Outcomes of Evisceration or Enucleation by Resident Trainees in Patients with Endophthalmitis or Panophthalmitis

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Research Article

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Abstract

Background

To evaluate the outcomes of evisceration or enucleation with primary implantation performed by ophthalmology resident trainees in patients with endophthalmitis or panophthalmitis.

Methods

In this retrospective analysis, the clinical records of all patients diagnosed with endophthalmitis or panophthalmitis who underwent enucleation or evisceration with primary implantation over a 13-year period were reviewed. The predictive factors related to implant exposure or extrusion were identified using multivariate analysis.

Results

Sixty-six patients, with a median age of 46.8 years, were enrolled. Thirty-six (55%) out of 66 patients were diagnosed with panophthalmitis. The most common causes of endophthalmitis or panophthalmitis were trauma (13 patients) and corneal ulcer perforation (10 patients). Enucleation was performed in 53 patients (80%). Four patients (6%) had implant exposure, and 4 patients (6%) had implant extrusion. Multivariate analysis demonstrated that *Pseudomonas aeruginosa* infection (P = 0.021, adjusted odd ratio [aOR] 33.75) and not receiving intravitreal antimicrobial drugs before the eye removal procedure (P = 0.02, aOR = 30.11) were associated with implant exposure or extrusion. Patients with panophthalmitis who underwent evisceration had a higher rate of implant exposure or extrusion than those who underwent enucleation (P = 0.031, aOR 38.38). Other complications included socket discharge in 14 patients, lower lid laxity in 5 patients who underwent the lateral tarsal strip procedure, and wound dehiscence in 3 patients. At the last visit, 65 patients had successful prosthesis fitting.

Conclusion

This study suggests that evisceration or enucleation with primary implant placement in patients with recalcitrant endophthalmitis or panophthalmitis can be performed by resident trainees with acceptable surgical outcomes and a low rate of serious complications.

Background

Endophthalmitis is defined as ocular inflammation that is attributable to an infection of the intraocular cavity. The causes of endophthalmitis consist of endogenous and exogenous causes, such as direct trauma, intraocular surgery and adjacent infection [1]. If infection is uncontrolled, inflammation can progress to involve the sclera, which is called panophthalmitis [2].

The management of fulminant endophthalmitis or panophthalmitis, which is refractory to other medical treatments, is evisceration or enucleation to eradicate the infection. However, surgical choices, timing, and types of implant placement remain controversial [3–5]. Over the past decade, evisceration with primary implants has been frequently performed with acceptable outcomes, including a low rate of implant extrusion or exposure and postoperative infections [6–9].

In Songklanagarind Hospital, a residency-training tertiary hospital in southern Thailand, many patients with intractable endophthalmitis and panophthalmitis required eye removal surgery, which had to be performed by resident trainees. These operations included evisceration and enucleation in eyes with large areas of necrotic or melting scleral tissue, with primary implant placement being preferred.

The purpose of this study was to evaluate the outcomes of evisceration or enucleation with primary implants performed by resident trainees in patients with recalcitrant endophthalmitis or panophthalmitis.

Methods

Study Population

The medical records of all patients with endophthalmitis or panophthalmitis who underwent enucleation or evisceration with primary implants by resident trainees at Songklanagarind Hospital between 1 January 2006 and 31 December 2018 were enrolled. Patients who had a follow-up period of less than 6 months were excluded.

Data Collection

Patient characteristics, causes, and causative organisms of endophthalmitis or panophthalmitis, as well as surgical procedures and techniques, were documented. In addition, postoperative outcomes, including postoperative complications, prosthesis fitting results, and adjunctive surgical procedures, were also collected.

Main Outcome Measures

The primary outcome measures were the rates of implant exposure or extrusion and the predictive factors related to implant exposure or extrusion using multivariate analysis. The secondary outcome measure was the percentage of patients who achieved eye prosthesis fitting.

Statistical Analysis

Data were collected in EpiData software version 3.1 (The EpiData Association, Odense M, Denmark). Analysis was performed using SPSS software (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics, including means ± standard deviation (SD), medians, percentages and frequencies, were demonstrated for the variable of interest. Categorical variables were compared by Pearson's chi-square test and Fisher's exact test. Continuous variables were compared by the Mann-Whitney test. Factors associated with

surgical outcome were identified using multivariate analysis, which used the logistic regression model based on stepwise regression models. A *P* value of < 0.05 was considered statistically significant.

Results

Patient characteristics

From a total of 66 patients with a median age of 46.8 years (mean: 44.3, range; 4–84 years), 43 patients were males. The follow-up period ranged from 7–139 months (mean: 56 months). Thirty-six (55%) out of 66 patients were diagnosed with panophthalmitis. Thirty-six (55%) out of 66 patients had traumatic causes, 13 patients (20%) had previous perforated corneal ulcers, 10 patients (15%) experienced endogenous infection, and 7 patients (11%) developed postoperative endophthalmitis or panophthalmitis (6 from cataract surgery and 1 from trabeculectomy with mitomycin C).

Surgical Procedures and Microorganisms

Enucleation was performed in 53 patients (80%), while evisceration was performed in the remaining patients. The duration before enucleation or evisceration ranged from 1 to 54 days (mean: 9 days). The vitreous and/or aqueous humor were collected and sent for culture and sensitivity in 48 patients. The results were positive for any organisms in 39 patients (81%); 14 patients had mixed organisms. The most common pathogen was *Bacillus species*, followed by *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, *ß-streptococcus group B*, and *Enterobacter cloacae*, which were positive in 14, 7, 6, 3 and 3 patients, respectively. Fungal infection was found in 4 patients. Antimicrobial drugs were used through various routes, including topical, intravitreal, oral, and intravenous routes.

Sixty-five implants (98%) used in these patients were of a nonporous type, including acrylic, glass, and silicone spheres in 59, 4, and 1 patient, respectively. Only 2 patients received a porous type (1 bovine hydroxyapatite and 1 porous polyethylene implant). Most implants were 20 mm in size; these were placed in 44 patients (60%), while 18-mm, 16-mm, and 14-mm implants were placed in 15, 6 and 1 patients, respectively. The mean operative time of enucleation was 215 minutes (range: 130–335 minutes) and that of evisceration was 194 minutes (range: 155–239 minutes)

Complications

Implant exposure was found in 4 patients at days 19, 23, 39 and 72 after surgery. All of them required surgical interventions to remove implants and dermis-fat grafts. Implant extrusion was noted in 4 patients (6%) at 9 months, 11 months, 5 years, and 10 years postoperatively, and 2 patients received dermis-fat grafts. All patients had implant exposure or extrusion, and 5 patients were diagnosed with panophthalmitis. Wound dehiscence developed in 3 patients at 14, 32, and 45 days postoperatively, and surgical wound repair had to be performed. Infected socket occurred in 3 out of 66 patients, resulting in implant exposure or extrusion. In addition, other complications consisted of socket discharge in 14 patients (21%), lower lid laxity in 5 patients (8%) who underwent the lateral tarsal strip procedure, late orbital cellulitis in 2 patients (3%) and infected tarsorrhaphy in 1 patient (1%).

Univariate analysis revealed that the predictors of implant exposure or extrusion are illustrated in Table 1. Multivariate analysis is shown in Table 2. The factors related to implant exposure or extrusion were *Pseudomonas aeruginosa* infection ($P = 0.021$, aOR 33.75) and not receiving intravitreal antimicrobial drugs before the eye removal procedure ($P = 0.022$, aOR = 30.11).

Table 1
Univariate analysis for factors related to implant exposure or extrusion

Variables	Implant exposure or extrusion		*P Value*	Odd ratio (95% CI)	*P Value*
	No	Yes			
	n = 58 (%)	n = 8 (%)			
Age (years)	44.7 (21.2)	41.6 (19.2)	0.421		
Mean (SD)	48.1 (3.9, 84.1)	34.9 (22.8, 83.8)			
Median (min, max)					
Age (years)	30 (51.7)	2 (25.0)	0.260	1	0.173
> 46.8	28 (48.3)	6 (75.0)		3.21 (0.60, 17.27)	
≤ 46 .8					
Gender	38 (65.5)	5 (62.5)	1.000	1	0.867
Male	20 (34.5)	3 (37.5)		1.14 (0.25, 5.27)	
Female					
Diagnosis of affected eye	27 (46.6)	3 (37.5)	0.719	1	0.631
Endophthalmitis	31 (53.4)	5 (62.5)		1.45 (0.32, 6.65)	
Panophthalmitis					
Cause of endophthalmitis or panophthalmitis	32 (55.2)	4 (50.0)	0.971	1	0.920
Trauma	9 (15.5)	1 (12.5)		0.89 (0.09, 8.98)	0.811
Endogenous	6 (10.3)	1 (12.5)		1.33 (0.13, 14.10)	0.688
Postoperative cause	11 (18.9)	2 (25.0)		1.45 (0.23, 9.07)	
Others					
Cause of endophthalmitis or panophthalmitis	32 (55.2)	4 (50.0)	1.000	1	0.783
Trauma	26 (44.8)	4 (50.0)		1.23 (0.28, 5.40)	
Non-trauma					

CI Confident interval, *SD* Standard deviation, HM Hand motion

*Statistically significant

Variables	Implant exposure or extrusion		*P Value*	Odd ratio (95% CI)	*P Value*
	No	Yes			
	n = 58 (%)	n = 8 (%)			
Preoperative visual acuity	1 (1.8)	0 (0.0)		1	-
Better than HM	56 (98.2)	8 (100.0)		1 (omitted)	
HM or worse					
Duration before eye removal procedure (days)	30 (51.7)	6 (75.0)	0.275	1	0.230
≤ 6	35 (60.3)	2 (25.0)		0.36 (0.07, 1.92)	
> 6					
Types of operation	49 (84.5)	4 (50.0)	0.042*	1	0.033*
Enucleation	9 (15.5)	4 (50.0)		5.44 (1.15, 25.85)	
Evisceration					
Diagnosis of affected eye & eye removal procedure	30 (51.7)	3 (37.5)	0.017*	1	0.590
Panophthalmitis & enucleation	19 (32.7)	1 (12.5)		0.53 (0.06, 5.44)	0.358
Endophthalmitis & enucleation	8 (13.8)	2 (25.0)		2.5 (0.36, 17.60)	0.028*
Endophthalmitis & cvisceration	1 (1.7)	2 (25.0)		20.0 (1.37, 291.07)	
Panophthalmitis & evisceration					
Bacillus species	45 (77.6)	7 (87.5)	1.000	1	0.527
No	13 (22.4)	1(12.5)		0.49 (0.06, 4.39)	
Yes					
Pseudomonas aeruginosa	55 (94.8)	6 (75.0)	0.107	1	0.073
No	3 (5.2)	2 (25.0)		6.11 (0.85, 44.16)	
Yes					
Underlying diseases	35 (60.3)	4 (50.0)	0.707	1	0.579
No	23 (39.7)	4 (50.0)		1.52 (0.35, 6.70)	
Yes					

CI Confident interval, *SD* Standard deviation, HM Hand motion

*Statistically significant

Variables	Implant exposure or extrusion		*P Value*	Odd ratio (95% CI)	*P Value*
	No	Yes			
	n = 58 (%)	n = 8 (%)			
White blood cell count (cells/microliter)	11 (19.0)	1 (12.5)	1.000	1	0.659
≤ 9,500	47 (81.0)	7 (87.5)		1.64 (0.18, 14.72)	
> 9,500					
Intravitreal antimicrobial drugs	40 (69)	2 (25.0)	0.023*	1	0.028*
Yes	18 (31.0)	6 (75.0)		6.67 (1.22, 36.28)	
No					
Intravenous antimicrobial drugs	2 (3.5)	1 (12.5)	0.326	1	0.282
No	56 (96.5)	7 (87.5)		0.25 (0.02, 3.13)	
Yes					
Prior ocular surgery	14 (24.1)	4 (50.0)	0.199	1	0.137
No	44 (75.9)	4 (50.0)		0.32 (0.07, 1.44)	
Yes					
Type of orbital implant	57 (98.3)	8 (100.0)	1.000	1	-
Nonporous	1 (1.7)	0 (0.0)		1 (omitted)	
Porous					
Implant size (mm)	21 (36.2)	1 (12.5)	0.252	1	0.211
14–18	37 (63.8)	7 (87.5)		3.97 (0.46, 35.54)	
20					

CI Confident interval, *SD* Standard deviation, HM Hand motion

*Statistically significant

Table 2
Multivariate analysis for factors related to implant exposure or extrusion

Variables	Adjusted Odd ratio (95% CI)	*P Value*
Age (years)	1	0.107
≥ 46.8	7.65 (0.64, 90.88)	
< 46.8		
Pseudomonas aeruginosa	1	0.021*
No	33.75 (1.72, 663.73)	
Yes		
Diagnosis of affected eye & eye removal procedure	1	0.031*
Panophthalmitis & enucleation	38.38 (1.39, 1059.24)	
Panophthalmitis & evisceration		
Intravitreal antimicrobial drugs	1	0.022*
Yes	30.11 (1.64, 552.25)	
No		
CI Confident interval		
*Statistically significant		

Surgical Outcomes

At the last follow-up, 65 out of 66 patients (98%) had successful prosthesis fitting. Only one patient who developed early postoperative endophthalmitis from *Pseudomonas aeruginosa* after complicated cataract surgery could not retain the eye prosthesis because of a contracted socket after adjunctive surgery for implant exposure and requested a conformer instead.

Discussion

This study revealed that surgical outcomes of evisceration or enucleation with primary implant placement by resident trainees in patients with fulminant endophthalmitis or panophthalmitis were satisfactory, with a low rate of implant exposure or extrusion and residual infection and a high rate of successful prosthesis fitting. In patients with panophthalmitis, evisceration was significantly associated with a higher frequency of implant exposure or extrusion than enucleation. The predictive factors affecting implant exposure or extrusion were *Pseudomonas aeruginosa* infection and not receiving intravitreal antimicrobial drugs before the eye removal procedure.

The management of medically refractory endophthalmitis or panophthalmitis is evisceration or enucleation to eradicate the infection. However, surgical choices, timing and types of implant placement remain controversial. A discussion among international experts was performed in 2005; however, there was no consensus [3].

The advantages of evisceration are less operative time in addition to less disruption of orbital tissues [10] but may increase the risk of sympathetic ophthalmia [11, 12]. Evisceration is also thought to have higher extrusion rates due to the residual nidus in the sclera. Wills Eye Hospital found that the implant extrusion rate in eviscerated sockets was 22%, compared with 6% after enucleation [13]. Primary orbital implantation at the time of evisceration or enucleation, in cases of endophthalmitis, was previously believed to have a higher risk of implant extrusion. In 1988, Shore et al [14] performed delayed wound closure in 3 patients who had successful outcomes, but 1 patient underwent primary closure, which developed wound dehiscence and implant extrusion at 6 weeks postoperatively. However, there are many advantages of primary implant placement, including decreasing both the risks and expenses of two separate surgeries and early initiation of rehabilitation [4]. Primary orbital implantation has been performed recently in cases of endophthalmitis or panophthalmitis, with satisfactory outcomes and an acceptable rate of complications [6–9]. A retrospective nonrandomized comparative interventional case series was conducted by Tripathy et al in 2015 [15] to compare the outcome of evisceration with primary orbital implants in blind eyes, with and without fulminant infection, and there was no statistically significant difference in major complications between the two groups.

In 2017, Fu et al [5] conducted a survey among American Society of Ophthalmic Plastic and Reconstructive Surgery (ASOPRS) surgeons to assess practice patterns in the treatment of endophthalmitis and found that 72% preferred evisceration, while 28% preferred enucleation. If infection extended to orbital tissues, 59% preferred enucleation versus 27% who preferred evisceration. Primary implant placement was performed by 65% in enucleation and 58% in evisceration.

In 2007, Tawfik et al [9] studied the outcomes of evisceration with primary implant placement in 52 endophthalmitis patients and 15 panophthalmitis patients; implant extrusion occurred in 2 patients (3%), and successful prosthesis fitting was achieved by 62 patients (92%). In our study, implant extrusion was found in 2 patients with endophthalmitis and 2 patients with panophthalmitis. The extrusion rate was 6%, slightly more than that in a previous study [9]. This might be due to the higher proportion of panophthalmitis patients, which consisted of 55% with panophthalmitis in our study versus 22% with panophthalmitis in a previous study [9]. Additionally, we recruited only patients who underwent surgery by resident trainees. Thus, these comparable outcomes were satisfactory.

From this study, the rate of implant exposure or extrusion in patients with panophthalmitis was 67% in the evisceration group compared with 9% in the enucleation group. Hence, enucleation is recommended in cases of panophthalmitis. Diagnosis as endophthalmitis or panophthalmitis was not associated with surgical outcomes in our study, which might be due to a tendency to perform enucleation in patients with panophthalmitis.

Porous implant placement has been discussed in terms of concerns about the potential seeding of infection within a vascularized implant and subsequent extrusion. In this study, bovine hydroxyapatite and porous polyethylene were used as the primary implants in 1 patient each, and the result of prosthesis fitting of 2 patients who had porous implant placement was successful, without major complications. In accordance with the study by Park et al [16], they assessed the results of evisceration with primary porous implant placement in 29 eyes with endophthalmitis, and only 2 eyes developed implant exposure or infection.

In cases of ocular infection by virulent organisms, such as *Bacillus species* and *Pseudomonas aeruginosa*, scleral abscess, scleral melting, and perforation frequently develop, and these have a poor response to topical and systemic antibiotics [17, 18]. Previous studies suggested enucleation in these cases because the integrity of the sclera might not be strong enough to support an orbital implant, especially in diabetes mellitus and immunocompromised hosts [6, 7, 19]. Accordingly, this study demonstrated that implant exposure or extrusion more commonly developed in eyes infected by *Pseudomonas aeruginosa* than in eyes infected by other organisms. Therefore, the preoperative diagnosis was *Pseudomonas aeruginosa* infection, and secondary implant placement may need to be considered.

Various routes of antibiotic administration are used in endophthalmitis, and intravitreal injection is the main treatment because drugs are directly delivered into the infected part of the eye [1, 20]. In contrast with systemic medication, penetration into the ocular posterior segment is limited by the blood-retinal barrier [21, 22]. This study also showed the benefit of intravitreal antibiotics as lower rates of implant exposure or extrusion after enucleation or evisceration in cases of endophthalmitis or panophthalmitis. It is feasible that intravitreal injection can control some part of organism growth and reduce scleral invasion or orbital tissue infection.

Bee et al [23] reported that preoperative white blood cell counts of more than 9500 cells/microliter were associated with a higher risk of implant exposure, whereas in our study, implant exposure or extrusion was not significantly different in patients with either high or normal white blood cell counts.

The strengths of this study consisted of the following. First, long-term surgical outcomes were able to be assessed due to the long follow-up period (mean: almost 5 years), which was long enough to demonstrate late postoperative complications and the retention of implants. Second, this was the first study to demonstrate the results of evisceration or enucleation performed by resident trainees in patients with fulminant endophthalmitis or panophthalmitis. However, there were some limitations in this study, including the lack of evaluation of patient satisfaction after prosthesis fitting, a high loss of follow-up rate and incomplete data, due to this being a retrospective study. This information of our study encouraged the surgeons to perform enucleation in patients with panophthalmitis to prevent implant exposure or extrusion. Additionally, the resident trainees had the competency to perform the eye removal procedure in severe eye infection. However, the comparison of surgical results and complications of the eye removal procedure in this disease in ophthalmology consultants and resident trainees must be

evaluated prospectively. The assessment of surgical outcome in terms of cosmesis and satisfaction of prostheses is suggested.

In conclusion, evisceration or enucleation with primary implant placement can be performed by resident trainees in patients with endophthalmitis or panophthalmitis with an acceptable rate of implant exposure or extrusion. *Pseudomonas aeruginosa* infection and not receiving intravitreal injection before eye removal may be risk factors for postoperative implant exposure or extrusion; secondary implant placement may be considered in these situations. In patients with panophthalmitis, enucleation was preferred due to the lower rate of implant exposure or extrusion.

Abbreviations

aOR: adjusted odds ratio; SD: standard deviation; CI: Confident interval; HM: Hand motion

Declarations

Ethics approval and consent to participate

In this study was approved by the Institutional Review Board of Songklanagarind Hospital, Faculty of Medicine, Prince of Songkla University, and adhered to the guidelines of the Declaration of Helsinki. Informed consent was waived by the Institutional Review Board of Songklanagarind Hospital, Faculty of Medicine, Prince of Songkla University that approved the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Study concept and design: W.T. and O.A.; Acquisition of data: W.T. and O.A.; Analysis and interpretation of data: W.T. and O.A.; Drafting the manuscript: W.T. and O.A.; Revising the manuscript critically for

important intellectual content: W.T. and O.A.; Study supervision: OA. All authors had full access to all of the data in this study and take responsibility for the integrity of the data and the accuracy of the data analysis. All authors read and approved the final manuscript.

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