli, et al., 2024; Kirgiz, et al., 2024; Yucekul, et al., 2024; Bteich, et al., 2023a; Bteich, et al., 2023b; Jacob, et al., 2023; Nacaroglu, et al., 2023; Jacob, et al., 2018). Additional well-designed controlled comparative trials with large patient populations and long term follow-ups are needed.

**Professional Societies/Organizations:** The American Academy of Ophthalmology (AAO) preferred practice pattern for the treatment of corneal ectasia stated that "long-term results on CAIRS…are awaited", and no recommendation for or against CAIRS was given (AAO, 2023).

**Corneal Inlay:** Corneal inlays have been proposed as a treatment for presbyopia. The device is a thin disc shaped lens with micro-perforations proposed to help focus images clearly within the eye like glasses or contact lenses. Although the inlay has no refractive power, the goal of the device is to have the central opening function as a pinhole to increase depth of focus and improve near vision without changing distance vision. The inlay is implanted through a pocket-shaped laser incision of the cornea. Variations of corneal inlays described in the literature include the KAMRA® (AcuFocus™, Irvine, CA); the Raindrop® (ReVision Optics, Laguna Hills, CA), and the Flexivue Microlens™ (Presbia, Amsterdam).

On April 17, 2015, the KAMRA® inlay (AcuFocus™ Inc., Irvine, CA) received premarket application (PMA) approval from the FDA for the treatment of presbyopia. According to the FDA, the KAMRA inlay is indicated for intrastromal corneal implantation to improve near vision in patients between the ages of 45 and 60 years with presbyopia who have not had cataract surgery. Contraindications to device implantation include severe dry eye syndrome, eye infection or inflammation, and keratoconus. The pivotal study was a prospective, single-armed, multicenter clinical trial (n=508). The non-dominant eye of subjects was implanted with the AcuFocus corneal inlay. Patient selection criteria included uncorrected near visual acuity worse than 20/40 and better than 20/100

in the eye to be implanted, as well as distance visual acuity correctable to at least 20/20 in both eyes. Exclusion criteria included cataracts, corneal abnormalities, uncontrolled eyelid disease and keratoconus. At 12 months of follow-up, 80.8% of subjects achieved the primary effectiveness endpoint of uncorrected near visual acuity of 20/40 or better. Post-approval evaluation of the device required by the FDA includes a prospective multi-center observational study designed to monitor the safety of patients who participated in the pivotal trial and are still implanted with the KAMRA Inlay. Patients will be followed for an additional two years for a total of five years post-implantation. The KAMRA inlay has been marketed outside the US since 2009 and is available in 50 countries, including Australia, Austria, Canada, Chile, Hungary, Japan, Jordan, South Korea, Lebanon, Malaysia, Netherlands, New Zealand, Oman, Saudi Arabia, Singapore, Turkey, and the United Arab Emirates (FDA, 2015).

On June 16, 2016, the Raindrop® Near Vision Inlay® (ReVision Optics, Inc., Lake Forest, CA) received premarket application (PMA) approval from the FDA for the treatment of presbyopia. According to the FDA, the Raindrop Near Vision Inlay was indicated for intrastromal implantation to improve near vision in the non-dominant eye of phakic, presbyopic patients with the following characteristics:

- 41 to 65 years of age
- manifest refractive spherical equivalent of +1.00 diopters (D) to -0.50 D with ≤ 0.75 D of refractive cylinder
- do not require correction for clear distance vision,
- require near correction of +1.50 D to +2.50 D of reading add

The pivotal study for FDA approval was a multicenter prospective, single-armed, non-randomized clinical trial (n=373 patients). Selection criteria for subjects included presbyopic adults, needing from +1.50 D to +2.50 D of reading add with uncorrected near visual acuity worse than 20/40 and better than 20/200 in the non-dominant eye. Two years after implantation, the primary effectiveness endpoint was met, with 92% of patients (336/364) able to see with ≥ 20/40 vision at near distances with the inlay-implanted eye. The adverse event (AE) safety endpoints were that the total number of AEs should occur in < 5% of eyes and any single AE should occur in < 1% of eyes. Of the 22 AE categories, seven AE categories (e.g., secondary surgical intervention: 44/373 [12%]) exceeded the target rate of 1% (FDA, 2016). In March 2019, the FDA issued a Class 1 Device Recall of the Raindrop Near Vision Inlay, due to an increased risk of corneal haze. The inlay is not currently commercially available.

The Presbia Flexivue Microlens™ (PresbiBio, LLC., Sandyford Dublin) is a refractive optic corneal inlay that functions by altering the corneal index of refraction to improve near vision performance, by the means of a bifocal optic which separates distance and near focal points. The basic principle is corneal multifocality, providing distance vision through a plano central zone surrounded by one or more rings of varying additional power for intermediate and near vision. The Flexivue Microlens is a 3-mm-diameter, transparent hydrogel-based implant made from a hydrophilic acrylic material and contains an ultraviolet blocker. Depending on the add power, the thickness of the inlay varies from 15 µm to 20 µm. The Microlens received its CE Mark for the European Economic Area. It is not currently FDA-approved and is not commercially available in the U.S. (Beer, et al., 2020; Presbia, 2022; Moarefi, et al., 2017).

Additional options in corneal inlays are being studied with the Presbyopic Allogenic Refractive Lenticule (PEARL) techniques. PEARL is a procedure that places a small piece of tissue from one part of the cornea into another part. The inlay is proposed to change the shape of the cornea with the goal of improving near vision. The surgeon uses a laser to make a small cut in the cornea. A lenticule (a small disc of corneal tissue) is removed through the cut. The lenticule is sculpted and reshaped with a laser, then placed into a small pocket made in the patient's cornea. Because the inlay is made of the patient's own tissue, it is biologically compatible, making it less likely to cause

complications of artificial corneal inlays. The procedure is still under investigation (Moarefi, et al., 2017; Boyd, 2016).

**Literature Review:** Evidence in the published peer-reviewed medical literature evaluating the safety and effectiveness of corneal inlays is primarily in the form of case reports and case series (Darian-Smith, et al., 2022; Linn, et al., 2017; Verdoorn, 2017; Whang, et al., 2017; Jalali, et al., 2016; Dexl, et al., 2015; Yoo, et al., 2015; Yilmaz, et al., 2011; Seyeddain, et al., 2010). These studies included small patient populations with follow-up periods ranging from six months to four years. Adverse events included cataract progression and device explantation.

Vukich et al. (2018) conducted a prospective nonrandomized multicenter open-label single-arm study (n=507) to evaluate the safety and efficacy of the KAMRA corneal inlay. Patients aged 45–60 years, with presbyopia and corrected distance visual acuity (CDVA) to 20/20 in both eyes were included in the study. The eye to be implanted had uncorrected near visual acuity (UNVA) between 20/40 and 20/100 and cycloplegic refractive spherical equivalent of +0.50 diopters (D) to -0.75 D with 0.75 D or less of refractive cylinder, and required a near correction of +1.00 to +2.50 D of reading addition (add). The eyes also had a minimum central corneal thickness of ≥ 500 µm, corneal power ≥ 41.00 D and ≤ 47.00 D in all meridians and an endothelial cell count of more than 2000 cells/$mm^2$. The primary outcome was the percentage of eyes with a UNVA ≥ 20/40. Several subgroups were predetermined before study initiation to measure contrast sensitivity (n=335), defocus curve (n=114), and visual fields (n=224). The corneal inlay was implanted under a lamellar resection, either a corneal pocket created by a femtosecond laser (n=471) or under a corneal flap (n=37) created by a mechanical microkeratome. The mechanism of action of the KAMRA (increase in depth of focus by blocking peripheral unfocused rays of light) was reflected in the defocus curves. Reported outcomes at 36 months included the following:

- The implanted eyes exhibited 3.5 diopters of defocus range above 20/40, with 363/417 patients (87.1%) and 391/417 patients (93.8%) having 20/40 or better monocular and binocular uncorrected near visual acuity (UNVA). The mean visual acuities significantly improved for both positive and negative defocus after implantation.
- Patients implanted via a femtosecond laser pocket procedure demonstrated further improved near vision, with 131/145 patients (90.3%), 137/145 patients (94.5%) having 20/40 or better monocular and binocular UNVA, respectively.
- UDVA of 20/25 or better was maintained in 135/145 patients (93.1%) and 100% of implanted eyes.
- The results of a patient questionnaire showed that for those in the pocket group, near vision tasks were all graded as much easier to perform postoperatively than preoperatively ($p<0.001$). Minimal change was reported in ease of performing distance vision tasks. There was a significant reduction in the ease of watching television and driving at night ($p<0.05$).

Ocular adverse events included decreases in CDVA of ≥ 2 lines and secondary surgical interventions which included six inlay repositionings and 44 removals (8.7%). The removal rate was significantly less in the pocket group and further reduced with deeper implantation. There was also one event each of corneal edema, corneal haze, amorphous material around a fold in the inlay, and stromal thinning secondary to abnormal healing response to corneal trauma. Less than 1.0% of the patients reported severe glare or halos postoperatively. Author-noted limitations of the study included the fact that the questionnaire was not validated before the study; the deep implantation cohort was small relative to the whole cohort size; and the subgroups of lamellar resection and implantation depth were created following the study, which limited the statistical power of the analyses on these variables. Another limitation was the number of patients lost to follow-up (n=49; 8.7%).

**Corneal Tissue Addition Keratoplasty (CTAK):** Corneal tissue addition keratoplasty (CTAK) has been proposed for the management of corneal ectasia. During CTAK, preserved irradiated donor corneal tissue is cut to patient-customized size specifications with a femtosecond laser, then

placed in a laser-created channel in the recipient cornea, with the aim of reshaping the cornea and improving vision. The reported potential benefits of CTAK over corneal transplantation are shorter recovery time and a reduced risk of complications. The technique is currently under investigation.

**Literature Review:** The evidence in the published, peer-reviewed literature is insufficient to support the safety, efficacy, and long-term outcomes of CTAK for the treatment of keratoconus or any other condition.

Greenstein et al. (2023) conducted a single center prospective open label clinical trial of CTAK for the treatment of keratoconus and ectasia after laser in situ keratomileusis. The study included 18 adult patients (21 eyes). All subjects underwent placement of gamma-irradiated, sterilized, preserved corneal tissue (CorneaGen) cut to patient specifications with a femtosecond laser. At six months postoperatively, the average uncorrected distance visual acuity (UDVA) improved from 1.21 ± 0.35 logMAR lines (LL) (20/327) to 0.61 ± 0.25 LL (20/82) ($p<0.001$). The average corrected distance visual acuity (CDVA) improved from 0.62 ± 0.33 LL (20/82) to 0.34 ± 0.21 LL (20/43) ($p=0.002$), and the average manifest refraction spherical equivalent (MRSE) improved from -6.25 ± 5.45 diopters (D) to -1.61 ± 3.33 D ($p=0.002$). Twenty eyes (95.2%) gained more than two lines of UDVA, with 10 eyes (47.6%) gaining more than six lines, with no eyes worsening. Twelve eyes (57.1%) gained at least two lines of CDVA, with one eye worsening by more than two lines. At six months, the average topographic mean keratometry (Kmean) flattened by -8.44 D ($p=0.002$), the maximum keratometry (Kmax) flattened by -6.91 D ($p=0.096$ [NS]), and the mean point of maximum flattening (Kmaxflat) was -16.03 D. One subject experienced a partial tear of the channel wall during inlay insertion, requiring suturing and loss of three lines of CDVA. Limitations of the study included the small sample size, lack of control/comparator group, and short term follow-up.

**Hexagonal Keratotomy:** This technique uses a computer-assisted microkeratome to reshape the cornea. It works similarly to a carpenter's plane, making a hexagonal pattern of cuts versus the radial cuts seen in radial keratotomy (RK). Hexagonal keratotomy has been used to treat hyperopia which occurs naturally and also to treat presbyopia after RK. Hexagonal keratotomy is now rarely used, due to complications like poor healing and irregular astigmatism, and as newer techniques in refractive surgery have been developed (Mercer, et al., 2023).

**Keratophakia:** This technique involves the insertion of a donor cornea lens into the corneal stroma to change the shape of the cornea and modify its refractive power. Keratophakia was not addressed in the 2022 AAO Preferred Practice Pattern on Refractive Surgery, there is a paucity of studies evaluating keratophakia for refractive errors. The effectiveness of keratophakia for correction of refractive errors has not been proven in the peer-reviewed medical literature.

**Laser Epithelial Keratomileusis (LASEK):** LASEK, a modification of photorefractive keratectomy (PRK), is a surface ablation procedure that attempts to preserve the epithelium. The postoperative outcomes of LASEK have been reported to be similar to those of PRK. Proposed advantages of LASEK compared to LASIK are that more stromal tissue is reserved, and flap-related complications do not occur. However, patients undergoing LASEK experience more postoperative discomfort and slower recovery of vision than those who have had LASIK. The AAO Preferred Practice Pattern Refractive Surgery stated that the potential for the development of corneal haze remains a concern since LASEK is a modification of PRK (AAO, 2022a). There is a lack of evidence in the peer-reviewed literature to support the safety and efficacy of this procedure.

Kuryan et al. (2017) published results of a Cochrane review (n=3 RCTs/154 subjects) to assess the effects of LASEK versus LASIK for correcting myopia. RCTs were selected in which myopic subjects were assigned randomly to receive either LASEK or LASIK in one or both eyes. Patients

were included in the studies who were between the ages of 18 and 60 years with myopia up to 12 D and/or myopic astigmatism of severity up to 3 D, and who did not have a history of prior refractive surgery. All trials enrolled participants with mild to moderate myopia (< -6.50 D); only one trial included subjects with severe myopia (> -6.00 D). The primary outcome measure was uncorrected visual acuity (UCVA) at 12 months. The evidence showed uncertainty as to whether there was a difference between LASEK and LASIK in UCVA at 12 months. People receiving LASEK were less likely to achieve a refractive error within 0.5 diopters of the target at 12 months follow-up (RR 0.69, 95% CI 0.48 to 0.99; 57 eyes; very low-certainty evidence). One trial reported mild corneal haze at six months in one eye in the LASEK group and none in the LASIK group (RR 2.11, 95% CI 0.57 to 7.82; 76 eyes; very low-certainty evidence). None of the included trials reported postoperative pain score or loss of visual acuity, spherical equivalent of the refractive error, or quality of life at 12 months. Patients receiving LASEK were less likely to achieve a refractive error within 0.5 diopters of the target at 12 months follow-up (very low-certainty evidence). In terms of adverse events, refractive regression was reported only in the LASEK group (8/37 eyes) compared to 0/39 eyes in the LASIK group in one trial (low-certainty evidence). Likewise, low-certainty evidence of one trial reported adverse events of corneal flap striae and refractive over-correction only in the LASIK group (5/39 eyes) compared to 0/37 eyes in the LASEK group. This review was limited by the small sample sizes in studies and the low quality of the available evidence. The authors concluded that large, well-designed RCTs are needed to estimate the magnitude of any difference in efficacy or adverse effects between LASEK and LASIK for treating myopia or myopic astigmatism.

**Minimally Invasive RK (mini-RK):** Radial keratotomy involves the use of radial incisions in the cornea to correct mild to moderate myopia. Mini-RK is a modified radial keratotomy procedure that reduces the millimeters of cornea incised. The goal is to maximize corneal flattening with a minimum length and number of incisions. Mini-RK is considered an investigational procedure.

**Orthokeratology:** Orthokeratology also called ortho-K, is the use of rigid gas-permeable contact lenses as a nonsurgical and reversible method for the treatment of mild to moderate myopia. The center of the contact lens is deliberately fitted flatter than the central corneal curvature to transiently induce central corneal flattening, by a thinning or molding of the epithelium, which is proposed to reverse myopia during the day when the lens is not worn. However, the corneas tend to revert back to their original shape when the lens is not worn. The most serious complication that has been associated with orthokeratology is microbial keratitis (Coats and Paysse, 2024).

Rigid gas permeable lens are approved by the FDA as 510(k) Class II devices. FDA published an industry Guidance for Premarket Submissions of Orthokeratology Rigid Gas Permeable Contact Lenses (FDA, last updated March 2018). In their discussion of types of contact lenses, the FDA requires that eye care professionals be trained and certified before using overnight Ortho-K lenses in their practice. An example of an FDA approved gas permeable contact lens is the Boston $XO_2$ (Bausch & Lomb, Inc., Rochester, NY). One of the approved intended uses of the lens is "daily wear for the correction of refractive ametropia (myopia, hyperopia, astigmatism and presbyopia) in aphakic and non-aphakic persons with non-diseased eyes. Also, the lenses may be prescribed in other wise non-diseased eyes that require a gas permeable contact lens for the management of irregular corneal conditions such as keratoconus, pellucid marginal degeneration, or following penetrating keratoplasty or refractive (e.g., LASIK) surgery" (FDA, 2007).

The updated 2022 AAO Preferred Practice Pattern on Refractive Errors stated that attempts to predict which patients would respond to orthokeratology based on ocular biomechanical or biometric parameters have not been successful. The effects of orthokeratology have been unpredictable and poorly controlled. There are substantial variations in changes in eye length among children and there is no way to predict the effect for individual subjects. There is a lack of evidence showing that orthokeratology can slow the progression of myopia. According to AAO, the

safest way to incorporate contact lenses into clinical practice for reduction of axial elongation in young children remains to be determined.

There is insufficient evidence in the published, peer-reviewed literature to support the effectiveness of orthokeratology for the treatment of myopia. Studies are primarily in the form of case reports, retrospective reviews and case series with small patient populations, short-term follow-up and conflicting results. There is also a lack of data regarding a regimen for discontinuing ortho-k lenses (Lau, et al., 2023; Tsai, et al., 2021; Zhong, et al., 2020; Kang, 2018; Si, et al., 2015; Sun, et al., 2015).

Lawrenson et al. (2023) conducted a Cochrane systematic review and network meta-analysis of randomized controlled trials evaluating interventions for myopia control in children. The review included 11 studies (n=52-240 subjects) comparing orthokeratology lenses to single vision spectacle lenses (SVLs); single vision soft contact lenses (SVSCLs); rigid gas-permeable contact lenses (RGPs); atropine; or a combination of these interventions. Length of follow up was one to two years. The primary outcome for most studies was change in axial length. The authors judged the risk of bias as ranging from "some concerns" to "high risk". In the eight studies (n=787 subjects) comparing orthokeratology to SVLs or SVSCLs, a significant reduction in axial elongation was seen across two years (one year mean difference [MD] −0.19 millimeters [mm], 95% confidence interval [CI] −0.23 to −0.15; two year MD −0.28 mm, 95% CI −0.38 to −0.19). In two studies which compared low-dose atropine to orthokeratology, there was no significant difference in axial length between treatments. One-year data was based on 234 participants, and two-year data was derived from 49 participants. Among contact lens interventions, adverse events were more common in orthokeratology, and included corneal infiltrates and corneal staining, with four cases of corneal staining graded 3 or higher. There were 12 documented withdrawals due to adverse events. The authors concluded topical antimuscarinic agents and orthokeratology appear to be effective treatments for slowing childhood myopia progression, but also stated that there was uncertainty regarding the risk-benefit of orthokeratology and other contact lens interventions in children. Adherence to treatment was not formally assessed, despite these studies often being associated with high dropout rates (over 50% in some studies).

In a systematic review and meta-analysis Si et al. (2015) reported that orthokeratology may slow the progression of myopia in children but due to the limited evidence large-scale studies are needed to substantiate the results and to investigate the long-term effects of orthokeratology in myopia control. Studies were included if they included myopic patients aged ≤ 18 years; compared orthokeratology with control subjects (single-vision spectacles or soft contact lenses); and reported axial length (AL) elongation or more information relevant to myopia progression (e.g., vitreous chamber depth elongation). Two randomized controlled trials and five nonrandomized controlled trials (n=435) met inclusion criteria with 218 children being treated with orthokeratology. Maximum follow-up was two years. Subjects were aged 6–16 years. The weighted mean difference was -0.26 mm ($p< 0.001$) for axial length elongation based on data from seven studies and -0.18 mm ($p=0.02$) for vitreous chamber depth elongation based on data from two studies showed significant improvement with ortho-K. The author-noted limitations were: small sample sizes, short-term follow up, limited the reliability of the results, and the heterogeneity of the patient population, study protocols and designs. The authors noted that because the mechanism of myopia progression is still debatable, additional studies are needed to further elucidate the potential biological mechanisms that are involved.

Sun et al. (2015) conducted a systematic review and meta-analysis to evaluate the clinical treatment effects of orthokeratology to slow the progression of myopia. Seven studies (n=546) met inclusion criteria including two were randomized controlled trials, two retrospective reviews and three observational studies. Subjects were ages 6–16 years and follow-ups were for two years. The main outcomes included axial length and vitreous chamber depth. All studies reported

axial length changes after two years and two studies reported vitreous chamber depth changes. The pooled estimates indicated that change in axial length in the ortho-k group (n=218) was 0.27 mm less than the control group and myopic progression was reduced by approximately 45%. The combined results revealed that the difference in vitreous chamber depth between the two groups was 0.22 mm in favor of ortho-K. None of the studies reported severe adverse events. Limitations of the studies included: small patient populations, short-term follow-up, drop-out rates of 12.4%–46.2% and the retrospective study designs. Well-designed randomized controlled trials with large populations and long-term follow-ups are needed to assess the effectiveness of ortho-K for the treatment of myopia.

Van Meter et al. (2008) performed a technology assessment of case reports and noncomparative case series (n=75) to evaluate the safety of overnight orthokeratology for the treatment of myopia. It was found that overnight orthokeratology is associated with complications including infectious keratitis and induced astigmatism, however the prevalence and incidence of complications have not been determined. The authors noted that overnight orthokeratology puts patients at risk for vision-threatening complications they may not encounter otherwise. Large, well-designed randomized controlled studies are needed to provide a more reliable measure of the risks of treatment and to identify risk factors for complications Overnight orthokeratology for slowing the progression of myopia in children also needs well-designed and properly conducted controlled trials to investigate efficacy (Van Meter, et al., 2008).

**Scleral Expansion Surgery:** Scleral expansion surgery involves the use of scleral expansion band segments which are inserted beneath partial thickness scleral incisions (scleral belt loops) in each of the oblique quadrants. The procedure is claimed to improve accommodation and has been proposed as a treatment for presbyopia. The infrared laser has also been used to make deep scleral incisions to treat presbyopia presumably by mechanisms similar to scleral expansion bands (Kleinmann, et al., 2006). Many investigators dispute the proposed mechanism of scleral expansion to treat presbyopia, and the results of these various surgeries have not shown predictable or consistent effects on distance corrected near acuity or accommodative amplitude (Mercer, et al., 2023; AAO, 2022a).

There is insufficient evidence in the peer-reviewed literature to support the effectiveness of scleral expansion surgery for the treatment of presbyopia.

## Medicare Coverage Determinations

| | Contractor | Determination Name/Number | Revision Effective Date |
|---|---|---|---|
| NCD | National | Refractive Keratoplasty (80.7) | 5/1/1997 |
| LCD | | No Determination found | |

Note: Please review the current Medicare Policy for the most up-to-date information.
(NCD = National Coverage Determination; LCD = Local Coverage Determination)

## Coding Information

**Notes:**

1. This list of codes may not be all-inclusive since the American Medical Association (AMA) and Centers for Medicare & Medicaid Services (CMS) code updates may occur more frequently than policy updates.
2. Deleted codes and codes which are not effective at the time the service is rendered may not be eligible for reimbursement.

**Considered Medically Necessary when criteria in the applicable policy statements listed above are met:**

**Corneal Relaxing Incisions**

| CPT®* Codes | Description |
|---|---|
| 65772 | Corneal relaxing incision for correction of surgically induced astigmatism |

**Intrastromal Corneal Ring Segments**

| CPT®* Codes | Description |
|---|---|
| 65785† | Implantation of intrastromal corneal ring segments |

**†Note: Considered Experimental/Investigational/Unproven when used to report corneal allogenic intrastromal ring segments (CAIRS).**

**Considered Not Medically Necessary when used to report correction of refractive errors:**

| CPT®* Codes | Description |
|---|---|
| 65710† | Keratoplasty (corneal transplant); anterior lamellar |
| 66999 | Unlisted procedure, anterior segment of eye |

**†Note: Considered Experimental/Investigational/Unproven when used to report corneal tissue addition keratoplasty (CTAK).**

**Considered Experimental/Investigational/Unproven when used to report correction of refractive errors:**

| CPT®* Codes | Description |
|---|---|
| 65710† | Keratoplasty (corneal transplant); anterior lamellar |
| 65760 | Keratomileusis |
| 65765 | Keratophakia |
| 65785†† | Implantation of intrastromal corneal ring segments |
| 66999 | Unlisted procedure, anterior segment of eye |

**†Note: Considered Not Medically Necessary when used to report lamellar keratoplasty (non-penetrating keratoplasty) solely for the treatment of refractive errors.**

**††Note: Considered Medically Necessary when used to report intrastromal corneal ring segments (i.e., INTACS® prescription inserts).**

| HCPCS Codes | Description |
|---|---|
| V2599 | Contact lens, other type |

## References


1. American Academy of Ophthalmology (AAO). Preferred Practice Pattern. Corneal Ectasia. Sep 2023. Accessed Nov 12, 2024. Available at URL address: https://www.aao.org/preferred-practice-patterns

2. American Academy of Ophthalmology (AAO). Cornea/external disease summary benchmarks – 2023. Dec 2023. Accessed Nov 14, 2024. Available at URL address: https://www.aao.org/preferred-practice-patterns

3. American Academy of Ophthalmology (AAO). Refractive Errors Preferred Practice Pattern. 2022b. Accessed Nov 11, 2024. Available at URL address: https://www.aao.org/preferred-practice-patterns

4. American Academy of Ophthalmology (AAO). Refractive Surgery Preferred Practice Pattern. 2022a. Accessed Nov 11, 2024. Available at URL address: https://www.aao.org/preferred-practice-patterns

5. American Academy of Ophthalmology (AAO). Corneal inlays. Mar 4, 2024. Accessed Nov 14, 2024. Available at URL address: https://eyewiki.org/Corneal_Inlays

6. American Association for Pediatric Ophthalmology and Strabismus (AAPOS). Accessed Nov 12, 2024. Available at URL address: https://www.aapos.org

7. Beer SMC, Werner L, Nakano EM, et al. A 3-year follow-up study of a new corneal inlay: clinical results and outcomes. Br J Ophthalmol. 2020;104(5):723-728.

8. Bower KS. Laser refractive surgery. In: UpToDate, Li H. Jul 18, 2024. UpToDate, Waltham, MA. Accessed Nov 12, 2024.

9. Boxer Wachler BS, Christis JP, Chandra NS, Chou B, Korn T, Nepomuceno R. Intacs for keratoconus. Ophthalmology. 2003 May;110(5):1031-1040.

10. Boyd, K. PEARL. A promising new treatment for presbyopia. Nov 21, 2016. Accessed Nov 14, 2024. Available at URL address: https://www.aao.org/eye-health/news/pearl-promising-new-treatment-presbyopia

11. Bteich Y, Assaf JF, Gendy JE, Müller F, Jacob S, Hafezi F, Awwad ST. Asymmetric All-Femtosecond Laser-Cut Corneal Allogenic Intrastromal Ring Segments. J Refract Surg. 2023a Dec;39(12):856-862.

12. Bteich Y, Assaf JF, Mrad AA, Jacob S, Hafezi F, Awwad ST. Corneal Allogenic Intrastromal Ring Segments (CAIRS) for Corneal Ectasia: A Comprehensive Segmental Tomography Evaluation. J Refract Surg. 2023b Nov;39(11):767-776.

13. Bteich Y, Assaf JF, Müller F, Gendy JE, Jacob S, Hafezi F, Awwad ST. Femtosecond Laser-Assisted Graft Preparation and Implantation of Corneal Allogeneic Intrastromal Ring Segments for Corneal Ectasia: 1-Year Results. Cornea. 2024 Oct 29.

14. Centers for Medicare and Medicaid Services (CMS). Local Coverage Determinations (LCDs) alphabetical index. Accessed Nov 7, 2024. Available at URL address:

https://www.cms.gov/medicare-coverage-database/reports/local-coverage-proposed-lcds-alphabetical-report.aspx?proposedStatus=A&sortBy=title

15. Centers for Medicare and Medicaid Services (CMS). National Coverage Determinations (NCDs) alphabetical index. Accessed Nov 7, 2024. Available at URL address: https://www.cms.gov/medicare-coverage-database/reports/national-coverage-ncd-report.aspx?chapter=all&sortBy=title

16. Centers for Medicare and Medicaid Services (CMS). National Coverage Determination for Refractive Keratoplasty (80.7). Accessed Nov 7, 2024. Available at URL address: https://www.cms.gov/medicare-coverage-database/view/ncd.aspx?ncdid=72

17. Charm J, Cho P. High myopia-partial reduction ortho-k: a 2-year randomized study. Optom Vis Sci. 2013 Jun;90(6):530-9.

18. Cho P, Cheung SW. Retardation of myopia in Orthokeratology (ROMIO) study: a 2-year randomized clinical trial. Invest Ophthalmol Vis Sci. 2012 Oct 11;53(11):7077-85.

19. Coats DK, Paysse EA. Refractive errors in children. In: UpToDate, Tehrani N. Oct 25, 2024. UpToDate, Waltham, MA. Accessed Nov 12, 2024.

20. Colin J. European clinical evaluation: Use of Intacs for the treatment of keratoconus. J Cataract Refract Surg. 2006 May;32(5):747-55.

21. Colin J, Cochener B, Savary G, Malet F, Holmes-Higgin D. INTACS inserts for treating keratoconus: one-year results. Ophthalmology. 2001 Aug;108(8):1409-14.

22. Colin J, Malet FJ. Intacs for the correction of keratoconus: two-year follow-up. J Cataract Refract Surg. 2007 Jan;33(1):69-74.

23. Coscarelli S, Coscarelli SP, Torquetti L. Donut-shaped Corneal Allogeneic Intrastromal Segment as an Alternative to Deep Anterior Lamellar Keratoplasty in Advanced Keratoconus. Cornea. 2024 May 1;43(5):658-663.

24. Darian-Smith E, Gouvea L, Gendler S, Alshaker S, Din N, Weill Y, Skouras N, Rabinovitch T, Singal N, Chan CC, Rootman DS. KAMRA presbyopic inlay refractive outcomes: a Canadian perspective. Can J Ophthalmol. 2022 Dec 1:S0008-4182(22)00342-8.

25. Dexl AK, Jell G, Strohmaier C, Seyeddain O, Riha W, Rückl T, et al. Long-term outcomes after monocular corneal inlay implantation for the surgical compensation of presbyopia. J Cataract Refract Surg. 2015 Mar;41(3):566-75.

26. Elam AR, Tseng VL, Rodriguez TM, Mike EV, Warren AK, Coleman AL; American Academy of Ophthalmology Taskforce on Disparities in Eye Care. Disparities in Vision Health and Eye Care. Ophthalmology. 2022 Oct;129(10):e89-e113.

27. Ertan A, Kamburoğlu G, Bahadir M. Intacs insertion with the femtosecond laser for the management of keratoconus: one-year results. J Cataract Refract Surg. 2006 Dec;32(12):2039-42.

28. Gomes JA, Tan D, Rapuano CJ, et al. Global consensus on keratoconus and ectatic diseases. Cornea. 2015;34(4):359-369.

29. Greenstein SA, Yu AS, Gelles JD, Eshraghi H, Hersh PS. Corneal tissue addition keratoplasty: new intrastromal inlay procedure for keratoconus using femtosecond laser-shaped preserved corneal tissue. J Cataract Refract Surg. 2023 Jul 1;49(7):740-746.

30. Jacob S, Agarwal A, Awwad ST, Mazzotta C, Parashar P, Jambulingam S. Customized corneal allogenic intrastromal ring segments (CAIRS) for keratoconus with decentered asymmetric cone. Indian J Ophthalmol. 2023 Dec 1;71(12):3723-3729.

31. Jacob S, Patel SR, Agarwal A, Ramalingam A, Saijimol AI, Raj JM. Corneal Allogenic Intrastromal Ring Segments (CAIRS) Combined With Corneal Cross-linking for Keratoconus. J Refract Surg. 2018 May 1;34(5):296-303.

32. Jalali S, Aus der Au W, Shaarawy T. AcuFocus Corneal Inlay to Correct Presbyopia Using Femto-LASIK. One Year Results of a Prospective Cohort Study. Klin Monbl Augenheilkd. 2016 Apr;233(4):360-4.

33. Kanellopoulos AJ, Pe LH, Perry HD, Donnenfeld ED. Modified intracorneal ring segment implantations (INTACS) for the management of moderate to advanced keratoconus: efficacy and complications. Cornea. 2006 Jan;25(1):29-33.

34. Kang P. Optical and pharmacological strategies of myopia control. Clin Exp Optom. 2018 May;101(3):321-332.

35. Kirgiz A, Kemer Atik B, Emul M, Taskapili M. Clinical outcomes of femtosecond laser-assisted corneal allogenic intrastromal ring segment (CAIRS) in the treatment of keratoconus. Clin Exp Ophthalmol. 2024 Sep-Oct;52(7):713-723.

36. Kuryan J, Cheema A, Chuck RS. Laser-assisted subepithelial keratectomy (LASEK) versus laser-assisted in-situ keratomileusis (LASIK) for correcting myopia. Cochrane Database Syst Rev. 2017 Feb 15;2:CD011080.

37. Kymionis GD, Siganos CS, Tsiklis NS, Anastasakis A, Yoo SH, Pallikaris AI, et al. Long-term follow-up of Intacs in keratoconus. Am J Ophthalmol. 2007 Feb;143(2):236-244.

38. Lau JK, Wan K, Cho P. Orthokeratology lenses with increased compression factor (OKIC): A 2-year longitudinal clinical trial for myopia control. Cont Lens Anterior Eye. 2023 Feb;46(1):101745.

39. Lawrenson JG, Shah R, Huntjens B, Downie LE, Virgili G, Dhakal R, Verkicharla PK, Li D, Mavi S, Kernohan A, Li T, Walline JJ. Interventions for myopia control in children: a living systematic review and network meta-analysis. Cochrane Database Syst Rev. 2023 Feb 16;2(2):CD014758.

40. Li SM, Zhan S, Li SY, Peng XX, Hu J, Law HA, Wang NL. Laser-assisted subepithelial keratectomy (LASEK) versus photorefractive keratectomy (PRK) for correction of myopia. Cochrane Database Syst Rev. 2016 Feb 22;2:CD009799.

41. Lin CC, Rose-Nussbaumer JR, Al-Mohtaseb ZN, Pantanelli SM, Steigleman WA 3rd, Hatch KM, Santhiago MR, Kim SJ, Schallhorn JM. Femtosecond Laser-Assisted Cataract Surgery: A Report by the American Academy of Ophthalmology. Ophthalmology. 2022 Aug;129(8):946-954.

42. Linn SH, Skanchy DF, Quist TS, Desautels JD, Moshirfar M. Stereoacuity after small aperture corneal inlay implantation. Clin Ophthalmol. 2017 Jan 24;11:233-235.

43. McDonald MB, Durrie D, Asbell P, Maloney R, Nichamin L. Treatment of presbyopia with conductive keratoplasty: six-month results of the 1-year United States FDA clinical trial. Cornea. 2004 Oct;23(7):661-8.

44. Mercer RN, Waring GO, Rocha KM. Current Concepts, Classification, and History of Refractive Surgery. In: Yanoff M, Duker JS. Ophthalmology. 6th ed. Philadelphia, PA: Elsevier; 2023. 67-76.

45. Moarefi MA, Bafna S, Wiley W. A Review of Presbyopia Treatment with Corneal Inlays. Ophthalmol Ther. 2017 Jun;6(1):55-65.

46. Moshirfar M, Desautels JD, Wallace RT, Koen N, Hoopes PC. Comparison of FDA safety and efficacy data for KAMRA and Raindrop corneal inlays. Int J Ophthalmol. 2017 Sep 18;10(9):1446-1451.

47. Nacaroglu SA, Yesilkaya EC, Perk FFNK, Tanriverdi C, Taneri S, Kilic A. Efficacy and safety of intracorneal allogenic ring segment implantation in keratoconus: 1-year results. Eye (Lond). 2023 Dec;37(18):3807-3812.

48. Oyeniran E, Tauqeer Z. (2021). Update in the Management of Keratoconus. Advances in Ophthalmology and Optometry. 6. 307-324.

49. Patel SR, Jacob S. Intrastromal Corneal Ring Segments: Synthetic and CAIRS. In: Yanoff M, Duker JS. Ophthalmology. 6th ed. Philadelphia, PA: Elsevier; 2023. 114-116.

50. Peñarrocha-Oltra S, Soto-Peñaloza R, Alonso-Arroyo A, Vidal-Infer A, Pascual-Segarra J. Laser-based refractive surgery techniques to treat myopia in adults. An overview of systematic reviews and meta-analyses. Acta Ophthalmol. 2022 Dec;100(8):878-893.

51. Santodomingo-Rubido J, Villa-Collar C, Gilmartin B, Gutiérrez-Ortega R, Sugimoto K. Long-term Efficacy of Orthokeratology Contact Lens Wear in Controlling the Progression of Childhood Myopia. Curr Eye Res. 2017 May;42(5):713-720.

52. Seyeddain O, Riha W, Hohensinn M, Nix G, Dexl AK, Grabner G. Refractive surgical correction of presbyopia with the AcuFocus small aperture corneal inlay: two-year follow-up. J Refract Surg. 2010 Oct;26(10):707-15.

53. Si JK , Tang K, Bi HS, Guo DD, Guo JG, Wang XR. Orthokeratology for myopia control: a meta-analysis. Optom Vis Sci. 2015 Mar;92(3):252-7.

54. Siganos CS, Kymionis GD, Kartakis N, Theodorakis MA, Astyrakakis N, Pallikaris IG. Management of keratoconus with Intacs. Am J Ophthalmol. 2003 Jan;135(1):64-70.

55. Stahl JE. Conductive keratoplasty for presbyopia: 3-year results. J Refract Surg. 2007 Nov;23(9):905-10.

56. Sun Y, Xu F, Zhang T, Liu M, Wang D, Chen Y, Liu Q. Orthokeratology to control myopia progression: a meta-analysis. PLoS One. 2015 Apr 9;10(4):e0124535.

57. Torquetti L, Berbel RF, Ferrara P. Long-term follow-up of intrastromal corneal ring segments in keratoconus. J Cataract Refract Surg. 2009 Oct;35(10):1768-73.

58. Tsai HR, Wang JH, Chiu CJ. Effect of orthokeratology on anisometropia control: A meta-analysis. J Formos Med Assoc. 2021 Dec;120(12):2120-2127.

59. U.S. Food and Drug Administration (FDA). 510(k) summary. Boston $X0_2$ (hexafocon B) Rigid Gas Permeable Contact Lenses for Daily Wear. Aug 15, 2007. Accessed Nov 14, 2024. Available at URL address: https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm?ID=K071266

60. U.S. Food and Drug Administration (FDA). Types of contact lenses. Last updated Jan 16, 2018. Accessed Nov 14, 2024. Available at URL address: https://www.fda.gov/medical-devices/contact-lenses/types-contact-lenses

61. U.S. Food and Drug Administration (FDA). FDA-approved lasers for PRK and other refractive surgeries. Last updated Dec 3, 2019. Accessed Nov 14, 2024. Available at URL address: https://www.fda.gov/medical-devices/lasik/fda-approved-lasers-prk-and-other-refractive-surgeries

62. U.S. Food and Drug Administration (FDA). Medical Device Recalls. Class 1 Device Recall Raindrop Near Vision Inlay. Mar 5, 2019. Accessed Nov 14, 2024. Available at URL address: https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfRES/res.cfm?id=169984

63. U.S. Food and Drug Administration (FDA). New Humanitarian Device Approval. INTACS® Prescription Inserts for Keratoconus. H040002. Jul 26, 2004. Accessed Nov 14, 2024. Available at URL address: https://www.accessdata.fda.gov/cdrh_docs/pdf4/H040002A.pdf

64. U.S. Food and Drug Administration (FDA). Summary of Safety and Effectiveness Data (SSED). KAMRA® inlay. P120023. Apr 17, 2015. Accessed Nov 14, 2024. Available at URL address: https://www.accessdata.fda.gov/cdrh_docs/pdf12/P120023b.pdf

65. U.S. Food and Drug Administration (FDA). Summary of Safety and Effectiveness Data. KeraVision Intacs™. P980031. Aug 30, 1999. Accessed Nov 14, 2024. Available at URL address: https://www.accessdata.fda.gov/cdrh_docs/pdf/P980031B.pdf

66. U.S. Food and Drug Administration (FDA). Summary of Safety and Effectiveness Data. Raindrop® Near Vision Inlay. P150034. Jun 29, 2016. Accessed Nov 14, 2024. Available at URL address: https://www.accessdata.fda.gov/cdrh_docs/pdf15/P150034b.pdf

67. Van Meter WS, Musch DC, Jacobs DS, Kaufman SC, Reinhart WJ, Udell IJ; American Academy of Ophthalmology. Safety of overnight orthokeratology for myopia: a report by the American Academy of Ophthalmology. Ophthalmology. 2008 Dec;115(12):2301-2313.e1.

68. Verdoorn C. Comparison of a hydrogel corneal inlay and monovision laser in situ keratomileusis in presbyopic patients: focus on visual performance and optical quality. Clin Ophthalmol. 2017 Sep 20;11:1727-1734.

69. Vukich JA, Durrie DS, Pepose JS, Thompson V, van de Pol C, Lin L. Evaluation of the small-aperture intracorneal inlay: Three-year results from the cohort of the U.S. Food and Drug Administration clinical trial. J Cataract Refract Surg. 2018 May;44(5):541-556.

70. Whang WJ, Yoo YS, Joo CK, Yoon G. Changes in Keratometric Values and Corneal High Order Aberrations After Hydrogel Inlay Implantation. Am J Ophthalmol. 2017 Jan;173:98-105.

71. Woodward MA, Blachley TS, Stein JD. The Association Between Sociodemographic Factors, Common Systemic Diseases, and Keratoconus: An Analysis of a Nationwide Heath Care Claims Database. Ophthalmology. 2016;123(3):457-65.e2.

72. Ye P, Xu W, Tang X, Yao K, Li Z, Xu H, et al. Conductive keratoplasty for symptomatic presbyopia following monofocal intraocular lens implantation. Clin Experiment Ophthalmol. 2011 Jul;39(5):404-11.

73. Yilmaz OF, Alagöz N, Pekel G, Azman E, Aksoy EF, Cakir H, et al. Intracorneal inlay to correct presbyopia: Long-term results. J Cataract Refract Surg. 2011 Jul;37(7):1275-81.

74. Yoo A, Kim JY, Kim MJ, Tchah H. Hydrogel Inlay for Presbyopia: Objective and Subjective Visual Outcomes. J Refract Surg. 2015 Jul;31(7):454-60.

75. Yucekul B, Tanriverdi C, Taneri S, Keskin Perk FFN, Karaca Y, Kilic A. Effect of Corneal Allogenic Intrastromal Ring Segment (CAIRS) Implantation Surgery in Patients With Keratoconus According to Prior Corneal Cross-linking Status. J Refract Surg. 2024 May;40(6):e392-e397.

76. Zhang H, Li M, Cen Z. Excimer Laser Corneal Refractive Surgery in the Clinic: A Systematic Review and Meta-analysis. Comput Math Methods Med. 2022 Jun 15;2022:7130422

77. Zhao LQ, Zhu H, Li LM. Laser-Assisted Subepithelial Keratectomy versus Laser In Situ Keratomileusis in Myopia: A Systematic Review and Meta-Analysis. ISRN Ophthalmol. 2014 Jun 12;2014:672146.

78. Zhong Y, Ke L, Qiong W, Liu F. Orthokeratology lens for management of myopia in anisometropic children: A contralateral study. Cont Lens Anterior Eye. 2020 Feb;43(1):40-43.

## Revision Details

| Type of Revision | Summary of Changes | Date |
|---|---|---|
| Annual review | • Removed policy statements for corneal collagen crosslinking and corneal wedge resection.<br>• Added corneal allogenic intrastromal ring segments and corneal tissue addition keratoplasty to policy statement. | 12/15/2024 |
| Annual review | • Removed laser in situ keratomileusis, photorefractive keratectomy, and radial keratotomy from policy statement. | 10/15/2023 |