

Chapter 17

POSTTRAUMATIC ENDOPHTHALMITIS

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INTRODUCTION

Penetrating trauma to the globe (ie, a ruptured globe) is an ophthalmic challenge for many reasons. Few ophthalmologists see enough patients with this kind of injury to feel totally capable of handling them. Even surgeons who treat a large number of ruptured globes recognize that no two cases are exactly alike. Given this degree of variability in training and in case presentation, strategies for the repair of ruptured globes vary significantly. Endophthalmitis (ie, inflammation of the tissues within the eye) in the setting of trauma is another condition that the ophthalmologist sees infrequently; how the physician deals with penetrating trauma to the globe and resulting endophthalmitis can make the difference between salvaging vision or losing it to blindness or enucleation.

Posttraumatic endophthalmitis (PTE) comprises one fourth of all culture-proven cases of endophthalmitis. It is estimated to develop in 2% to 11% of penetrating globe injuries.¹⁻⁵ When an intraocular foreign body (IOFB) is present, the potential for endophthalmitis increases; the reported incidence ranges from 4.7% to 15.0%.⁶⁻⁹ Other risk factors include severe wounds, lens disruption, prolonged exposure of the intraocular contents to the environment, the setting in which the injury occurs, delays in diagnosis and treatment, advanced age of the patient, and compromised host immunity.^{1,2,4,7}

PTE frequently carries a much poorer prognosis than postoperative endophthalmitis (POE) following planned surgery. Damage to ocular structures, including the cornea, lens, and retina, or infection with more virulent organisms tends to lessen the chance of visual recovery (Figure 17-1). The advent of improved microsurgical techniques and aggressive antimicrobial therapy have improved visual outcomes, but eyes with PTE still tend to fare poorly.^{4,10}

The differences between PTE and POE are as profound as the differences between a number 64 Beaver blade and a machete, or an operating room and a barnyard. We ophthalmologists often extrapolate from our knowledge of POE when treating PTE, but the differences between the two must always be

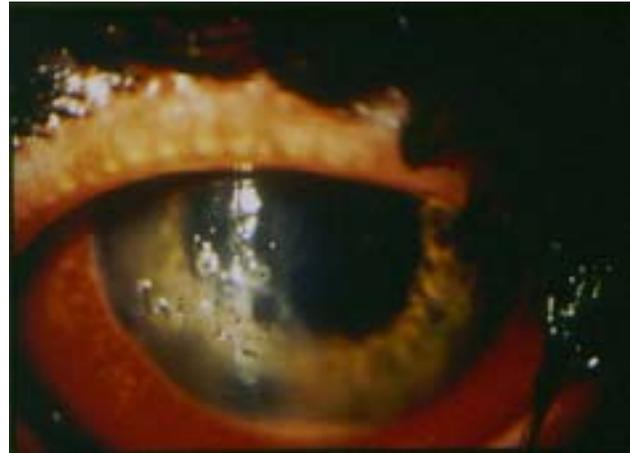


Fig. 17-1. Posttraumatic endophthalmitis with layered hyphema. Photograph: Courtesy of Department of Ophthalmology, Madigan Army Medical Center, Tacoma, Wash.

borne in mind. The differences begin with the vast differences in clinical setting. The uncontrolled environment that exists outside the operating room opens the door to many types of infectious organisms that are rarely if ever seen in POE. Contamination of a traumatic wound with soil or organic material is particularly likely, and such contamination is often associated with virulent organisms such as *Bacillus cereus* and *Fusarium solanae*, which are rarely encountered with POE. The likelihood of mixed infections is also much higher in the setting of trauma.

The difference between traumatic and planned surgical wounds is important both in terms of the greater exposure of intraocular contents to the environment with traumatic wounds and in the greater postoperative inflammation seen in these wounds. Inflammation and pain can mask the early signs and symptoms of PTE, making early diagnosis and treatment difficult. This delay in diagnosis and the accompanying damage to ocular structures contribute to a lower percentage of posttraumatic eyes recovering useful vision.¹¹

MICROBIOLOGY

The profile of likely infecting organisms in PTE differs from that of POE in several ways. Exhibit 17-1 lists the causative organisms found most commonly in traumatic and postoperative endophthalmitis. *Staphylococcus* species are the most commonly isolated bacteria in both the traumatic and

surgical environments. It is identified in up to 50% of posttraumatic cases and up to 47% of postoperative cases. The second most common organisms in the traumatic group are the *Bacillus* species, which typify the major difference between posttraumatic and postoperative endophthalmitis.

EXHIBIT 17-1**ORGANISMS MOST COMMONLY ISOLATED IN ENDOPHTHALMITIS**

Posttraumatic Endophthalmitis (PTE)

Staphylococcus species*Bacillus* species*Streptococcus* species

Polymicroorganisms

Gram-negative microorganisms

Fungal species

Postoperative Endophthalmitis (POE)

Staphylococcus species*Streptococcus* species

Gram-negative microorganisms

Polymicroorganisms

Bacillus species

Fungal species

Important references for the use of antibiotics in the treatment of endophthalmitis:

Barr CC. Prognostic factors in corneoscleral lacerations. *Arch Ophthalmol*. 1983;101:919–924.Bohigian GM, Olk RJ. Factors associated with a poor visual result in endophthalmitis. *Am J Ophthalmol*. 1986;101:332–341.Brinton GS, Topping TM, Hyndiuk RA, Aaberg TM, Reeser FH, Abrams GW. Posttraumatic endophthalmitis. *Arch Ophthalmol*. 1984;102:547–550.Endophthalmitis Vitrectomy Study Group. Results of Endophthalmitis Vitrectomy Study: A randomized trial of immediate vitrectomy and of intravenous antibiotics for the treatment of postoperative bacterial endophthalmitis. *Arch Ophthalmol*. 1995;113:1479–1496.Fisch A, Salvanet A, Prazuck T, et al. The French Collaborative Study Group on Endophthalmitis. Epidemiology of infective endophthalmitis in France. *Lancet*. 1991;338(8779):1373–1376.Forster RK, Abbott RL, Gelender H. Management of infectious endophthalmitis. *Ophthalmology*. 1980;87:313–319.Javitt JC, Vitale S, Canner JK, et al. National outcomes of cataract extraction: Endophthalmitis following inpatient surgery. *Arch Ophthalmol*. 1991;109:1085–1089.Kent DG. Endophthalmitis in Auckland 1983–1991. *Aust N Z J Ophthalmol*. 1993;21:227–236.Mieler WF, Glazer LC, Bennett SR, Han DP. Favorable outcome of traumatic endophthalmitis with associated retinal breaks or detachment. *Can J Ophthalmol*. 1992;27:348–352.Nobe JR, Gomez DS, Liggett P, Smith RE, Robin JB. Post-traumatic and postoperative endophthalmitis: A comparison of visual outcomes. *Br J Ophthalmol*. 1987;71:614–617.Parke DW II, Jones DB, Gentry LO. Endogenous endophthalmitis among patients with candidemia. *Ophthalmology*. 1982;89:789–796.Parrish CM, O'Day DM. Traumatic endophthalmitis. *Int Ophthalmol Clin*. 1987;27(2):112–119.Peyman GA, Daun M. Prophylaxis of endophthalmitis. *Ophthalmic Surg*. 1994;25:671–674.Puliafito CA, Baker AS, Haaf J, Foster CS. Infectious endophthalmitis: Review of 36 cases. *Ophthalmology*. 1982;89:921–929.Seal DV, Kirkness CM. Criteria for intravitreal antibiotics during surgical removal of intraocular foreign bodies. *Eye*. 1992;6:465–468.Speaker MG, Milch FA, Shah MK, Eisner W, Kreiswirth BN. The role of external bacterial flora in the pathogenesis of acute postoperative endophthalmitis. *Ophthalmology*. 1991;98:639–649.Thompson JT, Parver LM, Enger CL, Mieler WF, Liggett PE. Infectious endophthalmitis after penetrating injuries with retained intraocular foreign bodies. *Ophthalmology*. 1993;100:1468–1474.Thompson WS, Rubsamen PE, Flynn HW Jr, Schiffman J, Cousins SW. Endophthalmitis after penetrating trauma: Risk factors and visual acuity outcomes. *Ophthalmology*. 1995;102:1696–1701.Williams DF, Mieler WF, Abrams GW, Lewis H. Results and prognostic factors in penetrating ocular injuries with retained intraocular foreign bodies. *Ophthalmology*. 1988;95:911–916.Wilson FM. Causes and prevention of endophthalmitis. *Int Ophthalmol Clin*. 1987;27(2):67–73.

B cereus infections are seen in only 3% of POE cases, but they are implicated in up to 46% of cases of PTE. *B cereus* is a highly virulent organism with the potential to devastate an eye in only a few hours (Figure 17-2); the destructive power of these infections is due to the ability of *B cereus* to produce enzymes and exotoxins that ravage the eye. Eyes can worsen visibly during the 1 to 2 hours it takes to get the patient to the operating room for diagnostic tap and antibiotic injections. The ophthalmologist, therefore, must be hypervigilant in watching for the development of *B cereus* endophthalmitis in traumatic cases. This diagnosis should especially be considered in cases where there is soil contamination of the wound, trauma occurring outdoors or in an agricultural environment, injuries which include IOFBs, and in the presence of constitutional symptoms such as fever, sweats, and an elevated white blood cell count.

Additionally, PTE has a much higher incidence of mixed infections. These infections can be particularly difficult to treat, necessitating the use of two or more antibiotics with broad Gram-positive and

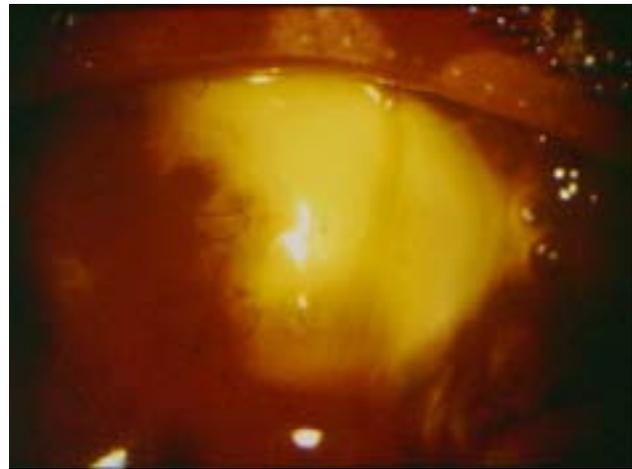


Fig. 17-2. Posttraumatic endophthalmitis caused by *Bacillus cereus*. Photograph: Courtesy of Department of Ophthalmology, Madigan Army Medical Center, Tacoma, Wash.

Gram-negative coverage. Synergism between these drugs may also be particularly important in the setting of mixed infections.

MAKING THE DIAGNOSIS

The most critical aspect of treating endophthalmitis is making a timely diagnosis. The visual outcome, even the preservation of the globe, hinges on making the diagnosis with minimal delay. Because of the more virulent profile of infecting organisms and the possibility of mixed infection in PTE, the need for rapid diagnosis is especially urgent. Cases of PTE pose a greater diagnostic challenge than cases of POE because of the confounding variables presented by inflammation, pain, and swelling following trauma and its surgical repair.

Two important rules to follow to improve the chances of making an early diagnosis of PTE are

1. observe the patient closely, and
2. maintain a high index of suspicion.

Patients should be examined frequently during the initial postoperative period, looking for early signs and symptoms of endophthalmitis. Endophthalmitis occurs quickly, usually within 1 to 4 days following trauma.^{2,10}

Purulent discharge, increasing anterior chamber or vitreous reaction, hypopyon, corneal edema, loss

of a red reflex, lid edema, proptosis, and fever are signs that point toward the diagnosis of endophthalmitis. Increasing pain and photophobia out of proportion to the injury and visual loss are also worrisome. The examiner faces the challenge in these cases of differentiating normal, postoperative inflammation from the inflammation driven by infection.

Some signs of PTE are distinctive and point to particular invading organisms. A corneal ring abscess is particularly likely to signify a *B cereus* infection. Intraocular gas, although a sign of globe perforation, can also indicate an infection with gas-forming organisms, such as *Clostridium* species.

Ancillary testing can also be quite useful in establishing the diagnosis of PTE. First, cultures obtained at the time of the initial repair must be continuously reviewed. Any early evidence of growth coupled with mounting signs and symptoms of infection should prompt immediate treatment. Imaging (ultrasonography, plain film radiography, and computed tomography) can all be used to detect an occult IOFB, which can substantially increase the likelihood of PTE.

MANAGEMENT DURING THE PRIMARY REPAIR

Every repair of a traumatized eye requires endophthalmitis management. The details of the history are sought to determine the likelihood of infection. Is there a retained IOFB? How long has the eye been open? These questions and more are asked to help predict and prevent PTE.

At the time of repair, cultures and stains are prepared of the conjunctiva, wound, and of any tissue or debris removed from the eye. Initial Gram's and Giemsa stains (for bacteria) and Gomori's methenamine-silver stain (for fungal elements) should be performed. Chocolate and blood agar plates and thioglycolate broth should be inoculated and incubated at 37°C. Separate plates of blood and Sabouraud's agar should be prepared and incubated at 25°C. Alternatively, aqueous and vitreous samples can be inoculated directly into blood culture bottles.

Topical and subconjunctival antibiotics are used routinely for prophylaxis against PTE, and intravenous antibiotics are given for at least 72 hours. Quinolone may be administered orally if access to the operating room will be delayed and if intrave-

nous antibiotics are not immediately available. These steps are a standard part of any repair of a ruptured globe.

The question of whether to use prophylactic intravitreal injections remains unanswered. In cases where the eye is violated by a grossly contaminated object, the decision to use intravitreal antibiotics at the time of initial repair—provided that the injections can be given safely and reliably into the vitreous cavity—is easy. In other cases where the likelihood of intraocular contamination is low, prophylactic antibiotics probably are not necessary. Unfortunately, most cases fall somewhere between these two extremes. In general, if the risk of infection is high and the posterior segment has been violated, then the use of prophylactic intravitreal antibiotics should be considered.

The use of subconjunctival steroids can be considered at the time of surgical repair of a ruptured globe. However, the use of systemic and intravitreal steroids should be avoided to reduce the chance of suppressing the immune system and the possibility of masking early signs and symptoms of infection.

MANAGEMENT AFTER INITIAL REPAIR

Following the initial repair, the patient must be monitored closely and frequently for the development of endophthalmitis. The ophthalmologist should take personal responsibility for checking all Gram stains. Cultures should be examined daily for growth. Any growth on the microbiological media in the presence of mounting signs or symptoms of PTE should be treated as an infection. Because PTE can rapidly cause overwhelming devastation, a high index of suspicion coupled with a low threshold for treatment is appropriate. If a diagnosis of endophthalmitis is a real possibility, anterior and posterior chamber taps with intravitreal antibiotic injections should be performed urgently. Hesitation leads to loss of vision and frequently loss of the eye. Both medical and surgical management aspects need to be considered.

Medical Considerations

Antibiotic Coverage

All cases of endophthalmitis, postoperative and posttraumatic, require broad-spectrum antibiotic

coverage. Broad-spectrum coverage is especially important in PTE. Although 75% of postoperative endophthalmitis is caused by Gram-positive organisms, only 45% of PTE cases are attributable to Gram-positive organisms. Many drug regimens cover a wide range of Gram-positive and Gram-negative organisms, but only a few can be delivered in bactericidal doses without being toxic to the eye.

The currently recommended combination of drugs for intravitreal injection is vancomycin, 1 mg in a volume of 0.1 mL, and ceftazidime, 2.25 mg also delivered in 0.1 mL. Vancomycin is an excellent agent for Gram-positive coverage. The Endophthalmitis Vitrectomy Study¹² found that all Gram-positive organisms were sensitive to vancomycin. Ceftazidime is preferred for Gram-negative coverage because of the breadth of its effectiveness and low toxicity. Amikacin (0.4 mg) may be substituted for ceftazidime for Gram-negative coverage.

Choices of antibiotics for subconjunctival and topical administration should also be made to provide for broad coverage of Gram-positive and Gram-negative

microorganisms. Vancomycin and clindamycin offer good Gram-positive coverage at doses of 25 mg, whereas ceftazidime (100 mg) gives good Gram-negative protection. Care must be taken not to introduce these agents inadvertently into the eye by either direct injection or injection in the area of a partially open wound. Topically, ciprofloxacin (0.3% hourly) or vancomycin (50 mg/mL) provides good coverage.

The use of systemic antibiotics in POE has not been proven beneficial.¹² However, most clinicians (including ourselves) recommend intravenous antibiotic coverage as prophylaxis. Prophylactic regimens against endophthalmitis in penetrating trauma without posterior segment involvement include both vancomycin (1 g, twice daily) and ceftazidime (1 g, three times daily) for at least 3 days. These antibiotics cross the blood-ocular barrier reasonably well and may reach therapeutic levels in the eye. Their entry into the eye is also aided by the weakening of the blood-ocular barrier that results from infection and trauma-induced inflammation. After 3 days of intravenous antibiotics, the patient (after discharge) is placed on 1 week of oral ciprofloxacin (500 mg, twice daily).

More aggressive treatment is warranted for treating PTE or providing prophylactic coverage in cases of penetrating trauma with contamination by dirt or vegetable matter, presence of an IOFB, or involvement of the posterior segment (Exhibit 17-2).¹³

Antifungal Treatment

Therapy for fungal PTE differs significantly from that of bacterial PTE. Unlike therapy for bacterial PTE, which is delivered at the time that specimens are collected, therapy for fungal endophthalmitis is *never* instituted unless (1) fungal elements are seen on stains from aqueous or vitreous specimens or (2) the cultures grow fungal species. Once the diagnosis is confirmed, intravitreal amphotericin-B (5 µg/0.1 mL) is given through the pars plana. Topical amphotericin-B drops (1.5 mg/mL) are given as frequently as every hour. Systemic amphotericin-B (0.25–1.00 mg/kg/d) is given intravenously in divided doses after consultation with an internist. Alternatively, fluconazole (100 mg orally, twice daily) can be administered for 2 to 4 weeks.¹³

EXHIBIT 17-2

ANTIBIOTIC RECOMMENDATIONS FOR POSTTRAUMATIC ENDOPHTHALMITIS

Use together for 3 d:

- Intravenous vancomycin, 1 g bid
- Intravenous ceftazidime, 1 g tid

Use for 1 wk after discharge:

- Oral ciprofloxacin, 500 mg bid

Use in combination:

- Intravitreal vancomycin (1 mg/0.1 mL); inject 0.1 mL through pars plana
- Intravitreal ceftazidime (2.25 mg/0.1 mL); inject 0.1 mL through pars plana

For injuries that run a high risk of contamination with *Bacillus* species:

- Intravitreal clindamycin (0.5 mg/0.1 mL); inject through pars plana

Use in combination:

- Subconjunctival cefazolin (100 mg) or vancomycin (25 mg)
- Subconjunctival ceftazidime (100 mg)

Use in alternation:

- Topical fortified cefazolin (50 mg/mL) or fortified vancomycin (50 mg/mL) every 1–2 h, alternating with ciprofloxacin (0.3%)

Source: Merbs SL, Abrams LS, Campochiaro PA. Endophthalmitis. In: MacCumber MW, ed. *Management of Ocular Injuries and Emergencies*. Philadelphia, Pa: Lippincott Williams & Wilkins; 1997: 280–281.

EXHIBIT 17-3**METHODS FOR OBTAINING INTRAOCULAR CULTURES AND DELIVERING INTRAVITREAL ANTIBIOTICS**

Aqueous fluid culture from anterior chamber tap:

1. Apply topical anesthesia to cornea or administer a retrobulbar block.
2. Prepare surface of eye with 5% betadine solution.
3. Place a sterile lid speculum.
4. Use a 27- or 30-gauge needle on a tuberculin syringe to perform a paracentesis into the anterior chamber, and remove approximately 0.1 to 0.2 mL of aqueous fluid. Take care not to hit the lens in phakic eyes.

Vitreous fluid culture from vitreous tap:

1. Apply topical anesthesia to conjunctiva and administer either a subconjunctival or a retrobulbar injection of local anesthetic.
2. Prepare surface of eye with 5% betadine solution.
3. Place a sterile lid speculum.
4. Use a 22- to 25-gauge needle on a tuberculin syringe to perform a paracentesis through the pars plana 3 mm posterior to the limbus in pseudophakic eyes and 4 mm posterior to the limbus in phakic eyes. Remove approximately 0.1 to 0.2 mL of liquefied vitreous. Take care to direct the needle toward the optic nerve and not to advance it more than 1 cm.

Vitreous fluid culture from vitreous biopsy:

1. Apply topical anesthesia to conjunctiva and administer either a subconjunctival or retrobulbar injection of local anesthetic.
2. Prepare surface of eye with 5% betadine solution.
3. Place a sterile lid speculum.
4. Perform a limited peritomy before creating the larger sclerotomy 3 mm posterior to the limbus in pseudophakic eyes and 4 mm posterior to the limbus in phakic eyes. Use a supersharp knife for 23-gauge and smaller vitrectors, and a microvitreal retinal (MVR) blade for a standard 20-gauge vitreous cutter.
5. Use an unprimed vitreous cutter to obtain approximately 0.3 to 0.5 mL of undiluted vitreous. Aspirate the sample into a syringe.
6. Close the larger sclerotomy with 7-0 Vicryl, and reapproximate the conjunctiva with 6-0 plain gut. Smaller sclerotomies will seal without suturing.

Administration of intravitreal antibiotics through the pars plana:

1. Apply topical anesthesia to conjunctiva and administer either a subconjunctival or retrobulbar injection of local anesthetic.
2. Prepare the eye with 5% betadine solution.
3. Place a sterile lid speculum.
4. Using a 30-gauge needle on a tuberculin syringe, inject 0.1 mL of the antibiotic 3 mm posterior to the limbus in pseudophakic eyes and 4 mm posterior to the limbus in phakic eyes. Take care to direct the needle toward the optic nerve and not to advance it more than 1 cm. Use a separate needle and syringe for each antibiotic, which must be delivered through separate injections.
5. Check the intraocular pressure at this point. If it is elevated, an anterior chamber paracentesis may be required to normalize the pressure.

Source: Merbs SL, Abrams LS, Campochiaro PA. Endophthalmitis. In: MacCumber MW, ed. *Management of Ocular Injuries and Emergencies*. Philadelphia, Pa: Lippincott Williams & Wilkins; 1997: 279–280.

Antiinflammatory/Immunosuppressant Therapy

All patients who sustain penetrating eye trauma receive topical prednisolone acetate 1% (every 1–2 h) to decrease intraocular inflammation and atropine 1% (every 12 h) to provide cycloplegia. Patients who undergo surgical repair and receive intravitreal antibiotics are given subconjunctival dexamethasone (20 mg) at the end of the case.

Oral prednisone (1 mg/kg/d) may be administered to patients with PTE 24 hours after antibiotic therapy is initiated, provided the stains are negative for fungal elements.

Surgical Considerations

After the initial repair, aqueous and vitreous samples are obtained when the diagnosis of endophthalmitis is first seriously entertained. These samples may be obtained by needle aspiration, using a 27- or 30-gauge needle for the anterior chamber paracentesis and a 22- to 25-gauge needle for the pars plana tap (Exhibit 17-3).¹³ Some clinicians recommend using a 23-gauge or smaller vitrector to obtain a vitreous biopsy.

What is less clear is when to perform a vitrectomy to retrieve a specimen and debride the eye. Several factors influence this decision, including

- integrity of the globe,
- visual acuity,
- the need for a large sample,
- the usefulness of vitreal debridement for reducing the infectious and inflammatory load, and
- the need for better dispersal of intravitreal antibiotics.

Owing to the difficulties inherent in any study of PTE, no clear or absolute guidelines have been developed to date with regard to the timing of this powerful treatment tool. However, if we extrapolate from the Endophthalmitis Vitrectomy Study,¹² any patient who develops PTE after initial repair of the injury should undergo vitrectomy if he or she only has light perception vision. Many vitreoretinal surgeons advocate performing vitrectomy and injecting intravitreal antibiotics even with vision better than light perception, especially if they are concerned that the eye might be infected with a virulent organism.

COURSE AFTER TREATMENT

After the diagnosis of PTE has been made and antibiotic therapy begun, much work remains. Cultures must be examined daily for evidence of growth, antimicrobial sensitivity tests must be checked, and the patient must be closely followed for signs of change. If the infection appears to be worsening, then the ophthalmologist, guided by microbiology reports, should consider repeating the injections or performing a vitrectomy within 48 hours of the diagnosis. Repeat cultures and Gram's stains are usually not performed at this point unless no organ-

isms were isolated from the previous cultures.

A patient with good response to treatment will report diminished ocular pain within 24 to 48 hours. The amount of anterior segment inflammation and the height of the hypopyon seen at 24 to 48 hours after initiation of antibiotic therapy are less reliable signs to follow. In fact, both of these signs may initially worsen after injection of intravitreal antibiotics. The antibiotics kill the intraocular organisms, causing them to release toxins, which may temporarily increase anterior segment inflammation.

SUMMARY

PTE is one of the most devastating complications of the already-serious problem of globe rupture. Much progress has been made since the mid 1970s with advances in surgical technique and antibiotic therapies, but some aspects of this problem are as common today as they were in the 1950s. Delays in diagnosis are dangerous. The greater virulence of

organisms associated with PTE, especially *B cereus*, diminishes the prognosis for recoverable vision. Also, traumatized eyes, especially when they are significantly disrupted, can have associated injuries to the cornea, lens, retina, and optic nerve. Severe damage to any of these structures can lessen the chance of obtaining useful vision from the eye.

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