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Pars plana vitrectomy with or without silicone oil endotamponade in post-traumatic endophthalmitis

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Abstract *Background:* Results of core vitrectomy in post-traumatic endophthalmitis are poor. Our initial results of complete vitrectomy with primary silicone oil endotamponade were promising. A comparative study of this procedure with conventional core vitrectomy was therefore carried out. *Methods:* A prospective randomized controlled study of 24 consecutive cases of post-traumatic endophthalmitis was conducted. Patients were randomized into two groups in the absence of clinical improvement after primary tap and treatment with intravitreal vancomycin and amikacin: group 1 consisted of patients who underwent core vitrectomy alone, group 2 of patients who underwent complete vitrectomy with silicone oil endotamponade. All patients included in the study received intravenous antibiotics and underwent lensectomy. Patients were followed up 1, 2, 4 and 12 weeks postoperatively. In all patients of group 2, silicone oil was removed 6 weeks after primary surgery. The mean duration of follow-up was 112±55 days. *Results:* Vision of 20/400 or better was obtained in 58.33% of cases (14/24). Visual acuity of only one patient in group 1 was ≥20/200, compared with that of 58.3% of patients (7/12) in group 2 (P=0.02). Intra-operative retinal breaks were found in 50% (6/12) of the patients belonging to group 1, but did not affect the final visual outcome. In group 1, 33.33% (4/12) developed rhegmatogenous retinal detachment in the immediate post-operative period. Only one of these patients had useful final visual outcome after resurgery. *Conclusion:* Complete vitrectomy with primary silicone oil endotamponade is a useful treatment modality which improves the anatomical and functional results in post-traumatic endophthalmitis.

Introduction

Endophthalmitis is a devastating complication of penetrating ocular injuries. Post-traumatic endophthalmitis constitutes 25% of all cases of infectious endophthalmitis [6, 8, 13]. Approximately 7% of cases of penetrating ocular trauma develop endophthalmitis [8, 13].

The results of conventional vitrectomy in post-traumatic endophthalmitis have not been encouraging [2, 6, 8, 13]. The higher incidence of polymicrobial infection, infection with more virulent and invasive organisms, complications of associated penetrating trauma and the presence of vitreous membranes that could lead to traction detachment of the retina all lead to a poorer outcome following vitrectomy in these cases [4]. Furthermore, contraction of residual vitreous in the periphery could lead to occurrence of retinal breaks resulting in retinal detachment. It is well known that retinal detachment following vitrectomy for endophthalmitis has a poor prognosis [11].

It has often been hypothesized that complete vitrectomy in patients of traumatic endophthalmitis might ensure complete removal of both the vitreoretinal traction and the microbial load within the vitreous cavity. Silicone oil

endotamponade at the end of vitrectomy could be used to carry out extensive excision of the vitreous base in a more secure way with a significant reduction in the risk of postoperative rhegmatogenous retinal detachment as well as a reduced risk of retinal detachment due to occult breaks in these cases. Our initial results with this paradigm of management were extremely encouraging. All eyes with post-traumatic endophthalmitis in which complete vitrectomy with silicone oil endotamponade was carried out could be salvaged: 60% (6/10) of the operated eyes had a visual acuity greater than 20/200 [15]. We therefore compared the results of this new treatment modality with conventional core vitrectomy in a prospective randomized controlled trial of patients with post-traumatic endophthalmitis.

Patients and methods

Twenty-four patients with post-traumatic endophthalmitis who presented to the Dr. Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences between January 1999 and June 2000 were included in this prospective randomized controlled study.

A detailed history was recorded regarding the nature of injury, time elapsed since trauma and previous medical or surgical intervention. In addition to evaluation of the best-corrected visual acuity, all patients underwent detailed clinical evaluation of the anterior segment by slit-lamp biomicroscopy and posterior segment evaluation by direct and indirect ophthalmoscopy. All patients underwent X-ray of the orbit to rule out the presence of retained intraocular foreign body and ultrasonography for evaluation of the posterior segment.

Only patients with clinical diagnosis of post-traumatic endophthalmitis were included in the study. Informed consent was obtained from all patients prior to inclusion in the study. The diagnosis of endophthalmitis was made based on:

1. Presence of hypopyon and vitreous exudation in patients with sealed corneo-scleral perforation who presented with pain, redness and dimness of vision
   or
2. Development of a moderate to severe anterior chamber reaction and occurrence of vitreous exudation during the follow up period in patients who had previously undergone primary repair for penetrating ocular injury.

Important inclusion criteria were: age >5 years; cornea clear enough for vitrectomy; absence of concomitant retinal detachment on ultrasonography; visual acuity less than 20/200.

Those patients presenting with post-traumatic endophthalmitis who had not had primary repair underwent a thorough evaluation under anesthesia and wound closure. All patients were given intravitreal antibiotics (vancomycin 1 mg in 0.1 ml and amikacin 0.4 mg in 0.1 ml) at presentation. Patients were assessed 48 h later. All patients who did not show evidence of improvement in media clarity or visual acuity underwent vitrectomy.

Vitreous samples were taken at the time of intravitreal injection or vitrectomy. These were sent for bacterial and fungal culture and sensitivity testing according to the technique described in the Endophthalmitis Vitrectomy Study [5].

Culture of the undiluted vitreous sample was placed on blood agar, chocolate agar (37°C), enriched thioglycolate broth and fresh Sabouraud dextrose agar (incubated at 25°C). Gram staining was performed in all cases.

Study patients were randomized into two groups based on management:

Group 1 Core vitrectomy
Group 2 Complete vitrectomy with silicone oil endotamponade

Surgical procedure

All patients were operated on under general anesthesia by a single experienced surgeon (D.T.). Standard three-port sclerotomies were made. A 6-mm infusion cannula was used for infusion of Ringer lactate with 8 μg/ml of gentamicin. Lensectomy was carried out prior to vitrectomy in all the cases.

In the patients of group 1, vitrectomy was carried out as per the guidelines of the Endophthalmitis Vitrectomy Study [5]. The goal of the surgery was to remove enough vitreous gel to visualize the disc and the macula. At least 50% of vitreous gel was removed in these cases. The peripheral cortical vitreous was left untouched. In patients in whom posterior vitreous detachment was not present preoperatively, no attempt was made to surgically induce such a detachment.

In group 2 patients, a complete vitrectomy was carried out. All adhesions of the vitreous gel to the retinal/optic disc surface were severed using high cut rates (>600 cuts/min) and low suction rates (<100 mmHg) of the vitreous cutter. In cases with retained intraocular foreign body, the fibrous adhesions around the foreign body were released with the help of the vitreous cutter and the foreign body was removed with a diamond-dusted intraocular foreign-body forceps either after enlarging the sclerotomy site or via the limbal route.

In patients in whom a posterior vitreous detachment had not been present, such a detachment was induced using the technique described by Mein and Flynn for macular hole [10]. The peripheral vitreous skirt was trimmed as close to the ora serrata as possible. The fibrous tract extending from the site of the penetrating injury to the point of impact on the retinal surface was removed with the vitreous cutter. Complete vitrectomy was followed by careful examination of the retinal periphery to rule out any peripheral retinal breaks. Endolaser of any visible retinal breaks and 360° of the peripheral retina was carried out after fluid–air exchange and followed by air–silicone oil exchange.

No intravitreal antibiotics were injected at the conclusion of the vitrectomy in any patient in either groups.

Systemic and topical medications

Postoperatively, all the patients were continued on intravenous antibiotics (ciprofloxacin hydrochloride 5–10 mg/kg every 12 h) and intravenous steroids equivalent to prednisolone 1.5 mg/kg/day in two divided doses for 7 days. Each patient received topical fortified antibiotics (cefazolin sodium 50 mg/ml and tobramycin sulfate 13.5 mg/ml) and topical steroids (prednisolone acetate 1%) hourly and cycloplegics (homatropine hydrobromide 2%) every 4 h. Administration of oral antibiotics (ciprofloxacin) and steroids (prednisolone 1.5 mg/kg) followed intravenous therapy for another 7 days. The patients were followed up 1, 2, 4 and 12 weeks after surgery.

Additional procedures

Four patients in group 1 developed retinal detachment and/or reaccumulation of vitreous exudates following vitrectomy. Repeat vitrectomy was carried out along with silicone oil endotamponade immediately in these patients. Silicone oil was removed in all patients who had received silicone oil tamponade 6 weeks after surgery.

Table 1 Patient characteristics and visual results in patients who underwent core vitrectomy (group 1). *RRD*R hegmatogenous retinal detachment, *TRD* tractional retinal detachment

Case	Age (years)/ sex	Nature of trauma	Injury type	Initial visual acuity (at presentation)	Time (in days)[a]	Culture	Postoperative complication	Final visual outcome (at 3 months)
1	6/M	Bow and arrow	Open globe zone 1 injury	PL+ PR inaccurate	4	Sterile	RRD	HMCF
2	6/M	Metal wire	Open globe zone 1 injury	PL+ PR inaccurate	7	*Staph. epidermidis*	Epiretinal membrane	20/120
3	9/F	Hairpin	Open globe zone II injury	PL+ PR inaccurate	7	Sterile	Chronic hypotony	20/800
4	11/M	Needle	Open globe zone 1 injury	PL+ PR accurate	3	*Proteus*sp.	RRD	No PL
5	15/M	Metal wire	Open globe zone 1 injury	PL+ PR accurate	5	*Staph. epidermidis*	TRD involving macula	20/400
6	10/M	Bow and arrow	Open globe zone 1 injury	PL+ PR inaccurate	7	*Staph. epidermidis*	TRD involving macula	20/400
7	9/M	Metal wire	Open globe zone 1 injury	PL+ PR accurate	6	Sterile	TRD involving macula	20/400
8	11/M	Metal wire	Open globe zone 1 injury	PL+ PR accurate	3	*Staph. epidermidis*	Reaccumulation of exudates with RRD	HMCF
9	5/M	Bow and arrow	Open globe zone 1 injury	PL+ PR accurate	2	*Staph. aureus*	Chronic hypotony	HMCF
10	11/M	Wooden stick	Open globe zone II injury	PL+ PR inaccurate	4	*Strep.*sp.	Macular pucker	20/400
11	10/M	Bow and arrow	Open globe zone 1 injury	PL+ PR inaccurate	5	Sterile	Chronic hypotony	PL + PR inaccurate
12	18/M	Hammer and chisel	Open globe z zone II injury	PL+ PR inaccurate	3	*Staph. epidermidis*	RRD	No PL (pthisical)

[a] Duration between trauma and presentation to us

Data were analyzed using the Mann–Whitney test and the Fisher's exact test.

Results

Baseline characteristics of the patients included in the study are given in Tables 1 and 2.

The majority of the patients in both groups were male (91.66%). The mean age of the patients was 10.08±3.70 years in group 1 and 13.66±6.82 years in group 2. The age distribution was comparable in the two groups (P=0.247).

Injuries due to bows and arrows accounted for 33.33% of cases (8/24). Injuries with a metallic object was found in 41.6% of the patients (10/24), including two patients with a retained intraocular foreign body. Other causes of injury included needles (two patients), wooden sticks (two patients), road traffic accident (one patient) and hairpin (one patient).

Sixteen (66.66%) of the 24 patients were found to have associated lens injuries; of these 50% (8/16) had focal lens capsule disruption overlying a localized cataract, 31.2% (5/16) had a diffuse cataract and 18.7% (3/16) patients had a frank lens rupture. A fibrinous exudative membrane was present on the anterior lens surface in all the patients.

Microorganisms were isolated in 62.5% of patients (15/24). The commonest microorganism isolated was coagulase-negative *Staphylococcus*, which was noted in 60% of the culture-positive cases (9/15). Other microorganisms cultured included gram-negative species in 14.2% of the cases (2/15), *Staphylococcus aureus* in 13.3% (2/15), *Streptococcus* species in 6.6% (1/15) and fungi in 6.6% (1/15). All gram-positive isolates demonstrated susceptibility to vancomycin and gram-negative isolates to amikacin. There was no significant difference in visual outcome between culture-positive and culture-negative patients (P=0.86).

The associated ocular injuries were classified according to the criteria of the Ocular Trauma Classification Group [15]: 70.8% of patients (17/24) had zone 1 injuries; zone II and zone III injuries were seen in 25% and 4.1% of patients (6/24 and 1/24) respectively. The distribution of patients according to the zone of injury was comparable in the two groups (P=0.66).

Successful outcome was defined as a final visual acuity of 20/400 or better 3 months after initial surgery. In our study the overall incidence of successful visual outcome was 58.33% (14/24); it was 41.6% (5/12) in group 1 and 75% (9/12) in group 2 (P=0.07). Of these patients, only one in group 1 had vision >20/200 in group 1, compared with 58.3% of patients (7/12) in group 2 (P=0.02).

Table 2 Patient characteristics and visual results in patients who underwent complete vitrectomy with silicone oil endotamponade (group 2). *RRD* Rhegmatogenous retinal detachment, *TRD* tractional retinal detachment

Case	Age (years)/ sex	Nature of trauma	Injury type	Initial visual acuity (at presentation)	Time (in days)[a]	Culture	Postoperative complication	Final visual outcome (3 months)
1	6/M	Bow and arrow	Open globe zone 1 injury	PL+ PR inaccurate	2	Sterile	Retinal break	HMCF
2	7/F	Bow and arrow	Open globe zone 1 injury	PL+ PR inaccurate	2	*Staph. epidermidis*	Chronic hypotony	No PL
3	15/M	Metal wire	Open globe zone II injury	PL+ PR accurate	1	Sterile	Chronic hypotony	HMCF
4	9/M	Bow and arrow	Open globe zone 1 injury	PL+ PR inaccurate	5	*Staph. epidermidis*	Retinal break (dialysis)	20/200 (6 months)
5	16/M	Metal wire	Open globe zone 1 injury	PL+ PR inaccurate	6	*Proteus*sp.	Retinal break	20/120
6	18/M	Hammer and chisel	Open globe zone II injury	PL+ PR accurate	6	*Staph. epidermidis*	Retinal break (dialysis)	20/120
7	26/M	Road traffic accident	Open globe zone III injury	PL+ PR inaccurate	3	*Staph. epidermidis*	None	20/40 (9 months)
8	8/M	Needle	Open globe zone 1 injury	PL+ PR accurate	3	Sterile	Retinal break	20/400
9	12/M	Metal wire	Open globe zone 1 injury	PL+ PR inaccurate	2	*Staph. aureus*	Retinal break (dialysis)	20/60 (9 months)
10	25/M	Hammer and chisel	Open globe zone II injury	PL+ PR inaccurate	5	Sterile	None	20/120
11	15/M	Wooden stick	Open globe zone 1 injury	PL+ PR accurate	18	*Aspergillus* sp.	Epiretinal membrane	20/400
12	7/M	Bow and arrow	Open globe zone 1 injury	PL+ PR accurate	7	Sterile	None	20/60 (6 months)

[a] Duration between trauma and presentation to us

Complications

Rhegmatogenous retinal detachment involving the macula was the commonest complication. Four (33.33%) of 12 patients in group 1 developed a rhegmatogenous retinal detachment in the immediate postoperative period, with one of the patients having concomitant refilling of exudates. All the four patients underwent surgery with silicone oil endotamponade. Three (75%) of this subset of patients with secondary silicone oil endotamponade developed redetachment with inoperable proliferative vitreoretinopathy changes after silicone oil removal.

Intraoperative breaks were found in 50% of patients in group 2 (6/12). These patients underwent argon laser photocoagulation intraoperatively and/or postoperatively. None of these patients developed a rhegmatogenous detachment during follow-up. Silicone oil was removed in all these patients 6 weeks postoperatively and the retina remained attached until the last follow-up (minimum of 3 months) in all the patients. Tractional retinal detachment involving the macula was found in 25% of patients in group 1 (3/12). Inferior tractional retinal detachment without macular involvement occurred in 16.66% of group 2 patients (2/12).

Discussion

Endophthalmitis is a devastating complication of penetrating ocular trauma. It is an important cause of visual failure following open globe injuries and may complicate apparently benign injuries such as small, self-sealing corneal perforations without associated intraocular damage.

The time between injury and presentation has been described to have a significant bearing on the final visual outcome in previous studies on vitrectomy for post-traumatic endophthalmitis [2]. It is postulated that patients with infection due to more virulent and/or a greater load of microorganisms tend to present earlier with a poorer visual outcome. Brinton et al. [2] reported that in their study group, a mean time between injury and presentation of 8 days was found in patients with successful outcome and 3 days in those with poor outcome. In our study, useful visual outcome (≥20/400) was seen in none of the four patients in group 1 who presented within 3 days. However, 50% of group 2 patients (3/6) had a useful final visual outcome (Fisher's exact test: upper tail P=0.16, lower tail P=0.03). Thus, while poor outcomes were noted in both the groups, useful visual outcomes were seen following surgery only in group 2 patients. It is possible that complete vitrectomy helps in preventing the inflammatory chorioretinal damage by more exten-

sive clearance of the microbiological load from within the vitreous cavity. This may well have contributed to a better visual outcome in patients with a more severe infection.

Microorganisms were isolated in 62.5% of all the cases (15/24). This is comparable with the results of earlier studies [7]. The predominance of *Staphylococcus* and absence of *Bacillus* species in the present study is probably due to the exclusion of cases in which the cornea was not clear enough to do a vitrectomy. Similar findings have been reported by Bartz-Schmidt et al. [1], who had only one case of *Bacillus* species infection in their series of 13 patients who underwent vitrectomy for post-traumatic endophthalmitis. Endophthalmitis due to coagulase-negative *Staphylococcus* in general is considered to have a good prognosis. However, this has not been uniformly so. Duch-Samper et al. [4] reported a poor outcome in 5 out of 17 cases of post-traumatic endophthalmitis due to coagulase-negative *Staphylococcus*. In our study, patients with infection with virulent microorganisms tended to have a better visual outcome in group 2. However, the number of culture-positive cases with more and less virulent microorganisms in each group was too small for statistical analysis.

Conventional vitrectomy has a poor outcome in cases of post-traumatic endophthalmitis [8]. Our study seems to substantiate this, with only 41.66% of patients (5/12) undergoing conventional vitrectomy achieving a useful visual outcome (≥20/400) and only one patient achieving a final visual acuity ≥20/200. Reaccumulation of vitreous exudates, formation of cyclitic membranes and occurrence of rhegmatogenous and tractional retinal detachment often complicate conventional vitrectomy and result in a poor final visual outcome in this group of patients [1]. It is well known that postoperative occurrence of retinal detachment following conventional vitrectomy for endophthalmitis has a poor prognosis [11]. Four (33.33%) of the 12 patients in group 1 developed retinal detachment following vitrectomy. These patients underwent resurgery with silicone oil endotamponade. However, severe proliferative vitreoretinopathy developed in these patients following resurgery. The retina redetached in 75% of these patients (3/4) following silicone oil removal. Similar difficulties in achieving anatomical success in patients with retinal detachment following vitrectomy for endophthalmitis were reported by Nelsen et al. [11]. In group 2, 75% of patients (9/12) had a visual outcome better than 20/400 (P=0.07) and 58.3% (7/12) achieved a visual acuity greater than 20/200 (P=0.02). Complete vitrectomy ensures the complete removal of vitreous membranes and prevents fibrous proliferation and tractional detachment. Clearance of anteriorly placed exudates prevents the formation of a cyclitic membrane and ocular hypotony. Due to the extensive vitreous base clearance, a high rate of intraoperative breaks (50%) was noted in these patients. To tamponade such breaks silicone oil was used. The occurrence of peripheral retinal breaks was not found to influence the outcome following vitrectomy with primary silicone oil endotamponade. There has previously been a reluctance to use silicone oil as a tamponading agent in vitrectomy for endophthalmitis. This is due to fear of loculation of infection behind the silicone oil bubble [3]. There are occasional reports in the literature of the use of silicone oil as a primary tamponading agent following vitrectomy for traumatic endophthalmitis. Bartz-Schmidt et al.1996 [1] have reported the use of primary silicone oil endotamponade following vitrectomy for endophthalmitis.

Complete vitrectomy with vitreous base excision not only helped in complete removal of the microbiologic load from within the vitreous cavity, improving the possibility of successful eradication of the infection, but also prevented the formation of peripheral vitreous tractional bands and cyclitic membranes. We observed that the control of infection was better in these patients with better media clarity postoperatively. Probably this is so because the vitreous cavity, comprising 80% of the intraocular space within the eyeball, is filled with silicone oil, which is optically clear and impenetrable to any intraocular infection. Furthermore, it is possible that silicone oil plays an adjunctive role by compartmentalization of the eye into an anterior compartment (i.e., up to the anterior chamber) and a posterior compartment with an attenuated vitreous phase (between the retinal surface and the posterior surface of the silicone oil bubble). It is well known that topical antibiotics can reach up to the anterior chamber in therapeutic concentrations [9, 12]. Thus effective management of the anterior segment inflammation and infection is possible with topical antibiotics and steroids. The attenuated vitreous phase lying adjacent to the inflamed retinal surface, which forms the posterior compartment, is also likely to achieve high antibiotic levels following intravenous administration due to the absence of diffusion into the vitreous cavity. Support for this hypothesis has come in a study carried out by us in which it was shown that antibiotic levels in the retro-silicone oil space after oral administration of ciprofloxacin in two 750-mg doses exceeds the MIC_{90} for most bacterial species [16].

Intravitreal antibiotics were not administered after vitrectomy in any of the patients. It was felt that an intravitreal antibiotic injection was not desirable in a silicone-filled eye since it was not possible to quantify the intravitreal antibiotic dose requirement in this situation and the patient might be subjected to the risk of inadvertent retinal toxicity. Furthermore, since the vitreous cavity is filled with silicone oil, which is impenetrable to bacteria, there is no question of reinfection of this space. Silicone oil is preferable to intraocular gas tamponade, since gas could permit growth of aerobic organisms. The added advantage of silicone oil endotamponade is the presence of an optically clear medium. This permits early visual

rehabilitation of the patient and necessitates laser photocoagulation of any missed breaks in the postoperative period. Silicone oil also prevents the occurrence of severe hypotony in the early postoperative period (when the risk of ciliary body shock is high).

Our results suggest that the final visual outcome is better following complete vitrectomy with silicone oil endotamponade than after conventional vitrectomy in patients with post-traumatic endophthalmitis. These outcomes could be a consequence of the complete vitrectomy carried out in these patients or may reflect the combined positive effects of a complete vitrectomy along with compartmentalization of eyes by silicone oil in these patients. There is a need for a randomized controlled study to evaluate the role of silicone oil endotamponade on the visual outcomes in eyes undergoing complete vitrectomy for post-traumatic endophthalmitis.

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