Overview of Refractive Errors Correction

Most refractive errors can be corrected with eyeglasses, contact lenses, or surgery.

Several factors are considered when choosing a corrective option:

- Age
- Cost
- Individual preference
- Lifestyle
- Occupation
- Other health conditions
- Severity and type of refractive error

Before making a selection, the pros and cons of all options should be discussed with an eye care practitioner.

Eyeglasses

Eyeglass lenses correct refractive errors by focusing light directly on the retina. The type of lens depends on the type and severity of the refractive error.

The strength of a lens (i.e., its refractive power) is measured in optical units called diopters. This measurement indicates how much refractive power the lens must have to focus images directly on the retina.

The type of refractive error determines the lens's shape. A concave (minus) lens is used to correct myopia (nearsightedness). In myopia, light rays fall in front of the retina rather than on it. Because a concave lens is thin in the center and thicker on the edges, it diverges (spreads out) light rays so that the eye's lens focuses them directly on the retina.

A convex (plus) lens is used to correct hyperopia (farsightedness). In hyperopia, light rays fall behind the retina. The lens is thickest in the center and thinnest on the outer edges. The convex lens converges (concentrates) light rays so that the eye's lens focuses them on the retina.

To correct astigmatism, which is caused by distortions in the shape of the lens or cornea, a cylinder lens is frequently used. The cylinder lens has two refractive powers on one lens. One power is placed over the entire lens and the other is oriented in one direction. This corrects the scattered pattern in which light enters the eye and creates one focal point on the retina.

Multifocal Lenses

People that have more than one refractive error may require two pairs of eyeglasses or glasses with multifocal lenses. Multifocal lenses contain two or more vision-correcting prescriptions.

- **Bifocals** are the most common type of multifocal lenses. The lens is split in two sections; the upper part is for distance vision and the lower part for near vision. They are usually prescribed for people over the age of 40 whose focusing ability has declined due to presbyopia.
-
- **Trifocals** have a third section used for middle distance vision (i.e., objects within arm's reach, such as a computer screen).

- **Progressive lenses** are sometimes referred to as "no-line" bifocals because there is no noticeable line dividing the different prescriptions. There is a continuous change in magnification from the distance, or upper, portion of the lens, to the near, or lower, portion of the lens. They therefore provide a smoother transition between distance and near vision that some feel is closer to natural vision than other multifocal lenses. However, not everyone adapts well to them.

Eyeglass Frames

The choice of frames usually depends on personal preference, fashion, comfort, and cost. Frames are made from metals, plastic, nylon, and other synthetics. Each material has its advantages.

Pure titanium, for example, is lightweight, strong, and durable and frames made from titanium are very light, long lasting, and hypoallergenic. They are also expensive. A titanium alloy called Flexon, or the "memory metal," has recently been developed. Flexon frames return to their original shape after being damaged or bent. This metal is very light and resists corrosion.

Eyeglass Lenses

Traditionally, lenses have been made from glass, but today, they are more commonly made from plastic. Glass lenses are breakable and are about twice as heavy as plastic ones; however, they are more resistant to scratches. Plastic lenses scratch more easily, even with scratch-resistant coatings, but they are much lighter, less likely to break, and can be treated with ultraviolet filters and antiglare coatings.

A number of "high tech" lenses are available, such as high-index, aspheric, photochromic, and polycarbonate.

High-index and aspheric. High-index and aspheric lenses are recommended by opticians for very strong prescriptions that often require very thick lenses. High-index plastics make it possible for strong prescription lenses to be thinner and lighter. The materials used in high-index lenses are dense, using less lens material to achieve the same degree of vision correction. High-index plastic can be used to correct nearsightedness, farsightedness, and astigmatism.

An aspheric lens, unlike a spherical lens, which has constant continuous curvature, has varying degrees of curvature over its surface. This design makes the lens flatter and appear thinner. An aspheric lens's optical properties provide the wearer with a larger, more usable portion of the lens and a clearer view throughout the lens than a conventional spherical design. They are ideal for strong prescriptions to correct farsightedness and in those patients who had cataract removal without replacing the eye's lens with an intraocular lens implant.

Photochromic. This type of lens changes from colorless to dark, depending on the amount of ultraviolet exposure. The lenses are clear, but in sunlight a tint appears, eliminating the need for prescription sunglasses. Photochromic lenses are available in plastic and glass and for nearly every type of refractive error.

Polycarbonate. This is the most impact-resistant material available and is 10 times less likely to break than glass or plastic. They are the lenses of choice for children and adults who engage in activities (e.g., sports) or occupations in which eyeglasses can be easily broken. They are also recommended for those who are monocular (have only one eye) and those who have one functioning eye. Polycarbonate lenses are lighter and thinner than other types of lenses and absorb ultraviolet light, thus negating the need to treat eyeglasses with ultraviolet filters.

Contact Lenses & Refractive Error Correction

Contact lenses can be used to correct any type of refractive error, and in many cases they provide clearer vision than eyeglasses. They rest directly on the cornea and are held in place by the eye's natural tears, which are always present. If fitted and used properly, contacts are effective and safe.

Not everyone is a good candidate for contact lenses due to the type of vision problem, shape of eyes, other eye conditions (e.g., dry eyes, allergies), or certain medical disorders. For example, severe arthritis in the hands makes it extremely difficult to put in or remove contact lenses. Working in a very dry atmosphere or where there is a lot of dust or particles in the air, also may make it difficult to wear contacts.

Wearing contacts requires compliance with specific instructions concerning how many hours they can be worn and how they must be cleaned, handled, and stored. Not adhering to instructions puts the wearer at risk for eye injury and infection. Contacts are also more expensive than eyeglasses. A pair of glasses can last many years, but contact lenses must be replaced more frequently. Contact lenses must be disinfected at regular intervals, requiring solutions and equipment that add considerably to the cost.

There are four main types of contact lenses: hard lenses, soft lenses, extended-wear lenses, and disposable lenses. Contact lenses are available in soft materials and hard gas-permeable varieties. All types of contact lenses, including bifocals and those for astigmatism, are available as disposable and frequent replacement lenses.

Hard Contact Lenses

The first-generation contact lenses were made of a hard, inflexible plastic material called polymethylmethacrylate (PMMA). They were very durable and usually provided the best vision correction. However, PMMA prevented oxygen from entering the cornea and carbon dioxide from leaving it. Because the cornea lacks blood vessels, it receives oxygen from the air. The hard lens interfered significantly with this process. Because of this, hard lenses could not be left in for long periods. Few patients still wear this type and most eye care professionals no longer fit this type.

Today's hard, gas-permeable lenses are similar to the hard lens in design and appearance but allow for the passage of oxygen and carbon dioxide. They are more expensive than hard lenses but more comfortable, can be left in longer, and are easy to clean and healthier for the eye. Hard lenses may provide better vision correction than soft lenses, especially when there is severe astigmatism or an irregularly shaped cornea. Disadvantages of hard lenses are that they are dislodged from the eye easily, debris can get under the lens, and the period of adjustment is long.

Soft Contact Lenses

Soft lenses are constructed of a flexible plastic that easily absorbs water, which allows the passage of oxygen and carbon dioxide to and from the cornea. The amount of water that a lens can absorb varies; low-water content, mid-water content, and high-water content lenses are available. Higher water content allows more oxygen to pass through, but high-water content lenses are fragile and difficult to keep clean.

Soft lenses are larger, more difficult to accidentally dislodge, easier to adjust to, and usually more comfortable than hard lenses. They are available for all types of refractive errors, including astigmatism. They are often difficult to insert, more fragile than hard lenses, and must be cleaned and disinfected daily, unless they are one-day-use disposable lenses. Protein from tears builds up more easily on soft lenses and cannot be removed by regular cleaning. As a result, soft lenses must be replaced every year, sometimes more frequently.

Extended-Wear Contact Lenses

Most extended-wear lenses allow better passage of oxygen to the cornea and can be left in the eyes for longer periods. These lenses are available in hard and soft materials. They can remain in the eyes for up to 7 days, without removal, and then must be cleaned and disinfected.

Extended-wear contacts increase the risk for infection and injury to the eye. The risk for keratitis or cornea infection is 4 to 10 times higher in people wearing extended-wear lenses than in those wearing lenses that are removed daily. Some eye care practitioners do not recommend them.

Disposable and Frequent Replacement Lenses

It is better for the eyes to replace contact lenses frequently because it reduces the risk for infection. Even when properly cleaned, protein deposits build up on the lenses over time, and these deposits attract bacteria that can cause infection and threaten vision.

Disposable lenses are worn for 2 weeks or less and then replaced with a fresh pair of contacts. Frequent replacement lenses are replaced monthly, bimonthly, or quarterly.

All types, except daily disposable lenses, require routine cleaning. Daily disposable lenses eliminate the need for cleaning and decrease the risk for infection. These lenses are more expensive than others, but the cost of disinfecting solutions and the time spent cleaning them are eliminated.

Bifocal Contact Lenses

Contact lenses are available as bifocals that have a prescription for near vision and one for distant vision in the same lens. Bifocal contacts are frequently prescribed for patients with presbyopia.

It takes time for the eyes to adjust to bifocal contacts and not everyone is comfortable with the vision while wearing them

---

Contact Lens Dos & Don’ts

Dos and Don'ts for Contact Lens Wearers

Not emptying the solution out of your contact lens case after each use could cost you your sight. That's because solutions that are left over in the case after a disinfection cycle are essentially "dirty." Using fresh solution each time helps reduce the risk of problems. Follow these dos and don'ts to protect your eyes.

DO

- Always wash your hands before handling contact lenses to reduce the chance of getting an infection.
- Remove the lenses immediately and consult your eye care professional if your eyes become red, irritated, or your vision changes.
- Always follow the directions of your eye care professional and all labeling instruction for proper use of contact lenses and lens care products.
- Use contact lens products and solutions recommended by your eye care professional.
- Rub and rinse your contact lenses as directed by your eye care professional.
- Clean and disinfect your lenses properly following all labeling instructions provided with your lens care products.
- Clean, rinse, and air dry your lens case each time lenses are removed. You may want to flip over your lens case while air drying so that excess solution can drain out of the case. Contact lens cases can be a source of bacterial growth.
- Replace your contact lens storage case every 3–6 months.

DON'T

- Don't use contact lens solutions that have gone beyond the expiration or discard date.
- Don't "top-off" the solutions in your case. Always discard all of the leftover contact lens solution after each use. Never reuse any lens solution.
- Don't expose your contact lenses to any water: tap, bottled, distilled, lake, or ocean water. Never use non-sterile water (distilled water, tap water, or any homemade saline solution). Exposure of contact lenses to water has been associated with Acanthamoeba keratitis, a corneal infection that is resistant to treatment and cure.
- Don't put your lenses in your mouth to wet them. Saliva is not a sterile solution.
- Don't transfer contact lens solutions into smaller travel size containers. This can affect the sterility of the solution which can lead to an eye infection. Transferring solutions into smaller size containers may also leave consumers open to accidentally using a solution that is not intended for the eyes.

Refractive Error Correction Surgery

Several surgical procedures can correct refractive errors. Some patients who undergo surgery no longer need eyeglasses or contact lenses, and others experience improved vision. The type and degree of refractive error determines whether or not a patient is a good candidate for surgery.

Laser In Situ Keratomileusis (LASIK)

Currently, LASIK is the most commonly performed surgery for refractive errors. The procedure takes between 7 and 10 minutes for both eyes. It can correct nearsightedness (myopia), farsightedness (hyperopia), and astigmatism. As in radial keratotomy, the cornea is reshaped to correct the refractive error.

After the eye is anesthetized with drops, the surgeon makes a corneal flap, a raised thin layer of the cornea, with an instrument called a microkeratome. This part of the procedure is a **keratectomy**. The flap is lifted and moved to one side. Using a computer-controlled laser, and on newer systems, an eye tracker, which follows the patient's minute eye movements, the surgeon removes tissue under the corneal flap to reshape the cornea.

To treat myopia, the cornea is made flatter by removing tissue from its center. For hyperopia, the cornea's center is made steeper. To treat astigmatism, the cornea is made rounder. The flap is replaced when the necessary tissue has been removed.

Healing occurs rapidly and stitches are not needed. Postoperative care varies from practice to practice. For example, some surgeons may cover the eyes with clear shields to protect them, while others find it unnecessary. The eyes should be rested the day of surgery and rubbing them should be avoided for a few days. Engaging in contact sports should be avoided for a couple of weeks and swimming for about a month.

Most patients experience some discomfort for 24–48 hours and notice improved vision within 1 to 5 days. However, visual acuity may not stabilize for several months.

The best results are achieved in patients with mild to moderate myopia. Approximately 93% have 20/40 vision or better following LASIK. For severely myopic patients and those with other types of refractive errors, LASIK may be less effective. Some patients who achieve 20/20 vision following LASIK report that it is not as crisp as the 20/20 they had with contact lenses, particularly the hard, gas-permeable type. This phenomenon is referred to as "loss of contrast sensitivity."

Rare complications include seeing glare or halos around bright lights at night, pain, blurry vision, eye dryness, infection, and problems with night vision.

Photorefractive Keratectomy (PRK)

PRK also uses a computer-controlled laser to reshape the cornea. In this procedure, the laser is used on the anterior part (surface) of the cornea, rather than under a corneal flap, as in LASIK. The corneal surface is prepared by removing the epithelium (outermost layer).

Healing takes longer with PRK, and patients usually experience discomfort and pain. Patients may require 3 to 5 days off from work following PRK, compared to an average of 1 day after LASIK. They also wear a bandage contact lens for 3–5 days after to help alleviate pain. Results are similar to LASIK, especially for patients with low to moderate myopia. Higher amounts of myopia do not respond well to PRK. The risk for complications is low, but the incidence of corneal scarring is slightly higher.

Intracorneal Ring (IRC)

IRC is used to correct mild myopia. It involves surgically placing a plastic ring into the cornea, which flattens the central area and corrects myopia. Unlike other surgeries, this does not permanently alter the eye. When the ring is removed, the cornea returns to its previous shape.

The eye is numbed with drops. A tiny incision is made near the upper edge of the cornea and the IRC is inserted between the tissue layers in the cornea. The procedure takes about 15 minutes.

Almost 100% of patients have 20/40 vision following IRC placement and 75% achieve 20/20. Complications are rare and include night vision difficulty, over- or undercorrection, glare, and increased astigmatism.

Clear Lens Replacement (CLR)

While not a common procedure for correcting refractive errors, the placement of an intraocular lens can help patients who are not candidates for RK, LASIK, or PRK. In this procedure, the eye's crystalline lens is removed and replaced with an artificial intraocular lens. Unlike other surgeries that alter the shape of the cornea, this one adjusts vision by changing the focusing power of the lens.

Generally, this procedure is not performed on patients younger than 40 because the implanted lens can cause difficulty in seeing close objects. Often reading glasses are required following the procedure. New types of intraocular lenses, however, are being developed that can be inserted into an eye without having to remove the natural crystalline lens. This type of lens, called a phakic intraocular lens, is currently undergoing FDA testing.

Most complications are minor and can usually be treated. Possible serious complications include retinal detachment, infection, or bleeding in the eye, but these are rare.

Radial Keratotomy (RK)

In this procedure, the cornea is reshaped to eliminate myopia and, in some cases, astigmatism. The eye is anesthetized and deep cuts are made in the cornea, like spokes in a wheel. The number of incisions and their location is determined by the degree of nearsightedness. The incisions cause the sides of cornea to bulge outward and the center to flatten, bringing the point of focus closer to the retina. Antibiotic and cycoplegic drops that paralyze the focusing ability of the eye are instilled after surgery and a patch is usually placed over the eye for about 2 hours.

Visual acuity may fluctuate for 6 months or longer and a second operation may be needed to further reduce myopia. About 50% of patients achieve 20/20 vision and about 85% achieve 20/40 vision. Improved techniques have significantly reduced the amount of regression (refractive power migrates back toward myopia) experienced by patients.

Glare around bright lights at night caused by a larger pupil and the peripheral incisions or an irregular cornea, can persist for up to 3 years and is the most common side effect following radial keratotomy.