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Evaluation of Prevalence and Risk Factors of Post-Craniotomy Meningitis in Non-Emergency Patients

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Abstract

Introduction: Post-neurosurgical meningitis can lead to severe complications and high mortality rates. The incidence varies in different conditions. The aim of this retrospective study is to determine the risk factors, occurrence, and microbiological spectrum of meningitis in patients with non-emergency craniotomy.

Methods: The patients who underwent non-emergency craniotomy at Poursina Hospital from September 23, 2016 to September 22, 2017 were selected. Exclusion criteria included traumatic surgery, only burr holing, only stereotactic surgery, and only trans-sphenoidal surgery. The medical records of each patient were reviewed, information on risk factors was extracted, and then the patients were evaluated for meningitis.

Results: Out of 140 patients in the study, 7 cases were identified as meningitides, with an occurrence rate of 5%. The risk of meningitis increased with the presence of preoperative hydrocephalus (p=0.001), the use of an EVD (external ventricular drain) (P=0.001), perioperative antibiotics (p=0.001) and a GCS (Glasgow Coma Scale) <12 (P=0.001). Three out of 7 patients with meningitis had positive cultures. The only isolated microorganism was *Acinetobacter* spp.

Conclusions: Even after non-emergency craniotomy, meningitis can be a major source of morbidity and mortality. Low levels of consciousness (GCS<12), perioperative antibiotics, the use of an EVD, and hydrocephalus carry significantly high risks of infection. Therefore, early identification of the risk factors will help physicians possibly prevent meningitis after non-emergency craniotomy in their patients.

Keywords: Craniotomy; Meningitis; Glasgow Comma Scale, EVD, Hydrocephalus, Prevalence, Risk factors

Introduction

Craniotomy is a surgical procedure in which a part of the skull is removed to reveal the meninges and brain tissue. According to previous studies, the occurrence of meningitis increases after craniotomy, but this rate varies due to different risk factors (1, 2, 3, 13, 15, 26, 27,). Meningitis increases the morbidity and mortality of patients (1, 2, 3). Therefore, identifying risk factors and finding solutions to prevent and control them can reduce the incidence of PCM (post-craniotomy meningitis), and thus decrease its resulting complications. Identifying the post-craniotomy meningitis (PCM) microorganisms involved and the risk factors including diabetes, a peri-craniotomy EVD (external ventricular drain), duration of surgery, and pre-operative corticosteroid use can help physicians accurately control them and ultimately reduce the occurrence of meningitis and its resulting complications. The aim of the present study is to evaluate the clinical parameters that lead to meningitis in patients who have underwent non-emergency craniotomy in the neurosurgical operation rooms of Poursina Hospital in Rasht, Iran.

Materials and Methods

Subsequent to reviewing the medical records of patients operated on by the neurosurgery department of Poursina Hospital of the Guilan University of Medical Sciences in Rasht from September 23, 2016 to September 22, 2017, the patient information for this study was collected.

The data collected includes the duration of hospitalization, the presence of underlying diseases (heart failure, chronic obstructive pulmonary disease, diabetes, chronic renal failure, cirrhosis, tissue disease and cancer), Glasgow Coma Scale (GCS), previous use of corticosteroid, preoperative antibiotic use, duration of surgery, indications for the surgery (brain tumor, trauma, brain cerebrovascular disease, and hydrocephalus among others), type of anesthesia (general, epidural, and local), synchronous infection (lower respiratory tract infection, urinary tract infection, gastrointestinal, blood, and wound infections), an external ventricular drain (EVD), time of death, post-surgical complications, microorganisms involved in meningitis, and other noteworthy information.

All of these patients underwent a non-emergency craniotomy and survived at least 7 days after surgery. Exclusion criteria included traumatic surgery, burr hole surgery, stereotactic surgery, and trans-sphenoidal surgery.

Due to the retrospective nature of the study, the data was recorded without obtaining any consent forms, so it was presented anonymously.

The data was analyzed using SPSS software, Version 23.0. Categorical variables were compared by using a chi-square test analysis. Odds ratio (OR) was also calculated with a 95% confidence interval (95% CI).

Results

In the present study, of 986 non-emergency patients, 140 cases (14.2%) underwent craniotomy. After craniotomy, none of the patients died within 7 days, and 7 patients (5%) suffered from meningitis. Table 1 illustrates parameters affecting post-craniotomy meningitis in non-emergency (PCM) patients. The prevalence of meningitis after non-emergency craniotomy for those younger than 50 years old was higher than that of those who were older than 50 years (5.74% vs. 3.77%). 54% of the patients were male, and 4 of 7 patients with meningitis were male (57%). 15 patients (10.7%) had a GCS <12, and 4 of them (26.6%) suffered from meningitis (p= 0.001). 8 patients (5.7 %) had an EVD before craniotomy, and 5 of 8 cases suffered from PCM.

Eleven patients (7.8%) had hydrocephalus before the operation, and 5 of those patients (45.5%) suffered from PCM (p= 0.001). For all patients, prophylactic antibiotics were injected 1 hour before the craniotomy; however, 5% (7 cases) suffered from meningitis. The operation lasted longer than 4.5 hours in 73 patients (52.1%); 6 cases of them (8.2%) suffered from PCM (P = 0.68). 1 of 10 patients with the use of corticosteroids suffered from PCM. 9 patients had diabetes, but none of them suffered from meningitis. 6 of 81 patients with brain tumors (7.4%) and 1 of 29 patients with aneurysms (3.4%) suffered from PCM. Three patients died from the 8th to 30th day after surgery, and 2 of them had meningitis. None of the patients with cranioplasty, or craniosynostosis surgery, and Chiari malformation surgery suffered from PCM. The unilateral analysis of the risk factors for PCM and the variables involved them are presented in Table 1. Factors with a P value less than 0.05 in a uniform analysis include: a GCS <12, preoperative EVD,

perioperative antibiotics, and preoperative hydrocephalus. There were 81 patients with brain tumors of which patients (6.2%) experienced meningitis. One (3.4%) out of the 29 patients with a brain vascular aneurysm had meningitis. There were 23 undergoing cranioplasty of which 1 (4.3%) experienced meningitis. There were 4 patients with Craniosynostosis and 1 with Chiari malformation, but none of them had meningitis.

Seven CSF samples were sent for detection of pathogens in our study. Positive cultures were only observed in 3 patients (42.9%). All three organisms were *Acinetobacter* spp (100%).

Discussion

The occurrence of PCM has been reported to be approximately 0.3%-8.9% in the literature (3, 5, 6, 7, 9, 10, 11,12,13,14, 15), but 8.6% in the Chen et al. study (1). In our study, the prevalence of meningitis was 5%. The lower PCM level may be due to the non-emergency aspect of our surgeries.

In the literature, gram-negative rods and *Enterobacteriaceae* have had an important role in the incidence of PCM (1, 3, 5, 6, 7, 11, 12, 13, 14, 16, 17, 18, 19). The rates of positive cultures in the studies of Chen (1) and Kourbeti (2) were 10.4 %, and 100%, respectively. The most common microorganisms in the Chen (1) and Kourbeti (2) studies were *Acinetobacter* spp, with rates accounting for 40% and 45%, respectively. Seven CSF samples were sent for detection of pathogens in our study. Positive cultures were only observed in 3 patients (42.9%). All three microorganisms were *Acinetobacter* spp (100%).

Diabetic patients were at a higher risk of developing meningitis than those without diabetes. The occurrence of PCM in diabetic patients was 18.5% in Chen's study and 4.1% in Kourbe's study, but it was 0% in our study. The lack of meningitis in our study may be due to the precise control of blood glucose levels prior to our non-emergency craniotomy or the absence of patients who required emergency attention. Therefore, we suggest further studies to prove these predictions.

Of the 131 patients in our study who received prophylactic antibiotics an hour before surgery, 3% of them (4 patients) suffered from meningitis. In the Chen et al. study (1), 10.8% of the patients suffered from meningitis. Barker's study (20) documents the benefits of antibiotics to prevent PCM. In our study, a significant relationship between the preoperative antibiotics and the prevention of PCM was found (P= 0.001).

The rate of the effect of steroids on the occurrence of PCM varied throughout the mentioned studies (21, 25, 27). In the Chen (1) and Kourbeti (2) studies, a 5% and 7.10% rate was found, and the relationship was statistically significant in the Kourbeti study (2). Among our patients with a history of corticosteroid use, no significant relationship was found (P= 0.45).

In our study, 8.2% of patients with a craniotomy lasting longer than 4.5 hours had meningitis (6 off 7 patients with PCM). Despite this observation, there was no significant relationship between craniotomy duration and meningitis (P=alue = 0.68), as in previous studies (1, 2).

According to previous studies, craniotomy in patients with EVD increases the occurrence of meningitis (1, 2, 4, 6, 8, 9, 11,13, 18,21,22, 23, 24, 26, 27). In our study, 57% of the patients who

had EVD (4 cases) suffered from PCM. To prevent PCM, we recommend that an EVD is avoided in unnecessary conditions, and if it is present, it should be removed as soon as possible.

Eleven patients (7.8%) had hydrocephalus prior to craniotomy, and 5 patients (45.4%) suffered from PCM, resulting in a significant relationship between hydrocephalus prior to craniotomy and PCM (P= 0.001). Therefore, it is recommended that special attention be paid to this significant relationship in future studies.

In our study, the greatest limitations were the fact that it was retrospective and dependent on the accuracy of the data in the clinical charts.

Conclusion

Unlike many studies, this study was conducted on non-emergency patients. We determined the prevalence, risk factors, and microbiology that can lead to PCM in our patients. We were able to confirm the importance of perioperative hydrocephalus, perioperative ventricular drains, perioperative antibiotics, and a GCS <12 in the development of PCM. The perioperative steroids, diabetes mellitus, duration of surgery, gender, and age were not significant risk factors for PCM. From the retrospective surveillance of infections in non-emergency patients, the offending pathogen was identified as *Acinetobacter* spp, which highlights another important aspect of this study. All in all, we believe that this finding will help physicians select the best empirical antibiotics for these patients.

Conflict of interest

The authors declare that there is no conflict of interest with respect to the present paper.

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Table 1. Parameters affecting post-craniotomy meningitis in non-emergency patients

Variable		**No. at risk**	**No. of meningitis**	**Rate of infection (%)**	**OR (%95 CI)**	**P value**
Age	Less than 50 years	53	2	3.77	0.64 (0.12-3.43)	0.60
	greater than 50 years	87	5	5.74		
Sex	Male	76	4	5.36	1.13 (0.24-5.24)	0.87
	Female	64	3	4.68		
GCS	<12	125	3	2.4	0.68 (0.01-0.34)	0.001
	≥12	15	4	26.6		
Preoperative EVD	No	132	2	1.5	108.33 (14.66-800.29)	0.001
	Yes	8	5	62		
Preoperative use of	No	130	6	4.6	2.29 (0.24-21.1)	0.45
	Yes	10	1	1		

corticoids						
Use of perioperative antibiotics	No	9	3	33	15.87 (2.88-87.44)	0.001
	Yes	131	4	3.05		
Surgery duration	>4.5 hours	73	6	8.2	5.91 (0.69-50.44)	0.68
	<4.5 hours	67	1	1.49		
Diabetes mellitus	Yes	9	0	0	0 (1.026-1.192)	0.47
	No	131	7	5.3		
Preoperative Hydrocephalus	Yes	11	5	45.4	52.9 (8.46-330.83)	0.001
	No	129	2	0.01		