Review Article

# Toxic anterior segment syndrome (TASS): A review and update

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Toxic anterior segment syndrome (TASS) is an acute, sterile, postoperative inflammatory reaction of the anterior segment without vitreous involvement, following an uncomplicated and uneventful ocular surgery, having broad and multiple etiologies. The symptoms of decreased visual acuity and ocular discomfort generally occur within the first 12–48 h after intraocular surgery. The clinical signs include prominent limbus-to-limbus corneal edema, anterior chamber cells, aqueous flare, fibrinous inflammation, and/or keratic precipitates. There can be sight-threatening complications of TASS, such as permanent corneal decompensation, intractable glaucoma, and cystoid macular edema. The causes of TASS are emerging and being reported, so are the newer treatment options for managing the inflammation and its complications. Prevention guidelines for TASS are being updated, and a traceability system for surgical instruments and intraocular fluids used during the surgery is being perpetually developed. It is important to recognize TASS and start treatment on an immediate effect. Hereby, we review the literature on TASS, emphasizing its etiology, pathophysiology, management, prognosis, complications, and the importance of prevention as well as prompt recognition.

**Key words:** Anterior chamber inflammation, corticosteroids, intracameral solutions, postoperative inflammation, sterilization, toxic anterior segment syndrome (TASS)

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Toxic anterior segment syndrome (TASS) is an acute, rare, sterile postoperative inflammatory reaction most likely caused by a noninfectious agent that gains entry into the anterior segment at the time of surgery and results in toxic damage to the intraocular tissues.[1] It was first described by Meltzer[1] in 1980 when nine eyes with intraocular lenses (IOLs) containing residual polishing compound on their surface developed sterile hypopyon.[2] The term "toxic anterior segment inflammation" was first described by Monson *et al*.[2] in 1992.

TASS has been reported after cataract surgery, penetrating keratoplasty, intravitreal anti-vascular endothelial growth factor (anti-VEGF) injections, and vitreoretinal surgery.[2] It is also uncommonly observed after anterior segment surgeries including iris-supported phakic IOLs, deep anterior lamellar keratoplasty (DALK), and Descemet stripping automated endothelial keratoplasty (DSAEK).[3-9]

## Incidence

TASS usually occurs sporadically or as a cluster of cases. Overall, clusters of three to 20 cases of TASS occur several times per year, translating to an estimated incidence of more than 1 in 1000 after cataract surgery. A retrospective study in India by Sengupta *et al*.[10] at the Aravind Eye Hospital reported 60 eyes with TASS from 26,408 cataract surgeries (0.22%). The overall incidence of TASS was also found to be 0.22% in a large case series published by Johnston.[11]

## Etiopathogenesis

The exact causative agent for the occurrence of TASS cannot be elucidated in many cases, and the causes still continue to expand. TASS is thought to be the result of toxicity and inflammatory reactions in response to a multitude of potential causes like toxins, contaminants, medications or preservatives, residues on surgical instruments, and packs and disinfectants used during surgery. Various causes of TASS that have been described in the literature include an aberrant pH, osmolality, or chemical composition of ophthalmic intraocular devices, irrigation solutions, and ocular medications.[12,13] Other possible causes of TASS include the use of preservatives and instruments or IOL contaminated by bacterial endotoxins and lipopolysaccharides, metal ion residues, or detergents. Improper cleaning of surgical materials and the use of enzymatic detergents and ultrasound baths are also some of the most frequent factors associated.[4]

Recently, Shaikh *et al*.[14] reported that 26 patients presented with a delayed, severe TASS reaction secondary to foreign bodies from surgery packs, and investigation revealed extensive microscopic debris covering the surgical drapes and other items. Residual liquid disinfectants such as alcohol,

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glutaraldehyde, or chlorhexidine on surgical instruments, detergents used to clean instruments, heat-stable bacterial endotoxins remaining on instruments after cleaning, residues on instruments after plasma gas sterilization, benzalkonium chloride in balanced salt solutions (BSSs), intracameral methylene blue, polishing compound of IOLs, and deteriorated sodium hyaluronate viscoelastics are other multiple possible inciting factors for TASS.[15,16]

## Use of Intracameral Solutions and BSSs

Kutty *et al*.[17] reported an outbreak of 112 postoperative TASS cases, caused by contamination of a specific brand of a BSS with bacterial endotoxins. Bielory *et al*.[18] reported that two out of three TASS cases related to the inadvertent injection of 10% benzalkonium chloride–containing medication needed corneal transplant. Benzalkonium chloride, the most common preservative in ophthalmic drops, although safe to use on the ocular surface, is known to be toxic to the corneal endothelium. Other agents like bisulfites or metabisulfites can also be toxic to the cells within the anterior segment of the eye and can lead to TASS.[19]

An outbreak of TASS that appeared after an uneventful cataract surgery, possibly due to intracameral use of 1 mg/0.1 ml cefuroxime as well as due to use of intracameral moxifloxacin has been reported.[15,20-22] There have been reports that accidental use of intracameral injection of methylene blue 1% for capsule staining resulted in extreme cytotoxicity, primarily on the corneal endothelium and iris epithelium.[23,24] Foreign bodies introduced during surgery have been reported from various identified sources like topical ophthalmic ointment, metallic dust from surgical instruments, and fibers from sterile drapes.[25-31]

Sorenson *et al*.[32] identified 10 cases of postoperative TASS, which were due to contamination of surgical instruments associated with contaminated autoclave fluid reservoirs that had bacterial biofilms, with the ability of generating heat-stable toxins that remain intact even after sterilization.

## IOL-Related Outbreaks

Wijnants *et al*.[33] reported an outbreak of 28 eyes presenting with a late-onset TASS after the implantation of a specific monofocal and extended depth-of-focus (EDOF) hydrophilic acrylic IOL. A laboratory surface analysis showed aluminum and silicon contamination as a possible contributing factor for the development of inflammation.

Jehan *et al*.[34] described a possible association between 10 cases of delayed-onset inflammation and the implantation of a specific hydrophilic acrylic posterior chamber IOL, Memory Lens (models U940A and U940S; CIBA Vision, Duluth, GA, USA). Various IOL-related outbreaks of TASS have been reported, where errors in the polishing, cleaning, and sterilizing procedures resulted in contamination by metal ion residues or detergents.[1,34-37]

## Intravitreal Agents

Sato *et al*.[38] reported five patients who presented with anterior and posterior chamber inflammation after intravitreal injection of bevacizumab of the same lot. Aflibercept-related sterile inflammation has also been associated with two major clusters that occurred in 2011 and between September 2017 and May 2018.[39,40] Table 1 summarizes commonly reported inciting/etiologic agents of TASS.

## Patient Factors

There are also patient-related factors like ocular history of proliferative diabetic retinopathy, uveitis, pseudoexfoliation syndrome, and systemic vascular disorders such as uncontrolled type 2 diabetes mellitus (DM), systemic hypertension, chronic ischemic heart disease, chronic renal failure, and hyperlipidemia, which may increase the risk of TASS after an uneventful surgery. A study by Yazgan *et al*.[41] suggested that poorly controlled type 2 diabetes, hypertension, hyperlipidemia, chronic ischemic cardiovascular disease, and kidney failure may increase the risk of TASS after an uneventful

**Table 1: Reported inciting/etiologic agents of TASS**

| |
|---|
| Cleaning and sterilization |
| Inappropriate disinfectant for skin preparation |
| Inadequate time and staff to allow good cleaning and sterilization practices |
| Residual cleaning agents such as enzymatic detergents |
| Use of ethylene oxide |
| The use of lint-containing towels during cleaning |
| Heat-stable bacterial endotoxins from ultrasonic cleaners, water baths, or autoclave reservoirs |
| Poor maintenance of surgical tools and cleaning/sterilizing equipment |
| Inadequate drying of instruments after cleaning |
| Materials used in polishing and sterilizing IOLs |
| Improper/inadequate flushing of reusable cannulas, handpieces, or tips from phacoemulsification or I–A handpieces |
| Contamination of IOLs and instruments with talc (from surgical gloves) |
| Residual denatured viscoelastics |
| Reusage |
| Reuse of single-use items |
| Use of reusable cannulas |
| Use of tap water for cleaning |
| Heavy metals and their oxides, for example, degraded brass instruments |
| Intraocular substances |
| Irrigating solutions with inappropriate composition, osmolarity, or pH |
| Preservatives in intraocular solutions, for example, bisulfites or metabisulfites |
| Intracameral anesthetics of inappropriate concentration/ containing preservatives |
| Intracameral antibiotics with incorrect concentration, pH, osmolality |
| Intraocular dyes with impurities or inadequate dilutions |
| Mitomycin-C |
| Surgery related |
| Retained intraocular viscoelastic materials |
| Residual cortical lens material |
| Intravitreal anti-VEGFs/steroids |
| Use of povidone-iodine at completion |
| Ophthalmic ointments used at completion of surgery |
| IOL-related contamination |
| Heavy metals, such as aluminum, NaOH contamination, polishing compounds during manufacturing of IOLs and fluids in hydrophilic IOLs |

I–A=Irrigation–aspiration, IOL=Intraocular lens, TASS=Toxic anterior segment syndrome, VEGF=Vascular endothelial growth factor

cataract surgery. We can also possibly determine a patient's predisposition to TASS by making biochemical and metabolic profile tests before cataract surgery.

## Pathophysiology of TASS

There are nonmicrobial inflammatory cascades in response to intraocular foreign materials or solutions during surgery.[42] Among multiple etiologies of TASS, cellular toxicity is a common pathway.[4,43] Furthermore, accumulation of free radicals derived from intracameral agents in a complicated anterior segment surgery may lead to TASS. The inflammatory trigger caused by toxic substances together with the alteration in the aqueous humor dynamics will result in breakdown of the blood–aqueous barrier, which, in turn, leads to a release of aqueous flare and cells causing further fibrinous reaction and hypopyon because of damage to the iris and trabecular meshwork. TASS involves activation of inflammatory cascade–elicited cellular toxicity, free radical damage–induced apoptosis, along with breakdown of blood–aqueous barrier, leading to inflammatory reaction and breakdown of endothelial junctions with loss of barrier function that results in corneal edema and decompensation.[4,5,43]

## Clinical Manifestations

Patients typically present with blurred vision, mild ocular pain, and redness following an intraocular surgery. There is prominent and severe "limbus-to-limbus" corneal edema, which is a fairly specific clinical finding in TASS [Fig. 1a]. This diffuse limbal-to-limbal corneal edema is due to widespread damage of the corneal endothelial cells. On examination, there can be mild to moderate decrease in visual acuity, conjunctival injection or chemosis, keratic precipitates, irregular, poorly dilating, or fixed dilated pupil due to iris ischemia, severe anterior chamber (AC) reaction which can involve fibrin in AC and/or hypopyon [Fig. 1b] and is associated with no pain or mild discomfort, normal or increased intraocular pressure (IOP), and/or vitreous cells, and rare involvement of the posterior segment with vitreous inflammation.[43] The study of Wijnants *et al*.[33] summarizes that these patients may also develop chronic cystoid macular edema.

## Investigations

The patients should undergo a detailed and careful slit-lamp examination, gonioscopy, IOP monitoring, and dilated fundus examination. If there is severe AC reaction and it is difficult to view the posterior pole, the patient should have an ultrasound B-scan to rule out any posterior reaction. AC aspirate, vitreous tap, and vitreous biopsy for bacterial culture (both aerobic and nonaerobic) and fungal culture should be sent to investigate for any infectious etiology.

Ultrasound B-scan may show a little or no inflammation in the vitreous. There can also be posterior segment involvement in TASS as seen with newer imaging techniques. Sorkin *et al*.[44] used spectral domain optical coherence tomography (SD-OCT) imaging and found that TASS could possibly have a transient effect on choroidal thickness. Polymerase chain reaction may be used to differentiate between noninfectious ad infectious endophthalmitis (IE).[45]

## Differential Diagnosis

TASS needs to be differentiated from IE, retained lens material, and uveitis. TASS usually appears 12–48 h postoperatively, whereas endophthalmitis usually appears 4–7 days postoperatively. Although TASS usually presents 12–48 h postoperatively, there have been cases with "delayed onset" of presentation of TASS.[5] Suzuki *et al*.[36] described a TASS outbreak with a mean of 38 days until presentation that involved posterior segment with minimal vitreous opacities in 21.5% of the patients. Miyake *et al*.[46] reported six cases of TASS that developed between 42 and 137 days after cataract surgery. Table 2 summarizes the distinguishing features between TASS and IE.

## Complications

In severe cases of TASS with inflammation, irreversible corneal endothelial damage can occur, which can be further complicated by cystic epithelial downgrowth onto the Descemet membrane.[47,48] Moreover, inflammatory deposits on the iris may lead to dilated and fixed pupil, iris ischemia, iris atrophy, pupillary distortion, poor pupillary dilatation, ocular hypertension, and secondary glaucoma.[1,5]

## Treatment

### Medical therapy

Treatment regimen for the inflammatory reaction in TASS includes topical steroid drops prescribed in slow tapering dose for an extended period of time, like topical prednisolone acetate 1% or dexamethasone 0.1% every one to two hourly, along with mydriatics/cycloplegics, with concomitant close

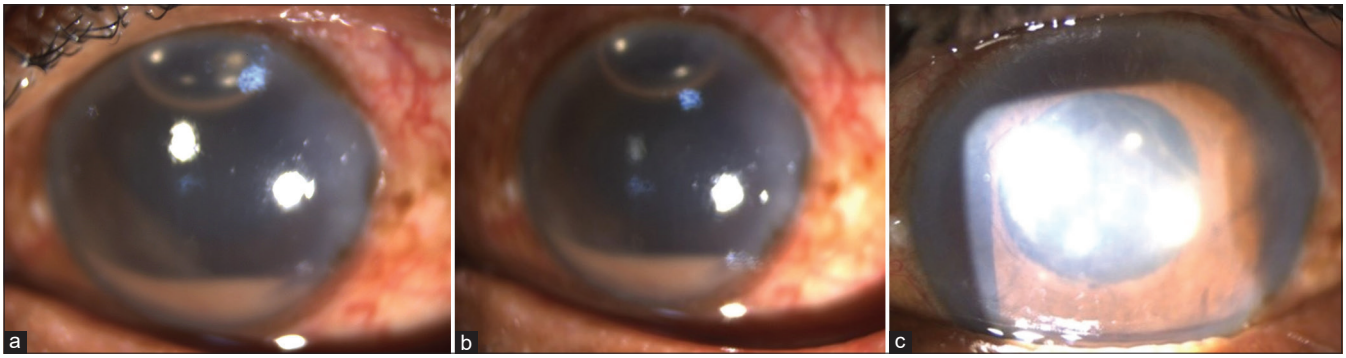


**Figure 1:** (a) Slit-lamp image showing moderate corneal edema and hypopyon. (b) Slit-lamp image at day 3 showing improvement of corneal edema and decrease in hypopyon. (c) Slit-lamp image at day 8 showing clear cornea and absence of hypopyon, following treatment

**Table 2: Key differentiating features of TASS from early postoperative IE**

| | TASS | IE |
|---|---|---|
| Pain | Absence of pain | Moderate to severe |
| Inciting event | Typically occurs following anterior segment surgery of any kind | Anterior or posterior segment surgery |
| Onset | Within 24 h | 4–7 days |
| Cornea | Complete limbus-to-limbus corneal edema is seen with TASS | Rarely happens in IE |
| Pupil/iris | Fixed and dilated<br>Permanent iris and/or trabecular meshwork damage is common in TASS | Reactive |
| Extent | Almost always limited to the anterior segment | May involve all the intraocular tissues |
| Culture | Always gram stain and culture negative | Positive |
| Response to steroids | Improves with topical and/or oral corticosteroids and typically resolves within 1–3 weeks | May worsen |

IE=Infectious endophthalmitis, TASS=Toxic anterior segment syndrome

IOP monitoring.[49] Topical nonsteroidal anti-inflammatory agents can also be used to alleviate symptoms of ocular pain and mild inflammation.

Slit-lamp examination should be done every few hours after initiating therapy as these patients require close follow-up, especially in the first few days to monitor the response to treatment and also monitor IOP. In severe cases with hypopyon and fibrin formation, steroid injections are also given and oral prednisolone up to 40 mg per day may be necessary to control the inflammation [Fig. 1c]. Based on the severity of TASS, steroids in gel form, emulsions, ointments, subconjunctival injections, oral steroids, or even intravitreal triamcinolone or dexamethasone (400 mg/0.1 ml) may be considered.[8,50] In some cases of TASS, cystoid macular edema can occur, which may require intraocular steroids or anti-VEGF injection for treatment.[51]

Dotan *et al*.[52] evaluated the safety and therapeutic effect of intracameral injection of recombinant tissue plasminogen (25 µg/0.1 ml) in cases with refractory TASS and showed complete clearance of the fibrin reaction in 80% of the patients 1 day after the treatment. In a recent study, Osaadon *et al*.[53] reported that the application of recombinant tissue plasminogen activator (r-tPA) was a quick and efficacious therapeutic approach for the management of severe fibrinous reactions in TASS after cataract surgery. If the inflammation is not responding to steroid therapy, we need to reconsider the possibility of an infective etiology and a vitreous tap or a repeat culture may be required.

## Surgical Management

AC washout may be done for an inflammation that does not respond to maximal medical treatment and there is persistent corneal edema. Dua and Attre[54] reported that AC washouts can be performed in patients who develop steroid-responsive glaucoma, with I-stents placed intraoperatively to help control the pressure while continuing the use of topical steroids. In cases of secondary glaucoma following TASS, antiglaucoma medications and, sometimes, glaucoma surgery are needed.[55,56] Prostaglandin analogs may be avoided as they can worsen the inflammation.

In cases of severe TASS with irreversible damage showing marked corneal edema and residual chronic anterior segment inflammation, there is need for corneal transplantation. Endothelial keratoplasty techniques like Descemet membrane endothelial keratoplasty (DMEK) and Descemet-stripping automated endothelial keratoplasty (DSAEK) have replaced penetrating keratoplasty as the procedure of choice for endothelial decompensation with favorable clinical outcomes in patients with TASS-related corneal decompensation.[57,58]

In a retrospective study, Necip *et al*.[59] evaluated the visual and anatomical outcomes of DMEK in patients with corneal decompensation secondary to TASS and found that DMEK seems to be a safe and an effective treatment option in eyes with TASS-related endothelial decompensation.

Oshika *et al*.[35] reported that of 147 eyes, a total of 29.3% required surgical intervention, including irrigation of AC, vitrectomy, and removal of IOL. Angle-closure glaucoma due to posterior synechiae can result in resistant glaucoma that usually requires glaucoma surgeries, causing serious damage to the intraocular tissues and vision loss.[60]

## Management of an Outbreak

As soon as an outbreak of TASS occurs, attempting to analyze the source of a potential TASS outbreak is crucial. A thorough investigation of possible causes like solutions, medications, detergents used in the operating room (OR), and OR protocols should be undertaken. We need to investigate incidents of TASS to track down the etiologic agents involved and help eliminate the potential sources of this sterile, postoperative inflammation.

We need to develop protocols that can help in the onsite analysis of the outbreak and provide assistance in the evaluation and prevention of such episodes. The surgical team comprising operating surgeon, surgical nurses, operation theatre (OT) technicians, and anyone participating in the preparation should work together and undertake a complete review of all OR protocols.

1. A careful investigation and elimination of all the possible causative factors combined with thorough management of all possible risk factors is crucial.
2. The surgeon and staff at the center should carefully review all of the medications and solutions that are used during routine anterior segment surgery.
3. The team involved in investigating should carefully evaluate any fluids, solutions, or medications used during the surgery and record all the involved lot and batch numbers for potential etiologic agents.

4. All cases need to be treated promptly and vigorously along with open communication with the surgical facility to follow any local investigation and reporting procedures.
5. We need to ensure that the fellow surgeons/colleagues are made aware of a TASS incident, so as to identify and report any further cases.

The Association of perioperative Registered Nurses (AORN) recommends that the records should be maintained of all cleaning methods, detergent solutions, and lot numbers of cleaning solutions. These records can be used to help investigate any suspected or confirmed cases of TASS.[7] Protocols and guidelines like the TASS Task Force from the Association of Cataract and Refractive Surgeons (http://www.ascrs.org/tass-registry) have been created to help in decreasing potential risk factors.

The American Society of Cataract and Refractive Surgery (ASCRS) funded and established the TASS Task Force to investigate and monitor any outbreaks of TASS in 2006. ASCRS, the American Academy of Ophthalmology (AAO), and the American Society of Ophthalmic Registered Nurses (ASORN) have also published guidelines on how to clean and sterilize intraocular surgical instruments to prevent TASS, which are easily available for all members of the surgical team to access.

It is also important to announce the outbreak of TASS to the outside surgeons in the same or different regions to share information and find the possible clues originating from the inciting IOLs or ophthalmic viscosurgical devices (OVDs).

Any outbreak of TASS is an inconclusive issue that mandates complete analysis of all medications and fluids used during surgery, as well as a complete review of OR and sterilization protocols.

## Prevention

Although TASS is a bewildering entity, it is fairly preventable if we continue to follow certain regulations. Standard and clear operative protocols are needed in the surgical centers for the cleaning and sterilization of instruments. It is crucial that the entire surgical team, including the nurses, OR technicians, and staff, is aware of appropriate etiquettes in ophthalmic surgery and take effort in the elimination of residue that could accumulate on reusable instruments and induce a toxic reaction.

1. There should be proper flushing, cleaning, and autoclave sterilization of all surgical instruments.
2. There should be separate cleaning and sterilization for ophthalmic instruments from other surgical instruments.[12]
3. Instruments that need to be reused such as phaco and irrigation–aspiration (I/A) handpieces should be thoroughly rinsed at the end of each case with sterile, deionized water through both their irrigation and aspiration ports. Both ports of the handpieces should be flushed with 120 ml of sterile distilled or deionized water after each case.[20]
4. There needs to be regular replacement of the fluids on a daily basis in any ultrasound or water bath used to clean instruments, which may be colonized with gram-negative bacteria producing endotoxins that are heat stable and cannot be deactivated by autoclaves.
5. The enzymatic detergents and other active ingredients must be removed from surgical instruments by using sterile water jet under pressure.
6. We need to ensure that the inside of the autoclave is cleaned and the water reservoir of steam autoclave sterilizers is changed, at least weekly, so as to prevent the accumulation of any potentially toxic residual material and the buildup of gram-negative bacteria with lipopolysaccharide endotoxins. Sorenson *et al*.[32] reported that 10 cases developed TASS after cataract surgery over a 1-year period because of contaminated reservoirs of two autoclaves with *Bacillus* species, *Williamsia* species, *Mycobacterium mucogenicum*, and *Candida parapsilosis*.
7. Instruments with lumens should be dried with forced or compressed air after thorough rinsing.
8. Proper BSS with the correct pH, osmolarity, and ionic composition should be used.
9. The safety of the dye agents used for anterior capsule staining should be ensured as these can become contaminated during the manufacturing process. Matsou *et al*.[61] reported five cases of TASS after uneventful cataract surgery, and Buzard *et al*.[62] reported two cases after using a generic trypan blue dye for capsule staining.
10. The intracameral drugs like epinephrine in the irrigating solution and intracameral lidocaine should be without preservatives and in the proper concentration/dosage.
11. Appropriate concentrations and dilutions of intracameral antibiotics should be used. It has also been reported that diluting vancomycin in sterile water instead of BSS can lead to severe corneal edema and glaucoma due to change in osmolality.[63]
12. Use of fresh ophthalmic visosurgical devices needs to be encouraged.
13. IOL tips, canula tips, and surfaces entering the anterior chamber should not be touched with a gloved finger as both powdered and powder-free gloves can cause TASS.[20]
14. The recommended procedures for cleaning and sterilization of the instruments should be adhered to and the manufacturer's directions for use should be followed.

## Prognosis

TASS can produce mild inflammation that may resolve in a few days without even being recognized by the patient. The clinical outcome is usually related to the degree of toxic insult to the anterior segment of the eye. Overall, early recognition of the symptoms and signs is directly associated to the prognosis and recovery in TASS. In mild cases, TASS typically resolves within a few days; however, if unresolved after 6 weeks, permanent damage is likely to occur despite medical treatment.[64]

Moyle *et al*.[49] reported that 11 consecutive patients undergoing phacoemulsification cataract surgery on two separate days by the same surgeon had developed TASS on the first postoperative day. After treatment with intense topical anti-inflammatory and steroidal drugs, active inflammation and corneal edema resolved within 6 weeks and visual outcome was 20/20 in all patients.

Patients who have had a severe initial injury often suffer from permanent damage to the anterior segment of the eye and present with diffuse, nonclearing corneal edema, which may even require cornea transplantation as treatment. Kaur *et al*.[65] reported that the time interval between the onset of TASS and DSAEK is the most important factor affecting the outcomes. In

**Table 3: Recent cases reported worldwide**

| Authors | Year, date | Number of cases | Onset | Inciting agents | Procedure |
|---|---|---|---|---|---|
| Li and Zhou[67] | 2023 | 2 | 1 week | Naphazoline hydrochloride, chlorphenamine maleate, and vitamin B12 eye drops | ICL implantation |
| Wijnants *et al*.[33] | 2022 | 28 | 24 h | Contaminated IOLs | Cataract surgery |
| Gil-Martínez *et al*.[68] | 2022 | 2 | 24 h | Quaternary ammonium compound (Gerdex®) | Uneventful trabeculectomy surgeries |
| Balparda *et al*.[69] | 2022 | 1 | 12 h | Unknown | Phakic intraocular lenses after ISBCS |
| Pintiliuc *et al*.[70] | 2022 | 1 | 48 h | Unknown | EyePCL implantation in a hyperopic patient |
| Matsushita *et al*.[71] | 2021 | 1 | 24 h | Barium from BGI | BGI surgery |
| Ahmad *et al*.[72] | 2021 | 1 | 24 h | Unknown | After laser *in situ* keratomileusis in hyperopia |
| Imamachi *et al*.[73] | 2021 | 7 | 24 h | Specific intraocular lens model | Cataract surgery with Lentis Comfort/LS-313 MF15 IOL |
| Kanclerz *et al*.[74] | 2021 | 1 | 30 h | Silicone oil batch | Uncomplicated vitrectomy |
| Amireskandari *et al*.[75] | 2021 | 1 | 24 h | Intracameral moxifloxacin | Uncomplicated cataract surgery |
| Hernandez-Bogantes *et al*.[76] | 2019 | 6 | 12 h | Powdered gloves | Phakic implantable Collamer lens |
| Singh *et al*.[77] | 2018 | 1 | 24 h | Intracameral pilocarpine | ICL implantation |
| Matsou *et al*.[62] | 2017 | 5 | 24 h | Generic trypan blue | Cataract surgery |
| Oshika *et al*.[35] | April–October 2015 | 147 | 24 h | Small heavy metals during the production process of IOL | Cataract surgery with Acrysof ReSTOR, ReSTOR toric, or Acrysof IQ toric |
| Suzuki *et al*.[36] | 2015 | 251 | 24 h | Aluminum contaminant | Cataract surgery with Isert model 251 |

BGI=Baerveldt glaucoma implant, IE=Infectious endophthalmitis, IOL=Intraocular lens, ICL=Implantable collamer lens, ISBCS=Immediate sequential bilateral cataract surgery

their report, a time interval of longer than 3 months resulted in 100% successful outcomes.

The significant damage to the trabecular meshwork, as well as possible peripheral synechia may also lead to glaucoma, which is often resistant to treatment. Oshika *et al*.[35] reported that only two out of 201 TASS cases resulted in best corrected visual acuity deterioration to 20/50 and 20/100, respectively, and those were due to macular edema.

## Reporting

We must encourage reporting of even a single case of TASS, as most outbreaks start as occasional, discrete, or isolated. Table 3 summarizes the recent reports of TASS worldwide. The most effective treatment of TASS is to impede its development, as TASS is unlikely to disappear. ASCRS established a TASS Task Force in 2006 and created two standardized questionnaires to obtain information about the products and instruments used during cataract surgery, which can be downloaded from the ASCRS website.[66] ASCRS-recommended practice states that all instruments "opened for the procedure should be transported from the OR in a closed container to the decontamination area where immediate cleaning (separate from other nonophthalmologic instruments) must take place." It is not just the surgeon and the OR team, but all the associated personnel responsible for handling ophthalmic instruments who must be aware of TASS-related issues to help prevent them.

Educating the medical community regarding the potential causes of TASS and its prevention is necessary for improving management of perplexing TASS cases. Unfortunately, we cannot completely eradicate TASS through prevention only; thorough investigations and reporting of TASS cases are crucial, concomitant with further studies regarding TASS's pathophysiology, systemic and ocular risk factors, and newer treatment options.

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