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Outcomes of Post-Traumatic Pediatric Endophthalmitis Following 25-Gauge Pars Plana Vitrectomy

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Submitted to the editorial board: August 23, 2025
Accepted for publication: December 12, 2025
Available online: March 23, 2026

The authors of the study declare that no conflict of interest exists in the compilation, theme and subsequent publication of this professional communication, and that it is not supported by any pharmaceutical company.

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SUMMARY

Aim: To evaluate the structural and functional outcomes of 25-gauge pars plana vitrectomy (PPV) in children with post-traumatic endophthalmitis.
Material and Methods: This retrospective study included 33 children (mean age: 6.5 ±2.6 years) with endophthalmitis following open globe injury who underwent 25G PPV. Preoperative parameters recorded were age, gender, time of onset, best-corrected visual acuity (BCVA), hypopyon, intraocular foreign body (IOFB), and retinal detachment (RD). Surgical details noted included timing of PPV, intraoperative findings, lens status, tamponade, and need for pars plana lensectomy (PPL). Vitreous samples were taken for microbiology. Minimum follow-up was 3 months.
Results: The mean interval between injury and onset of endophthalmitis was 4.72 ±3.75 days, and the mean time to PPV was 5.8 ±4.7 days. Hypopyon was present in 45.4%, IOFB in 12.1%, and RD in 6.1%. PPL was performed in 81% of eyes. Mean preoperative BCVA was 2.6 ±0.2 logMAR, improving significantly to 1.3 ±0.5 logMAR at 3 months ($p < 0.05$). Functional success (ambulatory vision > 3/60) was achieved in 33.3%. Anatomical success with retinal attachment was achieved in 72.7%, and endophthalmitis resolution in 90%. Retinal reintervention was required in 15%. Oil tamponade was used in 30% and gas in 9.1%. Microbiological positivity was seen in 39.3%, most commonly Gram-positive cocci.
Conclusion: Early 25G PPV in pediatric post-traumatic endophthalmitis offers favorable structural and functional outcomes. High rates of infection resolution and retinal attachment can be achieved despite severe presentation, particularly with timely vitrectomy, tailored tamponade, and lensectomy when indicated.
Key words: pediatric endophthalmitis, pars plana vitrectomy, trauma, vitreoretinal surgery, visual outcomes

Čes. a slov. Oftal., 82, 2026, No. x, p.

INTRODUCTION

Post-traumatic endophthalmitis (PTE) is among the most vision-threatening sequelae of ocular trauma in children. The pediatric age group is particularly vulnerable, due to the higher incidence of penetrating injuries, challenges in clinical assessment, and frequent delays in presentation [1]. In children, post-traumatic ocular infections are often caused by organic or contaminated materials, leading to rapid progression and a guarded prognosis. The incidence of pediatric PTE is reported to be 3.5–54.1% of all pediatric ocular trauma, with boys disproportionately affected, due to outdoor activities and unsupervised play [2,3]. Management of PTE is complex, requiring prompt diagnosis, effective antimicrobial therapy, and surgical intervention when indicated. Early vitrectomy has consistently been identified as a key factor in improving prognosis. However, outcomes remain suboptimal, due to the aggressive inflammatory response, media opacities, and the risk of complications, such as retinal detachment or phthisis [4]. Advances in vitreoretinal surgical technology, particularly microincision

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systems such as 25-gauge pars plana vitrectomy (25G PPV), offer potential advantages in children by reducing surgical trauma, enhancing intraoperative visualization, and enabling safer lens removal and tamponade use. Few studies have specifically examined the outcomes of 25G PPV in pediatric PTE. The present study evaluates the anatomical and functional outcomes of 25G PPV in children with post-traumatic endophthalmitis.

MATERIAL AND METHODS

This was a retrospective observational study, conducted at a tertiary eye care institute between March 2020 and February 2022. Children under 15 years of age with post-traumatic endophthalmitis who underwent 25G PPV and had a minimum of 3 months' follow-up were included. A total of 33 children (33 eyes) with post-traumatic endophthalmitis were included in the study. Exclusion criteria included children more than 15 years of age, patients with poor corneal clarity or corneal abscess, phthisical or prephthisical eyes. All open-globe injuries underwent primary repair under general anesthesia. For cases reporting more than 48 hours after injury, prophylactic intravitreal vancomycin (1 mg) and ceftazidime (2.25 mg) were administered. Standard postoperative antimicrobial regimens were administered. Any patient who developed clinical signs of endophthalmitis during follow-up underwent an urgent 25-gauge PPV, with vitreous biopsy for microbiology.

Data on demographics, injury details, ocular features, microbiological results, surgical details, and outcomes were collected. Media clarity was graded according to the Endophthalmitis Vitrectomy Study (EVS) scale, ranging from Grade 0 (clear media) to Grade 4 (no fundus view) [5].

Postoperative outcomes were categorized into functional and structural parameters. Functional outcomes were assessed, based on best corrected visual acuity (BCVA) at the 3-month follow-up. Functional success was defined as vision better than 3/60 (ambulatory vision) [3]. Structural outcomes included resolution of intraocular infection, retinal attachment status, and preservation of globe integrity.

Statistical analysis used descriptive statistics and paired t-tests to compare post-operative BCVA from preoperative BCVA, with $p < 0.05$ as significant.

RESULTS

The mean age at presentation was 6.5 ±2.6 years, with the majority being boys (27/33, 81.8%), resulting in a male-to-female ratio of 4.6:1. Most injuries were caused by sharp objects (30/33, 90.9%), including pencils/pens (n = 10), scissors (n = 8), knives (n = 3), broomsticks (n = 2), wire (n = 2), iron nail (n = 1), and fingernail (n = 1). Two cases (6.1%) resulted from firecracker injuries, and one case (3.0%) had an unidentified cause. The mean interval between the trauma and onset of clinical endophthalmitis was 4.7 ±3.7 days, while the average time from trauma to vitrectomy was 5.8 ±4.7 days.

Table 1. Highlights baseline demographic and ocular characteristics of the study population

Characteristic	Value (n = 33 eyes)
Mean age at presentation (years)	6.5 ±2.6
Sex distribution	Male: 27 (81.8%), Female: 6 (18.2%), Ratio: 4.6:1
Cause of injury	Sharp objects: 30 (90.9%) - Pencil/Pen: 10 - Scissors: 8 - Knives: 3 - Broomsticks: 2 - Wire: 2 - Iron nail: 1 - Fingernail: 1 Firecracker: 2 (6.1%) Unidentified: 1 (3.0%)
Interval between trauma and endophthalmitis onset (days)	4.72 ±3.75
Interval between trauma and vitrectomy (days)	5.83 ±4.73
Hypopyon at presentation	15 (45.5%)
Traumatic cataract	27 (81.8%)
Media clarity (EVS grading, assessable eyes only)	Grade 4: 10 (30.3%) Grade 3: 10 (30.3%) Grade 2: 3 (9.1%) Could not be assessed: 10 (30.3%)
Intraocular foreign body (IOFB)	4 (12.1%) – 2 metallic, 2 organic
Retinal detachment (pre-op USG)	2 (6.1%)

n – number, EVS – endophthalmitis vitrectomy study, USG – ultrasonography, IOFB –Intraocular foreign body

At presentation, hypopyon was observed in 15 eyes (45.5%). Traumatic cataract was common, being documented in 27 eyes (81.8%). Among these, 10 eyes had dense white cataracts precluding fundus visualization, whereas the remaining 17 eyes permitted some evaluation of media clarity. Of the eyes in which media clarity could be assessed, Grade 4 haze was seen in 10 (30.3%), Grade 3 in 10 (30.3%), and Grade 2 in 3 eyes (9.1%). Intraocular foreign bodies (IOFBs) were identified in 4 eyes (12.1%) – two metallic and two organic. Retinal detachment was detected in 2 eyes (6.1%) on preoperative ultrasonography. Table 1 highlights the baseline demographic details and ocular features of the study population.

Microbiological analysis revealed positivity in 13 eyes (39.4%). Gram-positive cocci were the most frequent isolate (8/33, 24.2%), followed by Gram-negative bacilli

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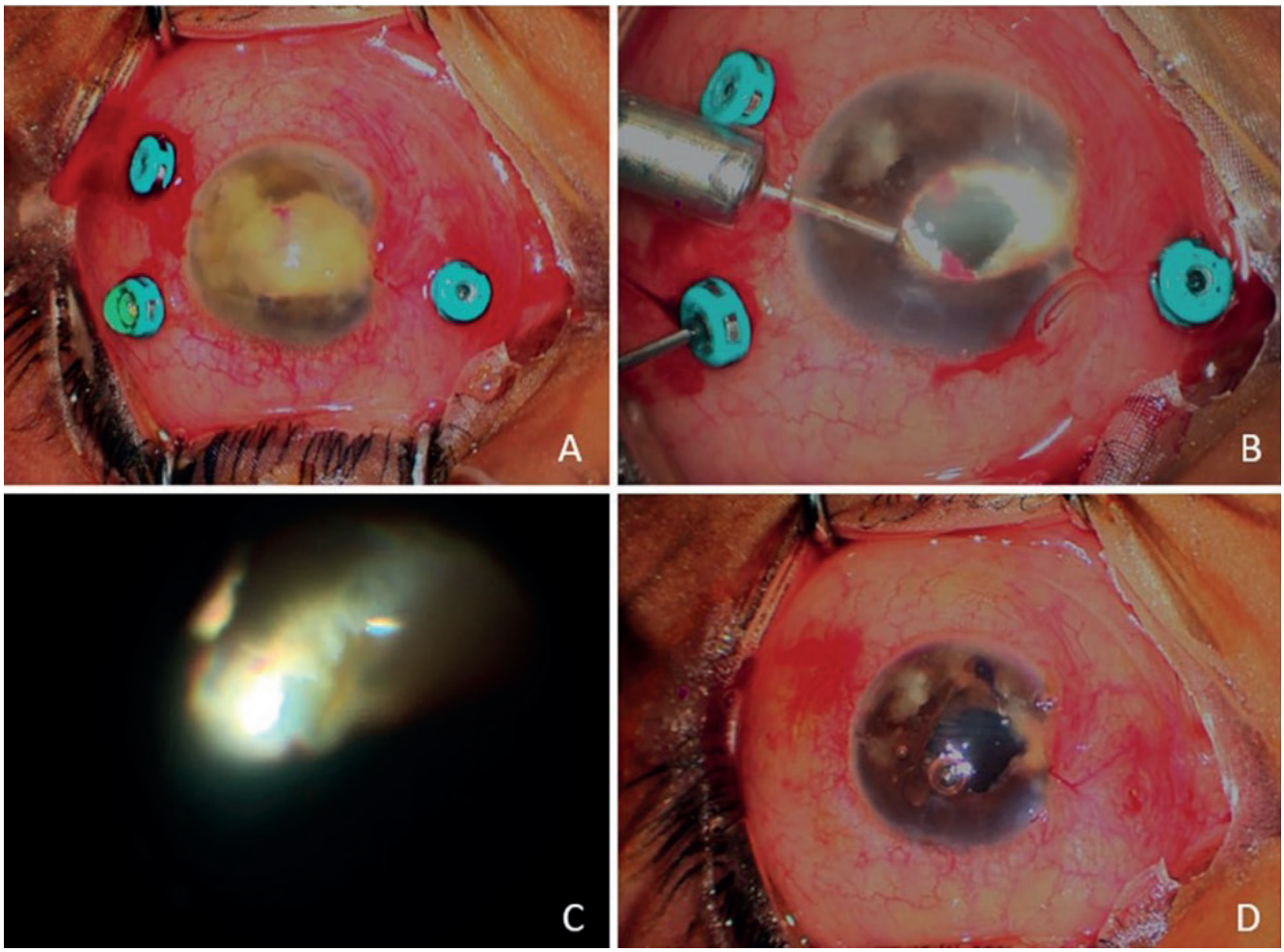


Figure 1. Demonstrates intraoperative images of an 8-year-old child who underwent PPL with PPV for post traumatic endophthalmitis. (**A**) Total white cataract with dense fibrin exudation in anterior chamber. Three standard 25gauge pars plana ports were made. (**B**) Pars plana lensectomy was done with infusion cannula secured in the anterior chamber. (**C**) Pars plana vitrectomy done, clearing dense vitreous exudation. (**D**) Silicone Oil tamponade given at the end of the surgery

PPL – pars plana lensectomy, PPV – pars plana vitrectomy

(2/33, 6.1%). Fungal elements (septate hyphae on KOH mount) were detected in 3 eyes (9.1%), all of which were associated with injuries involving wooden or organic materials.

Intraoperatively, pars plana lensectomy (PPL) was required in 27 eyes (81.8%), due to the presence of visually significant traumatic cataract. Tamponade was used in 13 eyes (39.4%): silicone oil in 10 (30.3%) and gas in 3 (9.1%). Figure 1 highlights intraoperative images of an 8-year-old child who underwent PPL with PPV for PTE.

Endophthalmitis resolved in 30 eyes (90.9%) following surgery. Anatomical success, defined as attached retina and preserved globe integrity at final follow-up, was achieved in 24 eyes (72.7%). Five eyes (15.2%) required secondary vitreoretinal intervention for persistent exudation or postoperative retinal detachment. Despite surgical efforts, 3 eyes (9.1%) developed phthisis bulbi, and 6 eyes (18.2%) had inoperable retinal detachments.

The mean preoperative BCVA was 2.6 ±0.2 log MAR, which improved to 1.3 ±0.5 log MAR at the 3-month follow-up ($p < 0.05$). Among the 24 eyes with anatomical success, 3 achieved BCVA better than 6/60, while 8 reached ambulatory vision (vision better than 3/60). Thus, functional success was achieved in 33.3% (n = 11/33) of the patients.

Overall, the study demonstrated that early 25G PPV facilitated favorable structural outcomes, with high rates of infection resolution and globe salvage, while providing meaningful visual improvement in one-third of the patients.

DISCUSSION

PTE in children remains one of the most devastating sequelae of open globe injuries, often resulting in irreversible vision loss, despite timely medical and surgical interventions [1]. Our study demonstrates that early PPV, using a 25-gauge system, leads to significant structural and functional improvement, with resolution of infection

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in 90% of eyes and anatomic success in nearly three-quarters of cases. These findings add to the growing body of literature supporting early surgical intervention in pediatric PTE.

The outcomes observed in our series are comparable to those reported in large contemporary cohorts. Li et al., in a recent study of 301 pediatric PTE cases, noted that timely PPV, combined with intravitreal antibiotics, was associated with better functional recovery, especially in eyes without retinal detachment or elevated intraocular pressure [2]. Similarly, Zhou et al. found that, although multiple surgeries were often required, PPV in children with traumatic endophthalmitis preserved globe integrity in most cases, despite final visual acuity frequently being poor due to associated retinal injuries [3]. In our study, final functional success, defined as ambulatory vision, was achieved in one-third of patients – higher than the 29% reported by Venkatesh et al. in their North Indian cohort, but still underscoring the guarded prognosis of pediatric PTE [4].

In a comparative series by Altan et al, 25-gauge pars plana vitrectomy (PPV) achieved superior visual outcomes and fewer complications than conventional 20-gauge PPV in acute postoperative endophthalmitis [5]. Final visual acuity of ≥ 20/100 was obtained in 83% of 25G eyes, versus 41% with 20G, with lower rates of retinal detachment and reintervention in the 25G group. These findings suggest that microincision vitrectomy offers similar or improved infection control with less surgical trauma. In our pediatric post-traumatic series, 25G PPV likewise yielded high infection resolution (90%) and anatomical success (73%), reinforcing its advantages for delicate inflamed eyes.

Microbiological results across studies consistently highlight Gram-positive organisms as the predominant pathogens. We found Gram-positive cocci to be the most frequent isolates, aligning with multiple reports [2,4]. Streptococcus species, in particular, have been strongly associated with poor outcomes, especially in preschool children [6]. Yang and colleagues demonstrated that, despite prompt vitrectomy and silicone oil tamponade, visual recovery in streptococcal infections was dismal, with most eyes failing to achieve vision better than counting fingers. This aggressive clinical course may explain the suboptimal visual prognosis in some of our patients. despite successful anatomic restoration.

Timing of intervention appears to be a critical determinant of outcome. Several studies emphasize that delayed wound repair or delayed PPV worsens prognosis [1]. In our cohort, the average time to PPV was nearly 6 days after trauma, which may partially account for the limited functional success rates observed. Rishi et al. have shown that patients undergoing early vitrectomy were 27 times more likely to have better outcomes [7]. The pediatric population poses unique challenges, including difficulties in early diagnosis, limited cooperation, and frequent delays in referral, all of which contribute to this delay in surgical intervention [1,8].

Lens involvement was common in our cohort, with pars plana lensectomy performed in the majority of eyes. While lens removal facilitates vitrectomy and infection clearance, it is also associated with worse visual outcomes in children, due to aphakia, amblyopia risk, and challenges with secondary intraocular lens implantation [9]. Indeed, Li et al. reported that lens extraction was an independent predictor of poor visual prognosis [2]. This highlights the delicate balance between achieving infection control and preserving visual potential in young children.

Our anatomical outcomes, particularly a retinal attachment rate of nearly 73%, are encouraging when compared with previous reports, where rates have ranged widely from 50% to 80% depending on case severity and surgical timing [3,4]. However, functional outcomes continue to lag behind anatomical success, a disparity that is consistently emphasized in the literature. Zhou et al. reported that most patients required multiple surgeries, and those with retinal injuries and silicone oil tamponade had worse final visual acuities [3]. Similarly, Yang et al. found that, even with aggressive surgical management, streptococcal PTE rarely resulted in vision better than counting fingers [6]. These data highlight the aggressive course of pediatric infections and the lasting visual morbidity, even after apparent infection control.

Another aspect worth noting is the microbiological yield, which was 39% in our series. Although this aligns with previously reported ranges, it underscores the limitations of conventional culture techniques, especially in children who have often received antibiotics before referral. Newer diagnostic modalities, such as polymerase chain reaction (PCR)-based testing or next-generation sequencing, could improve pathogen detection rates and may eventually guide more targeted therapy in this population [10,11].

Our study also brings attention to the epidemiology of pediatric PTE. Most injuries in our series were caused by sharp household objects, such as pencils and scissors, which mirrors previous reports identifying home as the most common location for childhood ocular trauma [1,8]. This emphasizes the importance of preventive strategies, including parental education, supervision, and restriction of access to sharp tools and fireworks.

Despite encouraging anatomical success, several limitations must be acknowledged. Firstly, the retrospective nature of our study introduces inherent biases, including variability in referral patterns, surgical timing, and follow-up duration. Secondly, the sample size, although among the larger pediatric cohorts, remains relatively small compared to adult series. Thirdly, microbiological yield was only 39%, which may reflect prior antibiotic use or limited culture techniques, but restricts pathogen-specific outcome correlations. Finally, follow-up was limited to three months, precluding assessment of long-term visual rehabilitation, amblyopia management, and secondary procedures such as intraocular lens implantation.

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CONCLUSIONS

In conclusion, our study reinforces that early 25-gauge PPV is an effective strategy for managing pediatric PTE, offering high rates of infection resolution and globe preservation. Nevertheless, functional visual recovery remains limited, due to the severity of trauma, delayed presentation, and pathogen virulence. Improving outcomes will require not only timely surgical intervention, but also preventive strategies to reduce pediatric ocular trauma, heightened clinical suspicion for early diagnosis, and structured amblyopia management post-surgery. Moreover, lens management remains a critical intraoperative consideration in these eyes. In our series, pars plana lensectomy (PPL) was performed in 81.8% of cases, primarily to enable complete vitreous clearance and infection control. However, recognizing the long-term visual implications of aphakia and amblyopia, these findings prompt a re-evaluation of whether selective lens preservation may be feasible in future cases. It also facilitates faster visual recovery, avoids the challenges of secondary intraocular lens implantation, and minimizes the need for prolonged optical rehabilitation. With advances in high-speed 25G systems and improved visualization, selective lens-sparing vitrectomy may thus offer superior long-term functional outcomes in this population.

Future multicenter, prospective studies with longer follow-up are warranted to develop pediatric-specific guidelines for the timing of surgery, antibiotic regimens, and visual rehabilitation in this challenging condition.

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