# Cataracts and Their Treatment in People with Diabetes

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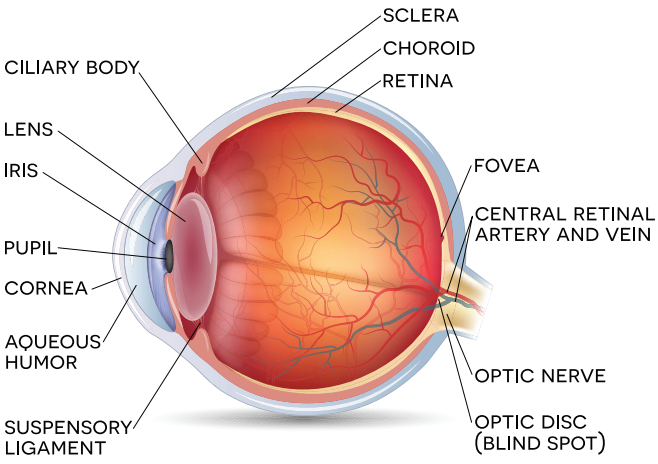
Nearly 90% of Americans surveyed in a 2014 nationwide poll said they considered eye health crucial to overall health, and almost 50% reported viewing a loss of vision as the worst possible health outcome they might experience in their lifetime (66). Two of the diseases that can profoundly affect vision are diabetes and cataracts. The National Institute of Diabetes and Digestive and Kidney Diseases estimates that 30.3 million people in the United States have diabetes (67), and the National Eye Institute projects that, by 2030, there will be almost 40 million people in the United States with cataracts (68). These statistics highlight how common both of these diseases are, yet only 65% of Americans surveyed knew what cataracts were, and just 37% were aware of some of the ways in which diabetes can affect the eye (66). Thus, it is very important for physicians and other primary care providers to know about these common diagnoses and how they affect each other, so they can counsel and educate patients appropriately to help preserve their vision.

## From Crystalline Lens to Cataract

The eye is like a camera; light is focused by the cornea and crystalline lens (the "camera lenses") in the front of the eye onto the retina (the "film") in the back of the eye. The portion of the retina that sees the central part of vision is called the macula, and even small amounts of edema or other pathology in the macula can cause significant visual compromise. The information that the retina collects is then sent by the optic nerve to the brain for processing and interpretation (Figure 3). Any irregularities and opacities in the cornea or crystalline lens interfere with the ultimate perception of a clear image in the brain, the way a smudge on a camera lens will create a blurred picture. The role of the retina will be discussed in the next chapter of this compendium.

**FIGURE 3** Cross section of the eye. Note that the course of light travels through the cornea, pupil, and crystalline lens (becomes the cataract) to the retina and then to the brain through the optic nerve.




The crystalline lens is one of the major structures that focuses light as it enters the eye. In the absence of congenital abnormalities, the crystalline lens is colorless when we are young. It becomes a cataract when it begins to acquire colored changes. Common causes of cataracts are age, trauma, iatrogenic factors (e.g., medications, radiation, or other intraocular surgeries), and disease (e.g., diabetes). Typically, the lens will become white, yellow, or a combination of the two. Cataracts are progressive and can be present for many years before they start to affect a person's vision and cause symptoms.

There are multiple types of cataract, and the different types are often associated with specific causes and can cause variable symptoms. The type of cataract most associated with aging is called a nuclear sclerotic cataract (NSC) and is diagnosed when the crystalline lens starts to turn yellow. The color of an NSC will usually progress slowly over years from yellow to amber to dark brown in very advanced cases. This type of cataract will appear to affect all layers of the crystalline lens (69).

A posterior subcapsular cataract (PSC) is one of the most common types of cataracts seen in diabetes (70) and occurs when the most posterior layers of the crystalline lens develop areas that look grainy and white. These opacities occur in discrete patches. If the PSC changes are in a peripheral portion of the crystalline lens, the cataract is asymptomatic; when the PSC opacities are in the central part of the crystalline lens, they can quickly become symptomatic. PSCs tend to be more rapidly progressive than NSCs, and their symptoms can develop over weeks or months.

Cortical cataracts are the other type of cataract that is often seen in people with diabetes (70). This type of cataract causes the middle and outer layers of the crystalline lens to become white. These changes can occur in triangular formations (called spokes) or in a more sheet-like arrangement. These cataracts are similar to PSCs in that they are typically symptomatic only when the changes affect the central portion of the crystalline lens, and their symptoms can progress rapidly.

Snowflake cataracts have sometimes been called "diabetic cataracts." Despite their name, they are much less common than the other types of cataracts that are associated with diabetes and can even occur rarely in people without diabetes. These cataracts have an abrupt onset of scattered opacities in a formation that can look like a snowflake beneath the capsule that surrounds the cataract. This type of cataract usually develops in young people with uncontrolled diabetes and may be the initial presentation of diabetes (70).

### Vision Changes in Diabetes

Diabetes may affect the eye in multiple ways, and it is important to be able to distinguish the possible causes of vision deficits in people with diabetes. Changes to the crystalline lens that are induced by diabetes can cause short- or long-term effects on the vision (70).

Aqueous humor is the fluid that fills the front of the eye and provides nourishment to the crystalline lens (Figure 3). Increased glucose levels in the aqueous humor lead to increased glucose levels in the crystalline lens. This development causes temporary swelling of the lens that can result in short-term fluctuations in vision (70). People with large fluctuations in their blood glucose levels often report vision fluctuations that mirror their glycemic control. If people with diabetes notice blurred vision across their entire visual field that only lasts for a few hours, short-term osmotic fluctuations in the crystalline lens structure are the likely cause and can be resolved by achieving more consistent blood glucose control (70).

The crystalline lens can enzymatically convert glucose to sorbitol, which is one of the many mechanisms that will eventually result in cataract formation (71). Vision that is consistently blurred over days to months and has no apparent relation to glycemic control is likely the result of a cataract or diabetes-related retinopathy (DR).

The symptoms of cataracts and DR are similar but can sometimes be distinguished by a careful history. A cataract likely causes glare, halos, or starbursts from bright sunlight or headlights at night. Decreased contrast vision, often manifesting as trouble distinguishing dark colors or needing brighter lights to read, is also a typical cataract symptom. Cataracts can also cause a change in the refractive error. A refractive error occurs when the shape and structure of the eye does not allow for light to be well focused on the retina. This lack of sharp focus results in a blurred image and needs an optical correction (usually eyeglasses or contact lenses) to allow the eye to see a sharp, clear image. A person who can obtain clear vision with a new eyeglasses prescription but finds the prescription gradually changing every few months to annually may have a cataract. Of note, in some cases, the presenting symptom of diabetes is a sudden, large change in refractive error that is stable over days to weeks. Diabetes should be considered in the differential diagnosis of patients with a sudden worsening of their refractive error, and eyeglasses should not be prescribed until a work-up is complete and their diabetes is controlled.

DR is discussed more fully in the next chapter of this compendium. Briefly, visual symptoms that are more typical of DR include a sudden onset of many new floaters (specks or "cobwebs" that float about in the field of vision) that can sometimes cause a sudden, profound decrease in vision, central vision distortion or focal blurring, and loss of a portion of the visual field. But symptoms can overlap, and cataracts and DR can coexist. Whenever patients with diabetes note a significant change in their vision, it is prudent to have them examined by an eye care specialist because most ocular conditions associated with diabetes require an examination by an ophthalmologist for diagnosis and treatment (64).

### Cataracts and Diabetes

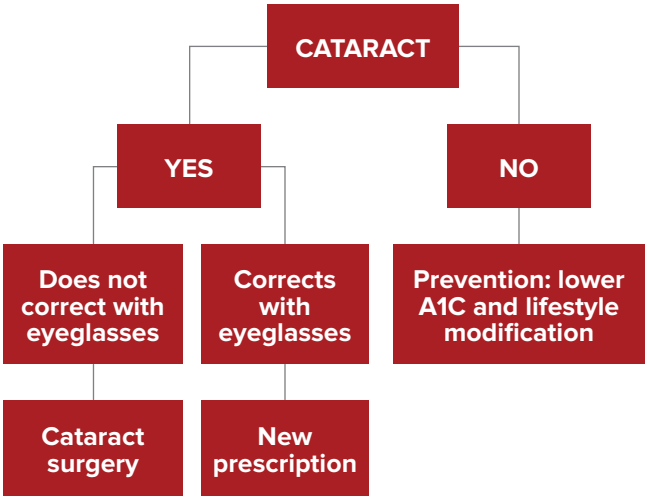
It is well established that both type 1 and type 2 diabetes are risk factors for cataract development (70). The risk factors more specifically associated with cataract formation in people with diabetes are a younger age, increasing duration of diabetes, presence of DME, and insulin use in people with type 2 diabetes (72); the latter two risk factors may be associated with poor glycemic control. The risk of developing cataracts that are specifically associated with diabetes is highest in younger people with diabetes (72). These patients' symptoms can progress more rapidly due to the types of cataracts that are more commonly associated with diabetes (i.e., PSC and cortical cataracts).

### Treatment of Cataracts

The definitive treatment for cataracts is surgical, but there are other options to consider before cataract surgery is necessary (Figure 4). Prevention of disease is preferred but ultimately not possible as an enduring solution because nearly everyone will get cataracts if they live long enough. The goal is to prevent the development of the early-onset cataracts that are associated with diabetes. The development of cataracts in younger people with diabetes is linked to hyperglycemia, so achieving tight glycemic control can help to slow the progression of cataracts. Exposure to ultraviolet light, smoking, advancing age, and steroid use are also linked to cataract development (70), and some of these risk factors can be avoided through lifestyle change.

If a cataract causes a shift in a person's refractive error, then a new eyeglasses prescription can help to improve his or her vision. Eventually, new eyeglasses will no longer correct the vision well enough to avoid surgery, but they can often delay the need for surgical treatment of cataracts.

**FIGURE 4** Decision tree for how to correct blurred vision in patients with diabetes.




### *Cataract Surgery*

As mentioned above, surgery is the ultimate treatment for cataracts. Cataract surgery is the most commonly performed surgery in the United States, and approximately 3.6 million cataract extractions were performed in 2015 (73). Cataract surgery is rarely an emergency and so is undertaken when patients' vision does not allow them to see well enough to perform visual activities they need or want to do in daily life. Another reason to pursue cataract surgery in people with diabetes might be to improve the view into the back of their eye. A clear view to the retina is required for the surveillance and possible treatment of DR.

Cataract surgery replaces a cloudy lens (the cataract) with a clear lens (the intraocular lens [IOL] implant), thus allowing light to enter the eye and be focused into a sharp image on the retina. Modern cataract surgery is almost always performed on an outpatient basis and often takes only about 10 minutes, although patients are typically at the surgery center or hospital for a few hours for their procedure.

Most patients receive light systemic sedation, along with local anesthesia in or around the eye; patients rarely require general anesthesia for cataract surgery. Patients often are prescribed steroid or antibiotic eye drops to use for about 1 month after getting cataract surgery. Some surgeons inject medications into the eye at the end of surgery, which obviates the need for eye drops during the postoperative period.

Most surgeons ask patients to follow light restrictions on physical activity for a short time, but patients are able to resume almost all of their normal activities immediately. Some types of local anesthesia allow patients to see during and just after cataract surgery, whereas other anesthesia techniques require patients to have their eye closed and patched overnight. Recovery of full vision after surgery can take weeks to achieve, and this interval may be longer for people with diabetes.

The most common approach to cataract surgery in the United States is through two small corneal incisions ranging in size from 1 to 3 mm (74). The cataract is broken up into very small pieces using ultrasound power in a process called "phacoemulsification." The small pieces are then aspirated out of the eye until the cataract is removed completely. The tissue capsule that used to house the cataract is then used to hold the new IOL implant in place. Barring extraordinary circumstances, the IOL should stay in place for the rest of the patient's life, and the cataract will not recur. Modern cataract extraction uses smaller incisions, has a shorter surgical time, and usually results in less inflammation than older techniques of cataract extraction (74).

There are two basic categories of IOLs that can be used during cataract surgery. The lenses have refractive or focusing power as part of their design. Measurements taken in the clinic before surgery can predict what patients' postoperative refractive error will be. Monofocal IOL implants will focus the eye in one location (e.g., for distance or near vision). Patients with a monofocal IOL will need eyeglasses to see clearly at distances other than the one location on which the IOL focuses their eye (e.g., they will need reading eyeglasses if their IOL is focused at far distance). Some people opt to have monofocal IOL used in such a way that will reduce their need for eyeglasses postoperatively, a result known as "monovision." In monovision, one eye is set to be near-sighted for reading vision, and the other eye is focused for distance vision.

Another option to reduce dependence on eyeglasses after cataract surgery is a different type of IOL. These IOLs try to focus the eye for both near and distance vision. There are many types of lens designs that try to achieve this goal. These lenses are usually not covered by medical insurance and cannot be implanted in every eye due to ocular contraindications. Patients' ophthalmologist will discuss their refractive goals before surgery so the lens selected to be implanted will have the best chance of fulfilling patients' vision preferences. It is important to note that, for multiple reasons, many people will still need a small vision correction from eyeglasses to achieve their best vision even at the distance at which their IOL is set to focus.

## Considerations for Cataract Surgery in Patients with Diabetes

Up to 20% of cataract surgeries are performed in people with diabetes (70), and there are some special considerations when planning cataract surgery for people with diabetes. These considerations encompass the preoperative through

postoperative time period. The advances in surgical technique and pre- and postoperative pharmacological management of DR have made cataract surgery safer for people with diabetes (75).

### *Preoperative Considerations*

As mentioned earlier, cataracts occur at a younger age in people with diabetes. This means that, at the time of cataract surgery, these younger patients still have a significant portion of their accommodation (ability to adjust the focus of the crystalline lens from near to distant objects).

Presbyopia is the gradual loss of accommodation that occurs as we age. Most older cataract surgery patients have already lost their accommodation and are thus used to relying on reading eyeglasses or bifocals for their near vision. In contrast, younger cataract patients with diabetes may not be using reading eyeglasses or bifocals for their vision preoperatively.

As noted above, the most common type of IOL used during cataract surgery is the monofocal IOL. If a monofocal IOL implant is well focused for distance, the patient will need eyeglasses for near-vision activities such as computer work, tablet use, and reading. This can be quite an adjustment for younger individuals who have had no experience with bifocals or reading eyeglasses. As such, it should be discussed in detail with patients before their cataract surgery so they will have appropriate expectations.

It may seem that younger patients with diabetes who are not used to reading eyeglasses would be ideal candidates for the type of IOL that focuses at both near and distance. Unfortunately, this type of IOL is not recommended in people with macular pathology such as DME. Thus, the presence of preoperative DME would rule out the use of this type of IOL. The lifetime risk of DME also needs to be considered in young patients who have diabetes but do not have DME preoperatively. IOL implants are considered permanent, so patients who choose an IOL contraindicated for macular pathology but then later develop macular disease such as DME may have late vision compromise.

The choice of an IOL is limited in another way by diabetes. IOLs that are made with silicone should not be used in people with diabetes. At some point, a retina surgeon may use silicone oil for surgical management of severe DR. Silicone oil may condense on silicone IOLs. Hydrophobic acrylic is typically the preferred material for IOLs in people with diabetes because it should retain its clarity if future retinal intervention is necessary.

### *Intraoperative Considerations*

The pigment epithelium of the iris can accumulate glycogen or develop neovascularization (the formation of new blood vessels) and a resultant fibrous membrane from diabetes. Both of these conditions cause the pupil to dilate poorly. The pupil needs to dilate well during cataract surgery to ensure adequate access to the cataract that sits directly behind the iris (Figure 3). Poor pupillary dilation can make cataract surgery more complicated.

There are surgical maneuvers during cataract surgery to expand pupillary dilation pharmacologically or mechanically. The more effective mechanical techniques can result in abnormally shaped pupils, iris pigment dispersion with subsequent intraocular pressure elevation, and iris depigmentation. Although these effects are typically very mild with modern approaches, they can increase the risk of complications during and after surgery (70).

### *Postoperative Considerations*

Corneal hypoesthesia (decreased corneal sensitivity) is common in people with diabetes. The two small corneal incisions needed for cataract surgery often will have small corneal epithelial defects overlying them at the end of surgery, similar to small corneal abrasions. Diabetes can slow the recovery of the epithelium after cataract surgery and prolong discomfort from the abrasions or result in recurrent corneal erosions (70).

A posterior capsular opacity (PCO) is a loss of clarity to the posterior surface of the tissue capsule that holds the IOL in place. This opacity can scatter light and cause blurry vision and glare similar to the effects of a cataract. A film of lens epithelial cells can grow behind the IOL implanted during cataract surgery, or the capsule can develop fibrosis and wrinkle.

Approximately 30% of people who have cataract surgery will develop a PCO in the months or years after their procedure (76). Younger people have a higher rate of PCOs (76). There are conflicting reports of whether PCOs are more common in patients with diabetes (76). However, we know that many patients with diabetes are younger at the time of their cataract surgery, so many of them will end up with a PCO sometime after surgery.

PCOs are treated in the clinic with a straightforward laser procedure that lasts a few minutes. Most of these are very routine, but there are some rare, yet serious, risks associated with the laser treatment of PCOs.

Endophthalmitis is an intraocular infection that can occur after cataract surgery. Many such infections can be treated successfully, but they do sometimes result in permanent loss of vision or loss of the eye completely. The rate of endophthalmitis is extremely low, at 0.044% with the modern use of intracameral antibiotics at the time of cataract surgery (77). People with diabetes have a 31% increase in the rate of endophthalmitis after cataract surgery (77). This increased risk of developing a devastating infection is

concerning, even though the overall number of endophthalmitis cases is very small even in patients with diabetes.

Other vision-threatening complications after cataract surgery in patients with diabetes involve the retina. Older studies reported an increase in DR and DME and a predisposition to anterior segment neovascularization after cataract surgery (75). These serious risks led to the recommendation that cataract surgery be delayed in patients with diabetes. The modern approach to cataract surgery has reduced the worst of the risks in uncomplicated surgeries, and thus must ophthalmologists use the same preoperative criteria in recommending cataract surgery for patients with or without diabetes. Still, there are some risks to the diabetic retina with the current approach to cataract surgery, and certain measures should be taken to ensure the best outcome for patients with diabetes (75).

The main postoperative concern about the retina of a patient with diabetes is the development or worsening of DME, which can lead to poor vision. In patients without DME preoperatively, the risk of postoperative visual compromise from the development of DME is greatest in people with preexisting DR, and there should be special consideration given to using eye drop nonsteroidal anti-inflammatory drugs (NSAIDs) in this group at the time of cataract surgery (75). In fact, regardless of the presence of DR, patients with diabetes who do not have DME have a lower relative risk of developing DME with the prophylactic use of NSAIDs in the perioperative period (75). This treatment is not without concerns, however. The course of treatment can last beyond the usual time course for postoperative eye drops, which may decrease compliance. This longer time period also results in increased cost to patients for drug copayments and exposes them to potential side effects from an additional medication.

Patients with diabetes who have pre-existing DME also need special treatment in the perioperative period. There are multiple treatment options for these patients at the time of cataract surgery that will help to prevent the worsening of their DME. These options include macular laser therapy, intravitreal anti–vascular endothelial growth factor medications, and intravitreal steroids (both injections and implants). Each of these options has risks, and a clear best choice for the treatment of preoperative DME has not yet emerged (75).

## Conclusion

The aging population and increasing prevalence of diabetes together ensure that the number of people with cataracts will continue to increase. Vision is one of the most important contributors to quality of life and is the sense people most fear losing (77). People with diabetes can decrease their risk of cataract formation by improving their glycemic control and controlling for other lifestyle factors that increase cataract risk. The many advances in cataract surgery technique and procedural and pharmacological management of DR have made cataract surgery a safe and effective procedure for people with diabetes in the vast majority of cases.