JAMA | Review

Cataracts
A Review

Stephanie P. Chen, MD; Fasika Woreta, MD, MPH; David F. Chang, MD

IMPORTANCE Age-related cataract, defined as progressive opacification or clouding of the eye's natural lens, is a leading cause of visual disability and blindness. Cataract surgery is one of the most commonly performed procedures in high-income countries. More than 3.5 million cataract operations are performed annually in the US.

OBSERVATIONS Older age is the primary risk factor for cataracts, with approximately two-thirds of the population older than 80 years affected. As the population ages, the number of people with cataracts in the US is expected to increase to 50 million by 2050. Additional risk factors for cataracts include a hereditary or genetic predisposition, certain medications (corticosteroids), ocular trauma, significant UV exposure or radiation therapy, and certain medical conditions such as uncontrolled diabetes, retinitis pigmentosa, Down syndrome, and congenital rubella. Painless, progressive blurring of vision and visual glare are common symptoms of cataracts. Cataracts are diagnosed during an eye examination by an ophthalmologist or optometrist. Surgery to remove the cataract and implant a permanent intraocular lens (IOL) is indicated if visual impairment impedes activities of daily living and is associated with lower rates of falls (>30%) and dementia (20%-30%). Most cataract operations are performed with topical anesthesia. Therefore, patients do not require preoperative general medical testing such as bloodwork or electrocardiogram, and do not need to discontinue anticoagulants for cataract surgery. Systemic α1-adrenergic antagonists for symptomatic benign prostatic hyperplasia, such as tamsulosin, increase the risk of surgical complications and some ophthalmologists temporarily discontinue the drug preoperatively. Intraocular antibiotics, such as moxifloxacin or cefuroxime, delivered intraoperatively have reduced the rates of sight-threatening postsurgical endophthalmitis from 0.07% to 0.02%. In addition to reversing and preventing progressive vision loss, cataract surgery can reduce dependence on eyeglasses. These optional refractive benefits are achieved with advanced technology IOL designs, such as multifocal IOLs. However, multifocal and other advanced technology refractive IOLs are associated with increased costs that are not covered by medical insurance.

CONCLUSIONS AND RELEVANCE Cataracts are common among older adults and may cause visual disability and blindness without treatment. Cataract surgery reverses and prevents progressive vision loss, and advanced technology lens implants facilitate reduced dependence on eyeglasses.

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Author Affiliations: Department of Ophthalmology, University of California, San Francisco (Chen, Chang); Department of Ophthalmology, Wilmer Eye Institute, Johns Hopkins University School of Medicine, Baltimore, Maryland (Woreta).

Corresponding Author: David F. Chang, MD, University of California San Francisco, 762 Altos Oaks Dr, Los Altos, CA 94024 (dceye@earthlink.net).

The term *cataract* comes from the Latin word *cataracta* or "waterfall" and is defined by progressive opacification, or clouding, of the eye's natural crystalline lens. Cataracts are a leading cause of visual impairment and blindness worldwide. Globally in 2020, among adults aged 50 years or older, cataracts accounted for an estimated 15 million cases of blindness and an additional 79 million cases of moderate to severe visual impairment.[1] The prevalence of cataracts increases with age, affecting more than two-thirds of the population older than age 80 years (**Box 1**).[2] In the US, the number of people with cataracts is projected to increase from 24.4 million in 2010 to 50 million by 2050 due to aging of the population.[2]

Cataract surgery is among the most common and cost-effective outpatient surgical procedures performed in the US, with more than 3.5 million cases performed per year.[3-5] Cataract surgery improves quality of life and economic productivity and is also associated with lower risk of falling by more than 30%.[6-8] Because visual impairment is associated with higher risk of developing dementia in elderly individuals (56% vs 17% with no visual impairment after 7 years of follow-up),[9] improving vision through cataract extraction may be associated with lower rates of dementia by approximately 20% to 30%.[10,11]

This review summarizes current evidence on the diagnosis and treatment of cataracts.

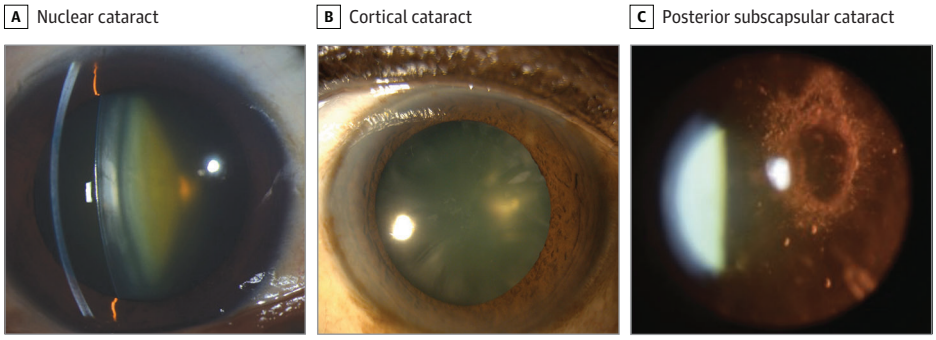
Box 1. General Medical Risk Factors for Cataract Surgery

Who is at risk for cataracts?
Older age is the primary risk factor for cataracts. Additional risk factors for cataracts include a hereditary or genetic predisposition, certain medications (corticosteroids), ocular trauma, significant UV exposure or radiation therapy to any part of the eye that has tumor cells, and certain medical conditions such as uncontrolled diabetes, retinitis pigmentosa, Down syndrome, and congenital rubella.

Which medications can commonly affect cataract surgery outcomes?
α-Adrenergic receptor antagonists, particularly tamsulosin, are linked to intraoperative floppy iris syndrome, a condition characterized by progressive pupillary miosis, and iris billowing and prolapse. Intraoperative floppy iris syndrome increases the risk of complications during cataract surgery. Consider cessation of α-blocker or transitioning to alternatives such as tadalafil preoperatively, or consider the need for cataract surgery prior to initiation of α-blocker therapy.

Do antiplatelet and anticoagulant therapies need to be discontinued prior to cataract surgery?
Antiplatelet and anticoagulant therapy do not need to be stopped prior to cataract surgery. Most cataract operations are performed under topical anesthesia with small corneal incisions that minimize the risk of bleeding.

Figure 1. Types of Cataracts



Ophthalmologists categorize different types of cataracts based on the location within the lens where visually significant opacification is found. This is determined using the slitlamp biomicroscope after pupil dilation. A, This shows the slitlamp view using an obliquely oriented slit beam of light. This method of illumination creates a sagittal view of the lens, which is visible just behind the iris. The golden yellow haze would be described as a nuclear cataract. B, This view is obtained using direct illumination; light reflecting from the fundus retroilluminates the lens and shows spokelike opacities in the anterior region of the lens. This is referred to as a cortical cataract because it is peripheral to the central nucleus. C, Using slitlamp retroillumination, the slitlamp microscope is focused on the posterior lens capsule. Just anterior to this is opacification referred to as a posterior subcapsular cataract because the opacification is located just within the posterior capsule.

Methods

PubMed was searched for English-language studies on cataracts and cataract surgery published between January 1, 2010, and November 22, 2024. Clinical trials and meta-analyses with large study populations were prioritized over smaller observational studies. Of 3691 articles identified, 83 were included for this review, including 8 randomized clinical trials (RCTs), 5 meta-analyses, 16 reviews, 19 longitudinal observational studies, 4 cross-sectional studies, 1 cost analysis, 2 preclinical studies, 12 guidelines and position papers from professional society groups, 11 expert statements and editorials, and 5 surveys. Some relevant articles published prior to 2010 were included.

Anatomy/Pathophysiology

The crystalline lens is derived from surface ectoderm during fetal development and is biconvex, elastic, and transparent at birth. The lens is avascular and consists of epithelial cells and lens fibers, which make up the nucleus and cortex. Surrounding the lens is a smooth, transparent basement membrane called the lens capsule, or capsular bag. Circumferentially attached zonular ligaments that insert into the peripheral edge of the capsular bag suspend the lens directly behind the iris. The cornea contributes approximately two-thirds of the focusing power of the eye, directing incoming light onto the retina. The lens accounts for the remaining third but can also change shape to dynamically adjust the focus. This process of shifting focus from far to near is called accommodation and is initiated by the ciliary muscles through their zonular attachments to the equator of the lens.

The lens is primarily composed of water and soluble proteins called crystallins, which require precise protein interactions to maintain proper function and lens transparency. With age, these proteins gradually become insoluble, and along with cumulative oxidative damage to lens epithelial cells, opacification of the lens develops and progresses. This loss of lens transparency is known as a cataract. Ophthalmologists classify cataracts according to the anatomic location of opacification, observed by slitlamp evaluation (**Figure 1**). Other risk factors for cataracts include heredity/genetic (congenital), exposure to radiation, high myopia, drug-induced (eg, corticosteroids), trauma, atopy with associated eye rubbing, cigarette smoking, high cumulative UV exposure, and prior intraocular surgical procedures, such as vitrectomy (**Box 2**). Cataracts

can be associated with systemic diseases such as diabetes, retinitis pigmentosa, Down syndrome, and congenital rubella.

Disparities in Cataract Prevalence and Surgical Treatment

The prevalence of cataracts in the US is disproportionately higher in racial and ethnic minority populations such as Asian, Black, Hispanic, and Native American individuals compared with White individuals; among those with lower income and education; and among women.[12] A recent US study reported that Asian, Black, and Hispanic patients and those of lower socioeconomic status were more likely to experience severe vision impairment from cataracts at the time of surgery, underscoring the need to address social determinants of health and remove structural barriers to equitable care.[13]

Worldwide, access to cataract surgery varies significantly. In low- to middle-income countries (LMICs), due to limited resources and inadequate numbers of surgeons, treatable cataract accounts for up to 50% of blindness compared with only 5% in high-income countries.[14] Cataract surgery rates, defined as the number of cataract operations per million population per year, are much lower in LMICs. For example, while the cataract surgery rates in high-income countries typically range from 4000 to 6000 per million, rates of cataract surgery in Latin America and parts of Asia are between 500 and 2000 per million, whereas Africa, China, and the lowest-income countries in Asia have rates of cataract surgery that are approximately 500 or less per million.[15] In high-income countries, cataracts are removed using ultrasound energy to emulsify the solid lens into small fragments that can be aspirated through small, sutureless corneal incisions. Because this technique, called phacoemulsification, requires more expensive technology, large incision techniques in which the solid lens is not fragmented are used more often in LMICs.[16,17]

Prevention

Currently, no treatments have been identified that prevent or delay age-related cataracts. Antioxidant supplements and dietary modifications interfering with the oxidative pathway, including vitamins A, B, C, and E, β-carotene, and lutein/zeaxanthin, have been extensively studied.[18,19] Some studies have suggested a benefit in delaying the onset of cataracts, while others showed no meaningful effect.[18,19] There is no high-quality evidence to support any specific dietary regimen to reduce the risk of cataracts. A multicenter clinical trial of 5802 individuals aged 55 to 80 years who had not undergone cataract surgery randomized patients to a Mediterranean diet (MedDiet) enriched with extra-virgin olive oil, a MedDiet enriched with nuts, or a control group that was recommended to follow a low-fat diet.[20] At 7 years of follow-up, there was no statistically significant difference in rates of cataract surgery among these 3 groups (206 in the MedDiet plus extra-virgin olive oil group [17.6 cases/1000 person-years], 174 in the MedDiet plus nuts group [16.2 cases/1000 person-years], and 179 in the control group [16.9 cases/1000 person-years]). The multivariable-adjusted hazard ratios were 1.03 (95% confidence interval [CI], 0.84-1.26; $P = .79$) for the control group vs the MedDiet plus extra-virgin olive oil group and 1.06 (95% CI, 0.86-1.31; $P = .58$) for the control group vs the MedDiet plus nuts group.[20] Additionally, high cumulative UV radiation exposure is associated with cataract development.[21] Both UV-A and UV-B can cause photo-oxidative damage to lens proteins and lens opacification. The World Health Organization and the US Environmental Protection Agency recommend wearing a brimmed hat and 99% to 100% UVA/UVB-blocking sunglasses to reduce the effect of solar radiation on ocular tissues.[22,23]

Box 2. Risk Factors Associated With Development of Cataracts

Risk Factor/Etiology[a]
Ocular
• High myopia
• Prolonged steroid use (topical/injected)
• Eye rubbing[b]
• Ocular trauma
• Vitrectomy history
• Uveitis
• Pseudoexfoliation syndrome
• Intraocular tumors
• Radiation treatment to the ocular structures
• Congenital
• Degenerative ocular disease (eg, retinitis pigmentosa)
Systemic
• Aging
• Female sex
• Diabetes
• Hypertension
• Prolonged steroid use (systemic)
• Current smoking
• Heavy alcohol consumption
• UV radiation[c]
• Laborer occupation
• Hypocalcemia
• Hyperthyroidism
• Genetic diseases and syndromes (eg, Marfan syndrome, retinitis pigmentosa, and Down syndrome)

[a] Congenital rubella is another risk factor.

[b] The mechanism associated with eye rubbing is believed to be repetitive microtrauma from the mechanical force of eye rubbing. Patients are, in general, advised to avoid eye rubbing.

[c] Includes UV exposure from sunlight and artificial sources of UV exposure such as frequent use of tanning beds.

Signs and Symptoms

Cataracts eventually result in painless, progressive blurring or clouding of vision, impairing the ability to discern fine details at distance (eg, freeway signs) or near (eg, small print). Moreover, light scatter from cataracts increases glare from headlights and sunlight, while reduced contrast sensitivity means greater effort is required to read in low light.

Diagnosis

Cataracts are diagnosed through a comprehensive eye examination. An ophthalmologist or optometrist uses slitlamp microscopy

Table. Factors to Consider for Cataract Surgery

	Typical recommendations	Exceptions
Preoperative medical evaluation	Not recommended for routine cases	History of MI, PCI, symptomatic arrhythmias, decompensated HF, acute severe pulmonary/neurologic conditions, malignant HTN, DKA/HHNS
Fasting	Hold clear fluids: 2 h before the procedure Hold light solids: 6 h before the procedure Hold GLP-1 agonists for 1 wk before the procedure	Fasting may be unnecessary for cases with topical anesthesia and minimal IV sedation
Anesthesia	Topical anesthesia with minimal IV sedation for routine cases reduces risk of hemorrhage and recovery time	General anesthesia recommended for pediatric patients and adults who are uncooperative from psychiatric or intellectual disabilities, have uncontrolled tremors, claustrophobia, difficulty lying still
Anticoagulation	Discontinuing antiplatelet and antithrombotics not routinely recommended	Data on DOACs limited, exercise caution[a]; DAPT should be withheld if peribulbar or retrobulbar anesthesia indicated
Intraocular antibiotics	Intraocular cefuroxime or moxifloxacin reduces risk of postoperative endophthalmitis[27-30,b]	Weigh risk of endophthalmitis against risk of mild-moderate allergy to cephalosporins or fluoroquinolones. Avoid if severe allergy (ie, anaphylaxis)
Systemic α-adrenergic antagonists	Notify surgeons of use because α-blockers increase risk for IFIS Consider temporarily stopping α-blockers and, if needed, substituting an alternative, such as tadalafil, until after cataract surgery	NA
Femtosecond laser–assisted cataract surgery	No recommendation for or against use; data have not shown improved outcomes and the extra cost is not covered by insurance	NA

Abbreviations: DAPT, dual antiplatelet therapy; DKA, diabetic ketoacidosis; DOAC, direct oral anticoagulant; GLP-1, glucagon-like peptide-1; HF, heart failure; HHNS, hyperosmolar hyperglycemic nonketotic syndrome; HTN, hypertension; IFIS, intraoperative floppy iris syndrome; IV, intravenous; MI, myocardial infarction; NA, not applicable; PCI, percutaneous coronary intervention.

[a] The risk of bleeding during cataract surgery is very low. There is slightly increased risk of bleeding with peribulbar/retrobulbar anesthesia, but even then the risk is extremely low. As written in the recommendations for anticoagulation, surgeons typically do not recommend stopping anticoagulants for routine cataract surgery. However, because data are limited for stopping/continuing DOACs with cataract surgery, high-quality evidence is not available for an explicit recommendation for DOACs.

[b] Specific protocol varies according to facility and/or surgeon.

to examine the ocular anatomy and identify any opacification of the lens after pupillary dilation. This method is more accurate than using a direct ophthalmoscope to evaluate the clarity of the fundus. Visual impairment is objectively measured by visual acuity testing, including under simulated glare conditions.

For otherwise healthy adults, the American Academy of Ophthalmology (AAO) recommends a comprehensive eye examination at age 40 years to detect early signs of ocular disease.[24] At age 65 years or older, eye examinations are advised by the AAO every 1 to 2 years to screen for age-related ocular disorders, including cataracts, macular degeneration, and glaucoma.

Treatment

Nonsurgical Management of Cataracts

Nonsurgical management of early cataract symptoms primarily consists of optimizing the patient's spectacle or contact lens prescription. Cataracts may cause the eye to become more nearsighted, and new eyeglasses may improve vision. Patients may use compensatory strategies such as magnification and increasing illumination in low-contrast environments. As visual symptoms worsen, cataract extraction with intraocular lens (IOL) implantation is the only treatment and definitive cure.

Potential pharmacologic therapies to arrest or reverse cataract formation are currently under investigation. The most promising therapies target oxidative stress or crystallin protein aggregation. For instance, thiol antioxidants, such as N-acetylcarnosine, upregulate the glutathione pathway in the lens, which reduces oxidative stress and inhibits progression of cataracts.[25] In addition, the oxysterol lanosterol dissociates large protein deposits, which reverses lens clouding in animal models.[26] However, to date, no pharmacologic therapeutic agents have advanced to human clinical trials.

Surgical Management of Cataracts

Indications for Surgery

Cataract surgery is indicated when the associated visual impairment interferes with activities of daily living. This can be assessed with patient questionnaires, including the National Eye Institute Visual Function Questionnaire or the Visual Function Index. Additional indications for surgery include correcting a significant refractive imbalance between eyes after contralateral cataract surgery and improving visualization of potential retinal pathology. The Snellen acuity chart tests image resolution using high-contrast letters, accurately measuring the distance blur of refractive errors such as myopia and astigmatism. However, cataracts often reduce contrast sensitivity and/or cause glare by scattering light instead of focusing light sharply on the retina. This effect produces halos around light sources and heightens sensitivity to bright lights. Visual acuity testing with high-contrast Snellen letters often does not measure the real-world functional disability of cataracts at earlier stages. For example, surgery may still be indicated even in a patient with 20/20 Snellen acuity if that patient feels unsafe driving at night due to severe glare.

Preoperative General Medical Assessment

Routine preoperative medical evaluations and testing before cataract surgery are not recommended by the AAO (**Table**) because they do not decrease ocular or systemic complications from cataract surgery.[5,31,32] Similarly, the American College of Cardiology and

American Heart Association recommend against routine preoperative cardiac evaluation for very-low risk procedures, such as cataract surgery, due to the type of anesthesia used.[33]

Selective preoperative medical testing may be considered for higher-risk patients. The Society for Ambulatory Anesthesia recommends delaying cataract surgery to optimize the following medical comorbidities and achieve hemodynamic stability or symptom control: myocardial infarction, symptomatic arrhythmias, decompensated heart failure, acute severe pulmonary or neurologic conditions such as pneumonia or stroke, malignant hypertension, and diabetic ketoacidosis or hyperosmolar hyperglycemic nonketotic syndrome.[34] Hypertension without end-organ damage should not delay surgery, and abrupt preoperative lowering of blood pressure is not recommended. Similarly, there is no threshold blood glucose concentration or hemoglobin A_{1c} level above which surgery should be postponed.[34] Risk assessment should be performed by the ophthalmic surgeon at the preoperative visit for cataract surgery, in consultation with the patient's primary care physician when appropriate.

Anesthesia Considerations

Because comparable outcomes are achieved regardless of the anesthesia technique used,[35,36] most outpatient cataract surgery is currently performed with topical anesthesia and intraocular lidocaine with patients positioned supine. For those unable to lay flat on their back (ie, chronic obstructive pulmonary disease, congestive heart failure), reverse Trendelenburg positioning may be helpful. Intravenous or oral sedation is often used as an adjunct to reduce procedure-related anxiety. Periocular injections are helpful for more complex cases to provide akinesia of extraocular muscles and longer-acting anesthesia. However, they are associated with a small risk of retrobulbar hemorrhage, and the prolonged corneal anesthesia and loss of the protective blink reflex necessitate postoperative eye patching. In contrast, patients who undergo cataract surgery with topical anesthesia are discharged without an eye patch. General anesthesia during cataract surgery is typically reserved for pediatric patients and adults who are unable to follow instructions due to intellectual or psychiatric disabilities, or are unable to lie immobile.

Instructions for sedation and surgery may include fasting after midnight prior to surgery to reduce the risk of emesis and aspiration. As of 2017, the American Society of Anesthesiologists recommends that patients withhold oral clear fluids 2 hours prior to elective surgery and light solids 6 hours prior to elective surgical procedures.[37] However, recent evidence suggests that procedural sedation and analgesia can be safely administered in nonfasting patients for certain procedures including cataract surgery.[38-40] A randomized, crossover, clinical trial of 109 consecutive patients undergoing cataract surgery with topical anesthesia demonstrated lower anxiety levels (mean [SD] score, 2.3 [2.0] vs 4.1 [2.4]; $P = .01$) and surgical pain (mean [SD] score, 0.6 [0.6] vs 2.6 [3.4]; $P = .003$) in nonfasting compared with fasting patients. These values were measured by the anesthetist using a 0 to 10 verbal rating scale, with 0 signifying no anxiety or pain. Nonfasting patients also received less sedation (1% of nonfasting cohort [95% CI, 0%-3.2%] vs 6% of fasting cohort [95% CI, 2.9%-8.9%]; $P = .04$) and had significantly shorter operating times (mean [SD], 16.0 [5.9] minutes vs 22.3 [6.1] minutes; $P = .03$).[41] Worldwide, there is variability in cataract surgery practice patterns related to perioperative care based on a global questionnaire administered to ophthalmologists from different practice settings.[42]

In 2023, the American Society of Anesthesiologists issued consensus guidelines for patients taking glucagon-like peptide-1 (GLP-1) receptor agonists undergoing elective procedures. Patients taking daily GLP-1 agonists are counseled to hold the medication on the day of surgery, and 1 week prior to surgery if using weekly dosing, due to the effects of GLP-1 agonists on delayed gastric emptying.[43]

Anticoagulants

Topical anesthesia and small, clear corneal incisions have reduced the risk of hemorrhagic complications associated with cataract surgery.[44] There is no evidence to support withholding antiplatelet or anticoagulant therapy before cataract surgery. The 2022 American College of Chest Physicians clinical practice guidelines recommended continuing antithrombotic medications, such as warfarin, perioperatively for standard cataract surgery, consistent with the general consensus from multiple subspecialty groups including the AAO, American College of Cardiology, American Heart Association, and Society for Ambulatory Anesthesia.[5,33,34,45] However, data on newer, direct oral anticoagulants are limited. For patients requiring a peribulbar or retrobulbar anesthetic injection, discontinuation of dual antiplatelet therapy reduces the risk of orbital hemorrhage; in contrast, warfarin may be continued if the international normalized ratio is in therapeutic range (2.0 to 3.0).[46]

Presurgical Ophthalmologic Evaluation and IOL Selection

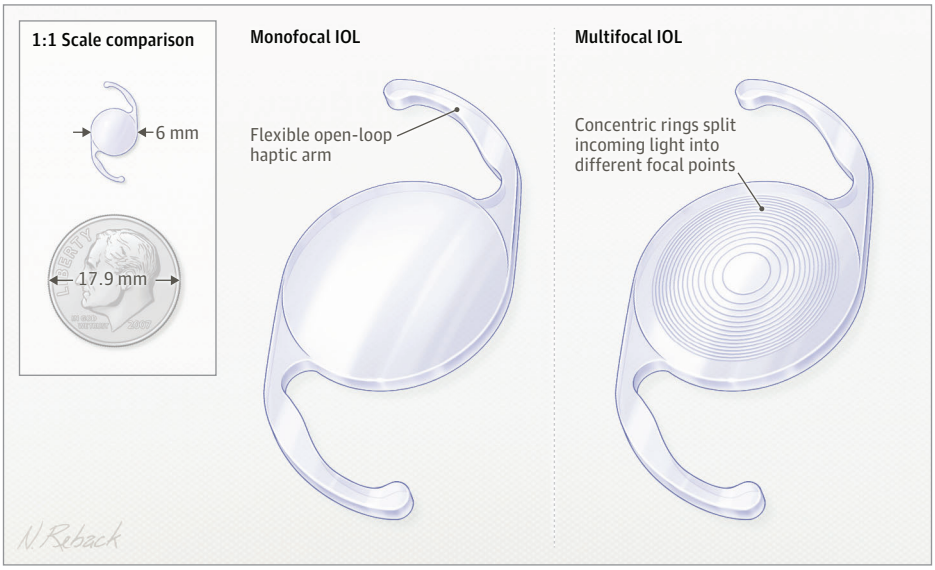
Prior to surgery, patients should undergo a comprehensive ophthalmologic history and examination by their ophthalmologist to determine medical necessity. Visual function questionnaires may be used to document subjective visual impairment. Diagnostic imaging and tests are also performed to identify ocular comorbidities that may affect visual outcome after cataract surgery, such as glaucoma and macular degeneration.

After the opacified lens is surgically removed, an IOL must be implanted to replace its focusing power. In addition to being clear and transparent, each IOL has optical power that determines where the eye is in focus without eyeglasses. The basic monofocal IOL (**Figure 2**) provides a fixed focus, and patients will receive new eyeglasses after surgery to optimize distance, intermediate (eg, computer monitor), and near focus. Bifocal, trifocal, and progressive eyeglasses combine multiple corrections into one frame.

Patients may elect several advanced technology IOLs (Figure 2) that provide additional refractive benefits to reduce postoperative dependence on eyeglasses. Toric IOLs correct preexisting corneal astigmatism by aligning with the eye's astigmatic axis, while presbyopia-correcting IOLs reduce dependence on bifocals and trifocals by extending depth of focus or providing multifocality for a wider range of vision. Some patients select different IOL designs or refractive targets for each eye (ie, one eye for distance vision, one eye for near vision). While all commercially available IOLs are static, research continues toward developing a truly dynamic, accommodating IOL.

Once the patient's refractive targets are identified, the ophthalmologist selects an IOL model with specific refractory powers for each eye, using mathematical formulas that incorporate biometric data such as axial length and corneal power. These formulas

Figure 2. Intraocular Lens (IOL) Design



IOLs are comprised of 2 parts: the optic, which is the central part providing the focusing power of the lens implant, and the haptics, which are the arms or appendages of the implant providing mechanical and rotational stability within the capsular bag. Left, Representative monofocal IOL design with a 6-mm optic and flexible, open-loop haptics. Right, Representative multifocal IOL design with concentric rings that split incoming light to different focal points.

must predict the exact postoperative axial position of the IOL, which cannot be precisely determined preoperatively. For eyes with astigmatism, the required toric power and axis must also be estimated in advance to achieve a desired refractive outcome without eyeglasses, an estimation that may not be exactly correct. The novel light-adjustable IOL is made from photosensitive material that allows postoperative adjustments of the lens power using targeted UV light from a specialized light delivery device to correct residual refractive error.

Because an IOL must be placed after cataract removal, the basic monofocal IOL is covered by medical insurance. Reducing the need to wear eyeglasses with advanced technology IOLs is a refractive benefit and not considered medically necessary. Patients may elect to pay additional costs out of pocket for these advanced technology IOLs.

Surgical Methodology

Cataract surgery is typically performed through small, self-sealing corneal incisions, eliminating the need for sutures. Modern cataract surgery uses phacoemulsification—ultrasonic waves delivered through a handheld probe—to fracture the clouded lens into small fragments through a circular anterior capsulotomy (**Figure 3** and **Video**). The fragments are then aspirated out of the eye while preserving the capsular bag and supporting zonules. A malleable IOL is injected into the eye and unfolds in the capsular bag. In addition to fixating the IOL in the same location as the natural lens, the avascular capsular bag sequesters the prosthetic IOL and minimizes foreign body reaction.

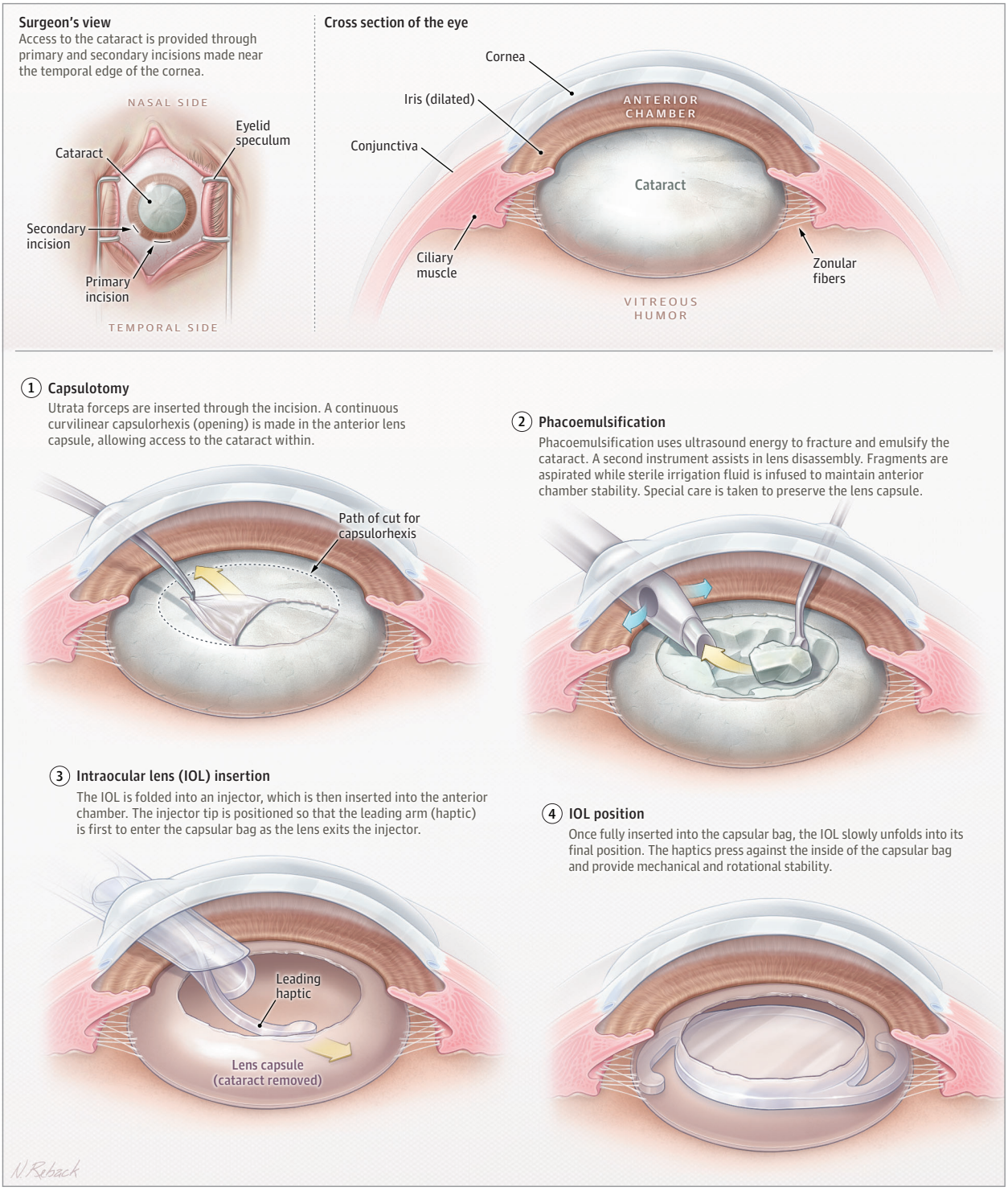
With extremely advanced cataracts, the lens nucleus may become too solid to emulsify with ultrasound. The hard unfragmented nucleus is then manually extracted through a larger incision that is then sutured closed. Manual large-incision surgery is also routinely performed in some LMICs due to resource constraints or because surgeons do not have the technology or training to perform phacoemulsification.

Femtosecond laser–assisted cataract surgery (FLACS) was approved by the US Food and Drug Administration in 2010 as a technology to automate the corneal incision, the anterior capsulotomy, and lens fragmentation in cataract surgery. However, RCTs have not demonstrated a statistically significant difference in overall complications or visual outcomes between FLACS and standard cataract surgery.[47,48] Additionally, the high cost of the technology, which is not covered by medical insurance, has limited greater use of FLACS.

Antibiotics

Although rare, postoperative endophthalmitis (POE) is a potentially blinding intraocular infection that is usually caused by gram-positive bacteria originating from the patient's eyelids and lashes.[49] The efficacy of intraocular antibiotic prophylaxis for POE has been extensively studied, but this complication is so rare that conducting a definitive RCT large enough to detect a significant effect is difficult. The only published multicenter RCT included 16 603 recruited patients and identified 29 cases of POE, with a 0.247% (95% CI, 0.119%-0.454%) incidence of POE in the absence of intraocular cefuroxime injected once at the conclusion of surgery compared with 0.049% (95% CI, 0.006%-0.178%) if cefuroxime was given.[27] Subsequently, large, retrospective studies supported efficacy of intraocular antibiotic prophylaxis.[28,29] A meta-analysis in 2018 of 17 studies (16 observational studies and 1 RCT) with more than 900 000 eyes showed that intraocular cefuroxime and moxifloxacin administered during surgery were associated with significantly lower rates of POE. Rates were reduced from 0.09% in the no antibiotic group to 0.0332% and 0.0153%, respectively, in the pooled analysis with minimal adverse effects from the antibiotics at standard doses.[30] Similarly, in a series of 2 million consecutive cataract operations, intraocular moxifloxacin was associated with lower POE rates (0.07% for the group who did not receive intraocular moxifloxacin and 0.02% for the group who received intraocular moxifloxacin) ($P < .001$).[29] As a result, moxifloxacin and cefuroxime are the most common intraocular antibiotics used for cataract surgery in the US and internationally.[50]

Figure 3. Cataract Surgery With Phacoemulsification



Cataract surgery is typically performed with the surgeon seated temporally. A hands-free eyelid speculum retracts the eyelids to maintain exposure throughout the case. Preoperative dilating drops are administered to achieve maximal pupil dilation. To access the cataract, a continuous circular opening is manually created in the anterior lens capsule. Ultrasound energy, delivered through the phacoemulsification probe, fragments the cataract into smaller pieces, which are then aspirated from the eye. After complete removal of the cataract, an artificial lens implant is inserted into the empty capsular bag. The incisions typically self-seal, eliminating the need for sutures.

Intraoperative Floppy Iris Syndrome

Intraoperative floppy iris syndrome (IFIS) is defined by progressive pupillary constriction and iris prolapse during cataract surgery. IFIS was first described in 2005 and is primarily associated with use of systemic α1-adrenergic antagonist therapy for benign prostatic hyperplasia (BPH).[51] The mechanism of IFIS involves a loss of iris dilator muscle tone, which does not affect a patient's vision but is associated with a higher risk of cataract surgical complications, such as iris trauma and lens capsule tears, particularly if not anticipated by the surgeon.[51-54] Initial population-based studies estimated the risk of major sight-threatening complications to be 7.5% in patients undergoing cataract surgery who were taking tamsulosin vs 2.7% among patients undergoing cataract surgery who were not taking tamsulosin.[53] Although the incidence of IFIS is currently approximately 1.0% among all cataract operations, recognition of IFIS and supplemental surgical strategies, such as temporary pupil expansion devices, have reduced the risk of severe complications over time.[55] Severe IFIS most commonly occurs with selective α-1A antagonists, such as tamsulosin and silodosin.[56,57] While IFIS can also occur with nonselective α-blockers, such as terazosin, alfuzosin, and doxazosin, it is generally less severe.[58]

Both the AAO and the American Society of Cataract and Refractive Surgery advise patients with symptomatic cataracts to consider cataract surgery prior to initiating nonemergent systemic α-blocker therapy for BPH.[59] Those already taking α-blockers are encouraged to inform their ophthalmologist prior to surgery, as temporary drug suspension may be recommended preoperatively. Despite efforts to increase awareness among prescribing physicians about IFIS, an online survey of 350 primary care physicians in the University of California San Francisco/San Francisco Bay Collaborative Research Network reported that only 46 (35.2%) were aware of the association of α-1 antagonist medications with IFIS, and only half of those included this association in treatment discussions with patients.[60] Similarly, in a 2016 survey of US urology residents and fellows and attending urologists (n = 175) only 30% reported routinely discussing IFIS with patients prior to initiating BPH treatment.[61] Patients with cataracts should be educated about the potential adverse effects of α-antagonist medications on cataract surgery in order to consider alternative medical therapies.[56] For example, a 2012 RCT of 511 patients reported that tadalafil, a phosphodiesterase-5 inhibitor, performed similarly to tamsulosin when compared with placebo in significantly improving lower urinary tract symptoms from BPH, and tadalafil is not associated with IFIS.[62]

Same-Day Bilateral Cataract Surgery

Patients with bilateral cataracts have traditionally been treated with staged, sequential procedures to avoid refractive errors and minimize the risk for bilateral complications such as endophthalmitis. This also allows the first eye to recover functional vision prior to the second eye surgery. However, some studies have suggested that same-day bilateral cataract surgery, under select circumstances, can provide similar safety and visual outcomes as sequential cataract surgery.[63,64] For instance, AAO's database of more than 5.5 million patients undergoing cataract surgery showed comparable POE rates of 0.06% regardless of whether surgery was completed in both eyes simultaneously or on separate days (adjusted odds ratio, 1.08 [95% CI, 0.87-1.31]; $P = .47$).[65] With the availability of more advanced technology IOL design options, however, an important benefit of staged surgery is that the patient can assess the refractive outcome of the first eye. This may lead to selecting a different IOL design or refractive target in the second eye.

Prognosis and Postoperative Course

Patients are typically prescribed a topical steroid alone or in combination with a nonsteroidal anti-inflammatory eye drop for a period of 2 to 4 weeks following surgery. Some surgeons use periocular or intraocular steroid injections at the time of surgery to reduce the need for or frequency of postoperative drops.[66] The use of topical antibiotic prophylaxis, which has not been shown to reduce POE rates, is declining with wider adoption of intraocular antibiotics.[67] There are minimal restrictions on physical activities and exercise following small incision cataract surgery. Visual improvement typically occurs within the first week, although prescribing new eyeglasses is typically delayed until the refraction stabilizes after several weeks. Patient satisfaction with cataract surgery management is high, with one multicenter study that included 740 patients reporting 98.2% overall satisfaction rates.[68]

Major complications during cataract surgery are uncommon and include a 1% to 5% rate of tears in the posterior lens capsule with vitreous prolapse.[29,69-71] A tear in the lens capsule may preclude implantation of certain advanced technology IOL designs and increases the risk for postoperative complications such as endophthalmitis (odds ratio, 7.1 [95% CI, 4.9-10.3]),[72] macular edema, and retinal detachment. The most common complication following cataract surgery is transient macular edema causing blurred vision for several weeks to months, which occurs in approximately 0.8% of patients within 3 months of surgery.[73] Although most cases of macular edema after cataract surgery are self-limited, anti-inflammatory eye drops, such as topical steroids and nonsteroidal anti-inflammatory drugs, facilitate resolution. Opacification of the posterior lens capsule behind the IOL is caused by migration of residual lens epithelial cells behind the lens optic and can occur several years following surgery. If this impairs vision, a central posterior capsulotomy can be made to clear the visual axis using a neodymium-doped yttrium aluminum garnet laser. Because this procedure does not require any intraocular instrumentation, it is not performed in the operating room. The incidence of neodymium-doped yttrium aluminum garnet capsulotomy ranges from 6% to 19% at 5 years post cataract surgery.[74]

Sustainability

In 2021, the World Health Organization declared climate change the single greatest health threat to humanity.[75] The health care sector is responsible for nearly 10% of US greenhouse gas emissions.[76] The manufacture, use, and disposal of medical supplies accounts for more than 70% of these emissions, making operating rooms a major contributor to environmental waste.[77-79] In questionnaires of North American and European cataract surgeons, 93% believed that waste from cataract surgery, such as operating room trash and single-use supplies, was excessive and should be reduced.[80,81] EyeSustain (https://www.eyesustain.org/) is a web-based consortium of 53 global ophthalmology societies collaborating to reduce

unnecessary waste and ophthalmology's significant environmental impact through education, research, innovation, and advocacy.[81-83] Ophthalmology is one of the first medical specialties to form such a coalition with a centralized educational site focused on sustainable health care delivery.

Limitations

This review has several limitations. First, this was not a systematic review, and the quality of the evidence was not evaluated. Second, some relevant studies may not have been included. Third, this review did not cover all cataract surgical techniques or complications.

Conclusions

Cataracts are common among older adults and may cause visual disability and blindness without treatment. Cataract surgery reverses and prevents progressive vision loss, and advanced technology lens implants facilitate reduced dependence on eyeglasses.

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