Chapter 5
Lens Complications in Uveitis

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Pathogenesis of Cataract in Uveitis Patients

Cataracts are one of the most common complications seen in uveitis patients. There are multiple factors contributing to cataract development, of which the inherent ocular inflammation plays the most significant role [1]. Specifically, the anatomic location of inflammation, duration of disease, and rates of relapse are strongly linked to its development. Therefore, it is not surprising that cataracts are found most frequently in patients with panuveitis, followed by chronic anterior uveitis, intermediate uveitis, and posterior uveitis [1]. Cataracts are especially prevalent in pediatric patients who present with pathology at a younger age, have more chronic disease, and may be more difficult to examine and to treat [2]. The treatment of uveitis also increases the propensity for cataract development as steroids in any form promote posterior subscapular opacification, and children may be more susceptible to the cataractogenic effects of steroids [3, 4]. Immunomodulatory therapies have gained popularity in recent years as an alternative to chronic steroids and do not increase the risk for cataracts [5]. Like their non-uveitis counterparts, uveitis patients can have age-related lens changes [6], and may require intraocular surgery such as pars plana vitrectomy that contribute to cataract formation. The biochemical mechanism of cataractogenesis in the setting of inflammation is not known.

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Table 5.1 Risks for and outcomes of cataract surgery in various uveitic entities

Disease	Estimated incidence of cataract formation	Surgical outcomes, Vision of 20/40 or better
Fuchs heterochromic iridocyclitis	64–75% [7–11]	85% [12]
Juvenile idiopathic arthritis	11–80% [4, 7, 13–15]	70% [16]
HLA-B27 uveitis	5–28% [17–19]	
Pars planitis	35–47% [20]	71% [12]
Behçet disease	12–57% [7, 21–23]	36–50% [7]
Vogt-Koyanagi-Harada Syndrome	40–56% [7]	49% [12]
Sympathetic ophthalmia	32% [24]	56% [12]
Ocular toxoplasmosis	4–10% [7, 25, 26]	90%[a] [27]
Herpetic uveitis	26.6–40% [7, 18]	36.8% [7]

[a]Without central scar

Uveitis Etiologies Associated with Cataract Development

All types of uveitis can promote cataract formation. Infectious etiologies include syphilis, toxoplasmosis, tuberculosis, and herpetic diseases. Systemic diseases associated with inflammation and cataracts include HLA-B27-associated diseases, Juvenile idiopathic arthritis, Behçet and sarcoidosis. Reported incidences and visual outcomes are listed in Table 5.1.

Prevention of Cataract Development in Uveitis Patients

Aggressive control of intraocular inflammation and judicious use of topical, periocular, and oral corticosteroids reduce the risk of cataract development. For refractory cases, early substitution of steroids with immunomodulatory therapy leads to control of chronic inflammation, reduction in corticosteroid burden, and delays visually significant cataract progression [28].

Preoperative Management

A detailed preoperative evaluation is essential to selecting the appropriate patient for surgery. A thorough ophthalmic exam, appropriate imaging, and review of the patient's history are necessary to estimate the visual potential, to determine appropriate surgical technique, and to optimize the timing of surgery. The type of uveitis greatly influences preoperative and intraoperative strategies. For example, surgery in a JIA patient is more challenging compared to a Fuchs uveitis patient due to more

abnormal intraocular anatomy and greater inflammatory response. Moreover, the surgeon must assess the patient's ability to access and administer medications and adhere to postoperative instructions.

Indications for Cataract Surgery

Cataract surgery is indicated in the following scenarios: [29].

- Phacoantigenic uveitis
- Cataract that limits view to the fundus in patients with suspected posterior segment pathology and in patients undergoing posterior segment surgery
- Visually significant cataract is an eye with potential for visual improvement

Timing of Surgery

Once the decision to proceed with cataract surgery is made, complete control of inflammation should be maintained for three months prior to surgery. Excellent preoperative control has been associated with reduction in postoperative CME and rebound inflammation [30–32]. Three months is generally accepted for all forms of uveitis except for Behçet disease. In these cases, a higher rate of recurrence have been reported if active disease is present within 12 months of surgery [33]. Therefore, some authors recommend delaying surgery in these patients, if possible, until at least 6 months of quiescence is achieved [34].

In the pediatric population, timing is important because cataracts can develop at an amblyogenic age. Children are also more likely to have higher rates of undesirable surgical complications as compared to adults. Therefore, timing of the cataract surgery must balance amblyogenic risks with surgical risks. Amongst children with uveitis, JIA patients have the poorest visual outcomes compared to those with other forms of uveitis (e.g. pars planitis). This finding is likely related to their younger age of onset, asymptomatic presentation, and more robust inflammatory response [30, 35, 36].

Evaluating Vision Potential

A thorough ophthalmic exam is required to identify potential ocular co-morbidities. This may reveal the need for combined or staged procedures and address patient expectations regarding visual prognosis.

Pre-existing posterior segment disease such as macular ischemia or optic neuropathy portends a worse prognosis. Ocular pathologies that should be addressed perioperatively are listed in Table 5.2.

Table 5.2 Ocular pathologies and perioperative management

Pathology	Indication	Management	Additional
Band keratopathy	Obstructs view to the anterior chamber	Disodium Ethylenediaminetetraacetic acid (EDTA) chelation	If possible, chelation should be performed pre-operatively. The epithelium should be healed prior to proceeding with cataract surgery. If necessary, chelation may be performed at the time of cataract surgery
Cystoid macular edema (CME)	CME must be minimized prior to surgery for all types of uveitis	Perioperative systemic steroids may be administered if the patient has active or prior CME. Intraoperative intravitreal triamcinolone acetonide (Triesence, TA) 4 mg in 0.1 mL [37, 38] or preoperative dexamethasone 0.7 mg intravitreal implant (Ozurdex, Allergan, Irvine, CA, USA) are reasonable alternatives [39]	
Elevated intraocular pressure (IOP)	IOP must be controlled prior to surgery	Medical management of ocular hypertension consist of topical antiglaucoma drops. This can be escalated to oral carbonic anhydrase inhibitors. If pressure is still uncontrolled on maximum medical therapy, consider staged or combined surgical procedure with cataract surgery	Gonioscopy should be performed to elucidate the etiology of elevated IOP, which can range from pupillary block, secondary angle closure from peripheral synechiae, or corticosteroid response. Avoid laser trabeculoplasty in patients with anterior uveitis

Other common ocular findings include corneal scarring, corneal neovascularization, reduced corneal sensation, endothelial disease from herpetic uveitis, fragile angle vessels, peripheral anterior synechiae (Image 5.1), posterior synechiae (Images 5.1 and 5.2), pupillary membranes, ciliary body atrophy, hypotony, vision obstructing vitreous opacities, macular scar, epiretinal membrane, macular ischemia, choroidal neovascularization, optic neuropathy, glaucoma, and retinal detachment. In children, additional complications include amblyopia and strabismus [36].

Beyond the clinical exam, additional investigations are helpful to detect pathology. Ancillary tests and diagnostic pathologies are listed in Table 5.3.

Image 5.1 6 year old juvenile idiopathic arthritis patient with poorly controlled inflammation, and excessive use of topical corticosteroids. There is a white cataract, extensive posterior synechiae, and a shallow anterior chamber

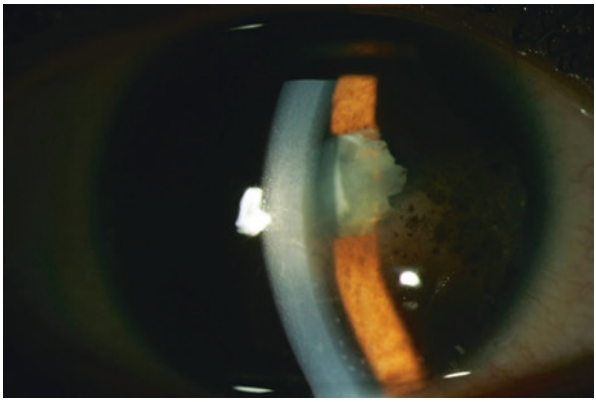

Image 5.2 Juvenile idiopathic arthritis cataract with posterior synechiae, band keratopathy, and inferior keratic precipitates

Table 5.3 Ancillary testing

Ancillary testing	Evaluation
Optical coherence tomography	Macular edema, macular hole, epiretinal membrane, optic nerve pathology
Fluorescein angiography	Macular ischemia, macular edema, choroidal neovascularization, optic nerve leakage, retinal vasculitis, posterior segment disease activity
Ultrasonography[a]	Ciliary body atrophy, retinal detachment, choroidal thickening or detachment

[a]Must be done when there is no view to the posterior segment

Control of Inflammation

There is no standardized protocol for controlling preoperative inflammation. It must be tailored to the patient's underlying uveitis and treatment history. A wide range of immunosuppressive therapies can be utilized from corticosteroids to antimetabolites, T-cell activation inhibitors, biologics, or alkylating agents. A variety of delivery systems for corticosteroids are available such as topical drop, subconjunctival injection, subtenon injection, intravitreal injection, steroid containing short or long acting implants and systemic oral medication. Switching to immunomodulating therapy is generally recommended if more than 5–10 mg of prednisone or its equivalent is required for more than 3 months, if inflammation persists after 1 month of high dose corticosteroids, or if unacceptable side effects arise [40].

Non-infectious Uveitis

In the perioperative period, most specialists will provide prophylactic or escalated doses of anti-inflammatory medications. Prophylaxis is typically initiated two to seven days prior to surgery and slowly tapered after cataract surgery [5, 41, 42]. For patients already on chronic oral corticosteroids, a stress dose should be added on the day of surgery [43]. When inflammation is not completely controlled, but cataract surgery is urgently required, intravenous methylprednisolone may be administered prior to or during surgery [8]. If there is systemic corticosteroid intolerance (e.g. diabetes mellitus) and no contraindications to local therapy (e.g. steroid response), subtenon or intravitreal triamcinolone acetonide (TA) or a short acting intravitreal steroid implant are reasonable alternatives for pre-operative management of inflammation.

For patients on chronic topical steroids, dosing may be increased to once every one to two hours prior to surgery [43].

Lastly, not all patients with uveitis need perioperative steroids. Patients with a single remote history of isolated anterior uveitis can usually be spared additional corticosteroids. Patients with FHI may also do well with no additional perioperative steroids.

Infectious Uveitis

For toxoplasmosis uveitis, the use of empiric anti-parasitic drugs is controversial. Additionally, the best medical regimen for prophylaxis has not been established. The risk of reactivation ranges from zero percent [44] to 36% [27], therefore the decision to start treatment is within the surgeon's discretion. Prophylaxis is commonly used when the lesion is vision threatening (i.e. within the macula or close to the optic nerve). Options include double-strength trimethoprim-sulfamethoxazole, pyrimethamine alone, pyrimethamine with sulfadiazine, azithromycin and atovaquone [5, 27].

For herpetic uveitis, oral acyclovir or valacyclovir may be started one week prior to surgery [5, 45].

Surgical Treatment

The surgical treatment for uveitic cataracts is complicated. Surgeons are often faced with significant structural abnormalities. Visibility through the cornea may be reduced by the presence of scars, band keratopathy, or neovascularization from chronic inflammation. Access to the crystalline lens may be limited by a miotic pupil, posterior synechiae, or pupillary membranes. Successful removal of the crystalline lens may be challenged by weak zonules, cyclitic membranes, and vitreous opacities reducing the red reflex.

General Approach and Technique

Most patients will undergo cataract surgery under monitored anesthesia care. However, additional regional anesthesia through peribulbar or retrobulbar block is generally recommended if significant iris manipulation is anticipated. This strategy eliminates ocular movement thereby creating a more stable surgical environment. This also maximizes patient comfort, as uveitic cataracts may require longer surgical time and manipulation of sensitive intraocular tissue.

The standard for cataract extraction is phacoemulsification with in-the-bag intraocular lens placement. This technique is associated with reduced postoperative inflammation, cystoid macular edema, epiretinal membrane, and posterior synechiae [43, 46–48].

Whenever possible, there should be minimal manipulation of intraocular tissues. During phacoemulsification, reducing the average phaco time also minimizes postoperative inflammation, corneal endothelial trauma, posterior capsular rupture and subsequent loss of nuclear fragments/vitreous loss.

Managing a Small Pupil and an Abnormal Iris

There are many causes of small pupils in uveitis patients. External and intrinsic disease of the iris can limit its size, manipulability, and therefore access to the lens. In addition to being floppy and atrophic, the iris may be occluded by membranes or adherent to the crystalline lens and/or peripheral corneal endothelium.

Some surgeons advocate dissection of PAS using viscoelastic material, using the cannula tip to sweep the iris away from the cornea. However, this is not always helpful, and may result in further damage to the peripheral iris.

Posterior synechiae may be addressed with gentle dissection using dispersive or cohesive viscoelastic material and by manual separation using the viscoelastic cannula, iris spatula, cyclodialysis spatula, or Kuglen hooks [43, 49]. If the edges of the pupil cannot be freed anteriorly, then a posterior approach via a peripheral iridotomy to introduce a cyclodialysis spatula can be done to lyse adhesions. For fibrotic membranes at the pupillary margin, the sheet of tissue can be cut with a scissors, and peeled off with microforceps.

Once the iris is free of adhesions and membranes, the pupil may remain miotic. Dilation can then be accomplished using intracameral preservative free epinephrine, iris hooks or pupil expansion devices such as Malyugin ring (Microsurgical Technologies, Redmond, WA, USA). Iris hooks are ideal in eyes with shallow anterior chambers or very atrophic irides. In general, surgeons should minimize iris manipulation as it promotes intraoperative floppiness, iris prolapse, bleeding, iris tattering and inflammation.

A surgical peripheral iridectomy can be considered in eyes with chronic flare or eyes that required extensive iris manipulation, although this is rarely required.

Beyond the Small Pupil

Once the cataract is adequately exposed, capsular dyes such as trypan blue provide good contrast for making a capsulorhexis. Ideally, smooth continuous curvilinear capsulorhexis of at least 5 mm should be fashioned. A small rhexis size or ragged capsular edges will increase the risk of capsular phimosis and synechiae [46]. (Image 5.4).

In cases of zonular weakness, capsular tension devices may be inserted to help center the IOL, stabilize the capsular bag, and reduce the risk of future capsular phimosis.

Intraocular Lens Considerations

With improvement in lens design and biomaterial, modern intraocular lenses (IOL) are now routinely placed in almost all patients with uveitis. The ideal placement is in the intact capsular bag. If the posterior capsule is violated, ciliary sulcus placement with a 3-piece IOL is also acceptable [50]. If there is inadequate anterior capsular rim support for sulcus placement, a scleral fixated IOL can be placed. Iris sutured or anterior chamber placement should be avoided as this may result in greater postoperative inflammation. In our experience, aphakia should be considered in cases of preoperative 360° of posterior synechiae, poor compliance, difficult to control inflammation, dense flare and hypotony. Should a lens be placed in these conditions, there is high risk for intraocular lens cocooning (Image 5.3).

A single piece acrylic IOL is the ideal lens choice for uveitic eyes. Acrylic outperforms silicone, poly methyl methacrylate (PMMA), and heparin-surface-modified PMMA in rates of PCO formation, inflammation relapse, and postoperative CME [51–53]. Hydrophobic and hydrophilic acrylic lenses have similar rates of postoperative complications such as macular edema, inflammation, corneal edema, and IOL decentration [54]. A long-term study comparing the two biomaterial have

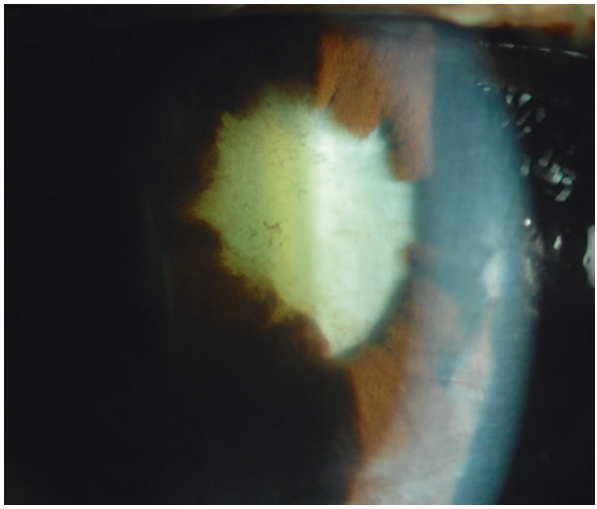

Image 5.3 This patient had a lens placed, apparently in the capsular bag. Dense inflammatory membranes formed, "cocooning" the intraocular lens. There is 360° of posterior synechiae as well as very anterior peripheral anterior synechiae (PAS)

shown that hydrophilic acrylic has better uveal biocompatibility, quantified as the least amount of cellular reaction on the IOL surface, but a higher rate of PCO compared to hydrophobic acrylic [55]. Multifocal lenses are discouraged because they reduce contrast sensitivity in patients with uveitis who may have coexisting macular or vitreous pathology [8, 56].

Pars Plana Vitrectomy

In patients with visually significant vitreous opacities, pars plana vitrectomy (PPV) can be offered as a combined procedure to optimize vision outcomes [57]. This can also improve intraocular inflammation and comorbid CME. Retinal detachments and epiretinal membranes can also be addressed simultaneously with combined cataract and vitreoretinal surgery.

Intraoperative Medications

The addition of steroids during surgery can reduce anticipated postoperative inflammation, need for post-operative steroids, and risk of CME. These strategies include adding dexamethasone to the infusion fluid, intravenous methylprednisolone, subtenon or intravitreal triamcinolone acetonide, intracameral dexamethasone, and short-acting dexamethasone intravitreal implants [12, 37, 38, 53, 58, 59].

Special Consideration in the Pediatric Population

The management of pediatric cataracts is controversial. Not only is the surgery technically challenging, but there may also be inaccuracies in biometry and opposing views regarding primary IOL implantation.

First, the decision to implant an IOL again requires proper patient selection, which needs to account for the type of uveitis, age of the child, and perioperative control of inflammation. With modern phacoemulsification, improved lens biocompatibility, use of immunomodulating therapy, and complete disease quiescence preoperatively, cataract surgery with primary IOL placement can be successful in children [30, 36, 60–62]. An intraocular lens is also a better option for amblyopia therapy. Aphakic children may not be able to tolerate optical correction with contact lenses or spectacles. However, others advise against IOL implantation [49, 63]. The presence on an IOL is thought to incite an inflammatory response and serve as a scaffold for secondary and cyclitic membranes [64, 65]. There is also a higher risk of secondary glaucoma [63]. Therefore, there is no consensus for primary lens implantation [66], although most surgeons will implant an IOL in children with well controlled uveitis.

Children are also more likely to develop posterior capsular opacification (PCO), independent of their uveitis status. As well, laser capsulotomy may be difficult to perform in young uncooperative children. Therefore, if a child is younger than six to eight years old, a primary posterior capsulotomy ± limited anterior vitrectomy should be considered at the time of surgery.

Post-operative Management

Postoperative care is equally as important as preoperative care. Close follow up and aggressive control of inflammation is critical, especially for younger patients who have a more robust inflammatory response. Medications initiated or increased preoperatively should be tapered slowly based upon clinical examination and ancillary testing. In recent years, advancement in pharmacology in the form of immunologic agents and steroid delivery vehicles have greatly expanded our armamentarium for postoperative management.

Management of Post-operative Complications

Early Complications

Recurrent Uveitis

Persistent or recurrent uveitis can reverse an initially good visual outcome. Inflammation can result in posterior synechiae to the anterior capsule or IOL, PAS, ciliary or pupillary membranes, CME, hypotony, and epiretinal membrane (ERM).

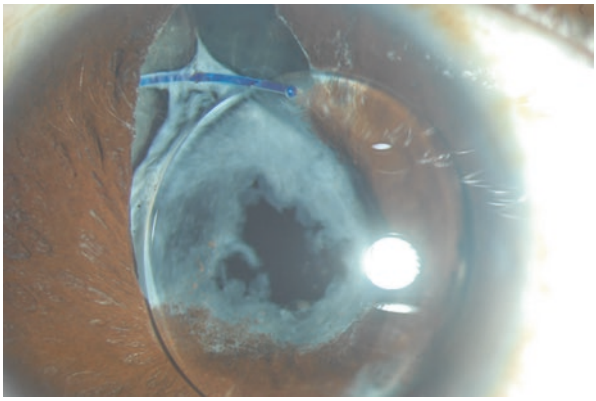

Image 5.4 Dislocated 3-piece intraocular lens with pupil capture. The IOL was apparently placed into the ciliary sulcus at the time of cataract surgery, but intraocular inflammation in this uveitis patient was not well controlled in the peri-operative period

Each of these complications can independently generate more complications. For example, pupillary membranes can distort the iris and cocoon or displace the IOL (Image 5.4), and ciliary body membranes can lead to ciliary body detachment and permanent hypotony (refer to late complications for more details). Therefore, post-operative inflammation needs to be identified early and be treated aggressively.

Cystoid Macular Edema

In cases of CME, inflammatory mediators interrupt the normal function of the retinal pigment epithelium and lead to fluid accumulation. Therefore, therapy is targeted at managing the inflammation. The first line of treatment is often intensive topical steroid and topical NSAID therapy. Periocular or intravitreal triamcinolone acetonide may also be used [37, 38, 54, 57, 67]. In up to half of the cases, triamcinolone only provides temporary resolution, and the CME relapses when the drug wears off [68]. Longer duration intravitreal fluocinolone acetonide implants (Retisert, Bausch& Lomb, Rochester, NY, USA, Yutiq, Eyepoint Pharmaceuticals, Watertown, MA, USA) [69] and the shorter-acting dexamethasone implant (Ozurdex, Allergen, Irvine, CA, USA) provide a more lasting resolution of CME. Unfortunately, longer exposure and higher doses of steroids are associated with intraocular pressure (IOP) rise, and may necessitate chronic antihypertensive drops or glaucoma surgery for pressure control [38, 54, 57, 69]. For patients intolerant to steroids, alternative agents include anti-angiogenic intravitreal injections such as bevacizumab [70, 71], systemic carbonic anhydrase inhibitors [72], and interferon alpha [73].

Acute Ocular Hypertension and Hypotony

An acute rise in IOP is often seen in the immediate postoperative period because of inflammatory debris, retained lens material or ophthalmic viscoelastic. IOP spikes can be addressed by releasing aqueous from the anterior chamber, increasing corticosteroids, starting anti-glaucoma drops, and/or systemic oral carbonic anhydrase inhibitors [67].

Low IOP can be problematic as well, and has been associated with inflammation, prostaglandin-mediated increase in uveoscleral outflow, supraciliary or suprachoroidal effusion. It is unclear if surgery is an independent risk factor for hypotony or if it is the underlying uveitis that predisposed the patient to both cataract formation and hypotony [74]. Raising IOP involves treatment targeted towards reducing intraocular inflammation.

Retinal Complications

Vitreous hemorrhage and retinal detachment are rare complications more often reported in patients with intermediate, posterior, and panuveitis. Non-clearing vitreous hemorrhages and retinal detachments require additional surgery and should be addressed by a vitreoretinal surgeon.

Like all routine cataract cases, uveitic eyes undergoing cataract surgery are also at risk for endophthalmitis. Currently, there are no studies that demonstrate an increased risk of endophthalmitis for the uveitis population.

Delayed Complications

Capsular and IOL Complications

Posterior capsular opacification (PCO) occurs in 34.3–81.7% of uveitis cases [75]. If the PCO becomes significant, it can be lasered with a neodymium-doped yttrium aluminum garnet (Nd:YAG) laser, using as little energy as possible in order to minimize the inflammatory response [49, 53, 67]. Importantly, the uveitis must be quiescent before proceeding. Nd:YAG is also effective for removal of giant cell IOL deposits [76].

As discussed previously, capsular phimosis and capsular membranes are manifestations of chronic inflammation. Phimosis can be treated using a Nd:YAG laser to make radial cuts on the fibrotic rim to prevent further capsular shrinking. Capsular membranes can also be lasered, but may reform in the setting of uncontrolled inflammation. Surgical removal may be required if the membranes become dense.

IOL—dislocation is a rare complication. Early dislocation is due to intraoperative loss of capsular integrity or zonular dehiscence. Over time, even in uncomplicated cases, the zonules can slowly dehisce leading to in-the-bag IOL dislocation. Correcting the dislocation depends on the degree of dislocation. Treatment options include observation, IOL removal, in-the-bag IOL re-fixation, and 4-point sutured scleral-fixated IOL [77].

Late Ocular Hypertension and Hypotony

Delayed or persistent ocular hypertension may be due to peripheral anterior synechiae or a steroid response. Therefore, all patients should undergo gonioscopy to assess for angle abnormalities. For steroid responders with persistent inflammation, every effort should be made to wean off steroids and to start immunomodulating medications. Extensive PAS can close the angle, necessitating filtering glaucoma surgery to lower the IOP. Ultimately, chronically high pressures can lead to secondary glaucomatous optic neuropathy.

On the opposite spectrum, late hypotony is another dreaded complication. Left untreated, the eye is at risk for choroidal effusion, macular edema, and phthisis. Hypotony is a consequence of ongoing inflammation which promotes the development of cyclitic membranes that damage the ciliary epithelium and place tension on the ciliary body. This can lead to tractional detachment of the ciliary body and increased uveal scleral flow. Ultrasound biomicroscopy can be used to identify the presence of epiciliary membranes, ciliary body detachment, and ciliary body atrophy. In the presence of atrophy, silicone oil has been successfully used to raise IOP, although this effect may not be long-lived [78]. In cases of epiciliary tissue or tractional detachment, a pars plana vitrectomy approach can be used to remove the membranes, again, with variable success [79, 80].

Conclusion

In the era of modern phacoemulsification, most uveitis patients have excellent visual outcomes if the following conditions are met: appropriate patient selection, strict control of preoperative inflammation, careful surgical planning, early detection and care of postoperative complications. With expansion of immunomodulating therapies, surgical outcomes will continue to improve, particularly in the pediatric population.

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