Journal of Pharmaceutical Research International

27(5): 1-6, 2019; Article no.JPRI.46723
ISSN: 2456-9119
(Past name: British Journal of Pharmaceutical Research, Past ISSN: 2231-2919, NLM ID: 101631759)

Prevalence and Risk Factors of Bacterial Meningitis after Craniotomy in Shahid Bahonar Hospital of Kerman in 2016

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Authors' contributions

This work was carried out in collaboration among all authors. Author MA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors YB and MA managed the analyses of the study. Author MA managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2019/v27i530180
Editor(s):
(1) Dr. Rahul S. Khupse, Pharmaceutical Sciences, University of Findlay, USA.
Reviewers:
(1) Frederico Ribeiro Pires, Brazil.
(2) Arthur N. Chuemere, University of Port Harcourt, Nigeria.
Complete Peer review History: http://www.sdiarticle3.com/review-history/46723

Original Research Article

Received 15 November 2018
Accepted 21 January 2019
Published 21 May 2019

ABSTRACT

Objective: Postoperative infections of the central nervous system are common complications of neurological surgeries, which can lead to bad consequences for the patient and increase the cost of treatment. Incorrect diagnosis or treatment of meningitis after craniotomy can lead to irrecoverable disabilities. Therefore, this study tends to investigate the prevalence and risk factors of bacterial meningitis after craniotomy in Shahid Bahonar Hospital of Kerman.
Methods: This was a cross-sectional, analytical, descriptive study. The statistical population was 146 patients who underwent craniotomy in Shahid Bahonar Hospital of Kerman during 2016. To find out the relationship between each risk factor and meningitis, multivariate logistic regression was used. Data was analysed by SPSS software version 16. For comparison of percentages

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between two groups, Chi-square test or Fisher's exact test was used. In order to compare quantitative variables between the two groups, independent t-test was used; if the data was nonparametric, U-Mann-Whitney test was used.

Results: Of 77 patients, who underwent elective surgery, 5 cases (6.5%) developed bacterial meningitis; of patents that underwent emergency surgery, 8 cases (11.6%) developed bacterial meningitis. Two of 43 female patients (4.7%) and 11 of 103 male patients (10.7%) developed bacterial meningitis of patients with underlying disease, 4 (5.6%) patients developed bacterial meningitis and 9 (12%) of other patients developed bacterial meningitis. There were 4 cases of cerebrospinal fluid leakage. Of 146 patients, 13 cases (8.9%) developed bacterial meningitis, of which 5 had positive bacterial CSF culture; one case of *Acinetobacter baumannii*, one case of *Staphylococcus Epidermidis* ,one case of *Streptococcus pyogenes*, one case of *Staphylococcus aureus* and one case of *Pseudomonas aeruginosa* were reported.

Conclusion: It can be concluded that prevalence of bacterial meningitis increases with the increase in the number of received blood units, the presence of associated infection, the increase in duration of stay in hospital and ICU, the increase in duration of mechanical ventilation and repeated craniotomy and lower GCS.

Keywords: Bacterial meningitis; craniotomy; cerebrospinal fluid leakage.

1. INTRODUCTION

Postoperative infections of the central nervous system are uncommon; but when they occur, they are followed by serious and bad consequences [1]. Postoperative meningitis is a serious complication which occurs after surgical interventions in the nervous system [2]. Although post-craniotomy meningitis is a rare complication of neurological surgeries, it can cause significant disabilities if diagnosis or treatment is incorrect. Meningitis increases the length of hospitalization and is more dangerous than most common complications of neurological surgeries [3]. Meningitis is inflammation of protective meninges that covers the brain and spinal cord. This inflammation can be bacterial-viral or caused by other microorganisms [4]. In practice, meningitis following surgical procedures for the central nervous system can be considered as bacterial infection, until the opposite is proved. Development of bacterial meningitis following neurological surgeries is different from meningitis acquired from community; its dominant pathogens are gram negative bacteria (*K. pneumoniae*, *P. aeruginosa* and *A. baumannii*). Meningitis symptoms usually begin in the first week after surgery and caution is required in the case of high fever, focal neurological symptoms, cerebrospinal fluid leakage, and increased leukocyte and decreased cerebrospinal fluid glucose. The only definitive diagnosis of bacterial meningitis is positive culture of the cerebrospinal fluid (gram staining is negative in 70% of cases) [5,6]. Strong clinical suspicion is required for meningitis in patients with clinical fever, neck stiffness, and reduced post-operative alertness. Delay in diagnosis or treatment can cause disability or death [7]. For this reason, the cerebrospinal fluid of patients suspected of meningitis should be sent to gram staining and culturing, and broad-spectrum antibiotics should be initiated; if the culture is negative, the steroid dose should be increased [8-11]. Considering the above, this study tends to examine the prevalence of bacterial meningitis following craniotomy and its associated risk factors in patients undergoing craniotomy in the Shahid Bahonar Hospital in 2016. Age, gender, drug addiction, number of blood units received during hospital stay, conditions of surgery (emergency or elective), cultured bacteria type (gram positive or gram negative), the underlying conditions, the score that the patient takes in the APACHE scoring system, associated infection, mechanical ventilation time, time of admission to ICU, spinal cord fluid leakage, repeated surgery, presence of surgical attendant, GCS and hospitalization time will be investigated separately. Finally, their relationship with prevalence of bacterial meningitis after craniotomy is examined, the results of which can help to select appropriate antibiotics and use more effective therapeutic strategies and better management of operating room conditions in order to reduce meningitis.

2. MATERIALS AND METHODS

This was a descriptive-analytic cross-sectional study on records of patients who underwent emergency or elective craniotomy in Shahid Bahonar Hospital of Kerman in 2016. All patients undergoing brain surgery within one year (2016) were included through census. In these patients,

meningitis was diagnosed based on the presence of fever 48 hours after craniotomy, associated with implications of bacterial meningitis in the cerebrospinal fluid included: white blood cell count > 100 / cells/μL with a percentage of neutrophils greater than 80 percent, increased protein concentrations>50 mg/dL, decreased concentration of glucose <40 mg/dl(with a CSF: serum glucose ratio of ≤0.4); lactic acid>3.5 mmol/lit and smear and culture of bacteria would be considered, if positive. Age, gender, drug addiction, number of blood units received during hospital stay, conditions of surgery (emergency or elective), cultured bacteria type (gram positive or gram negative), the underlying conditions, the score that the patient takes in the APACHE scoring system, associated infection, mechanical ventilation time, time of admission to ICU, CSF leakage, repeated surgery, presence of surgical attendant, GCS and hospitalization time were investigated separately. Data registration form was designed based on the variables and was completed based on the patient records. All records of the patients who underwent brain surgery in Shahid Bahonar Hospital in Kerman within a year (2016) were enrolled by census method. Prevalence of each of the risk factors was determined with a confidence interval of 95%. Multivariate logistic regression was used to find out the relationship between each risk factor with meningitis risk. Data was analyzed by SPSS software version 16. For comparison, Chi-square test or Fisher's exact test was used. In order to compare the quantitative variables between the two groups, independent T-test was used; Mann-Whitney-U test was used if data was non-parametric.

3. RESULTS

Of 146 patients who underwent craniotomy in Shahid Bahonar Hospital Kerman in 2016, 13 (8.9%) cases developed bacterial meningitis. Comparison of nominal and quantitative variables is presented in Table 1.

According to Table 1, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in 2016, 77 cases had elective surgery and 69 patients underwent emergency surgery. Of 77 cases undergoing elective surgery, 5 (6.5%) developed bacterial meningitis. Of patients who underwent emergency surgery, 8 cases (11.6%) developed bacterial meningitis; there was no significant difference in prevalence of bacterial meningitis between the two groups of patients undergoing emergency and elective craniotomy.

43 cases of 146 patients were female and 103 patients were male. Two of 43 female patients (4.7%) and 11 of 103 male patients (10.7%) developed bacterial meningitis. There was no significant difference in prevalence of bacterial meningitis between male and female patients.

13 cases of 146 patients undergoing craniotomy developing bacterial meningitis aged 50.76±5.2 and other patients aged 45.27±1.9, which indicated no significant difference.

35 cases of 146 patients were opium addicted and 111 patients were not addicted. Five of addicted patients (14.3%) developed bacterial meningitis and 111 of non-addicted patients (7.2%) developed bacterial meningitis. There was no significant difference.

71 cases had underlying disease and 75 patients had no underlying disease. Four of patients with underlying disease (5.6%) developed bacterial meningitis and 9 of other patients (12%) developed bacterial meningitis. There was no significant difference.

According to our results, the number of the blood units received was 2.85±0.64 in the group with bacterial meningitis and 1.21±0.22 in other groups; there was a significant difference between the two groups in terms of the number of blood units received.

13 patientes developed bacterial meningitis; 5 of them had positive culture of cerebrospinal fluid.

17 cases of 146 patients undergoing craniotomy, had associated infection; 9 of them (52.9%) developed bacterial meningitis. Of 125 cases who had no associated infection, 4 (3.1%) developed meningitis; bacterial meningitis was significantly higher in patients with associated infection.

The mean of APACHE score was 17±1.62 in the group with bacterial meningitis and 11.36±0.53 in other patients, and this difference was not significant.

Mechanical ventilation time was 37.23±8.50 days in the group with bacterial meningitis and 5.38±0.86 days in other patients. Mechanical ventilation time was significantly higher in the group with bacterial meningitis.

ICU admission time was 37.92±8.55 days in the group with bacterial meningitis and 6.87±0.88 days in other patients; ICU admission time was

significantly higher in the group with bacterial meningitis.

4 of 146 patients undergoing craniotomy had cerebrospinal fluid leakage and none of them developed bacterial meningitis; there was no significant difference in prevalence of bacterial meningitis in terms of cerebrospinal fluid leakage.

13 cases, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in 2016, 39 cases had repeated surgery; 9 of them (23.1%) developed bacterial meningitis. Of cases who had not repeated surgery, 4 developed meningitis; bacterial meningitis was significantly higher in patients with repeated surgery.

93 patintes were operated on in the presence of a neurosurgeon attendant; 8 of them (8.6%) developed bacterial meningitis. Of other patients, 5 (9.4%) developed meningitis; there was no significant difference in prevalence of bacterial meningitis in patients undergoing craniotomy in terms of the presence of neurosurgeon attendant.

According to results of present study, GCS was 9.85±1.21 in the group with bacterial meningitis and 12.65±0.32 in other patients; mean of GCS was significantly lower in the group with bacterial meningitis than other patients.

Hospitalization time was 45.61±8.39 in the group with bacterial meningitis and 13.45±1.28 in other patients; hospitalization time was significantly higher in the group with bacterial meningitis than other patients.

Table 1. Comparison of selected variables between meningitis and non-meningitis group in Shahid Bahonar Hospital of Kerman in 2016

Characteristic	Categories	Meningitis		Total	P
		Yes (%)	No (%)		
Gender	Female	2 (4.7%)	41 (95.3%)	43	*0.346*
	Male	11 (10.7%)	92 (89.3%)	103	
Age		50.76±5.2	45.27±1.9		*0.384*
APACHE score		17±1.62	11.36±0.53		*0.099*
Mechanical ventilation time		37.23±8.50	5.38±0.86		*0.01*
ICU admission time		37.92±8.55	6.87±0.88		*<0.001*
GSC		9.85±1.21	12.65±0.32		*0.012*
Hospitalization time		45.61±8.39	13.45±1.28		*<0.001*
Number of blood units received		2.85± 0.64	1.21± 0.22		*0.025*
Addiction	Yes	54 (14.3%)	30 (85.7%)	35	*0.302%*
	No	8 (7.2%)	103 (92.8%)	111	
Underlying disease	Yes	4 (5.6%)	67 (94.2%)	71	*0.177*
	No	9 (12%)	66 (88%)	75	
Positive culture	*<0.01*	5	0	5	
	<0.01	8 (5.6%)	133 (94.4%)	141	
Associated infection	Yes	9 (52.9%)	8 (47.1%)	17	*<0.01*
	No	4 (3.1%)	125 (96.9%)	129	
Cerebrospinal fluid leakage	Yes	0 (0%)	4 (100%)	4	*1.00*
	No	13 (9.2%)	129 (90.8%)	142	
Repeated surgery	Yes	9 (23.1%)	30 (76.9%)	39	*<0.01*
	No	4 (3.7%)	103 (96.3%)	107	
Presence of attendant	Yes	8 (8.6%)	85 (91.4%)	93	*1.00*
	No	5 (9.4%)	48 (90.6%)	53	
Surgery type	Elective	5 (6.5%)	72 (93.5%)	77	*0.28*
	Emergency	8 (11.6%)	61 (88.4%)	69	

4. DISCUSSION AND CONCLUSION

In general, 146 patients who underwent craniotomy in Shahid Bahonar Hospital of Kerman in 2016 were enrolled in this study; 13 cases (8.9%) developed bacterial meningitis, 5 of them had positive CSF culture for bacteria; one case of *A. baumannii, S. epidermidis*, one case of *S. pyogenes*, one case of *S. aureus* and one case of *P. aeruginosa* were reported.Various statistics have been reported for the prevalence of meningitis following craniotomy. In a study conducted in Brazil, the incidence of meningitis was 8.9% and gram negative bacilli were the most common causes of infection. Among the risk factors for infection, only repeated surgical procedures were significant [12]. In another study in Italy, the incidence of meningitis after head and neck surgery was 1.4% [13]. In another study, the incidence of meningitis was 5.5%, most of which were due to gram-positive cocci [14]. In a study in India, the incidence of infection was 2.1% with a mortality rate of 5%; the most common organism in this study was gram-negative bacilli [15]. In another study, the incidence of meningitis was 2.7%; the most common organisms were *S. aureus*, *A. Baumannii and P. aeruginosa*, [16]. In a study in Iran, this prevalence was 4.7%, which is higher than that of the developed countries [6]. According to the results obtained in this study, there was a significant relationship between the prevalence of bacterial meningitis after craniotomy and the amount of received blood, associated infection, hospitalization time, ICU admission time, duration of mechanical ventilation, repeated craniotomy and GCS. According to results of this study, the prevalence of bacterial meningitis increased with the increase in the number of received blood units, the presence of associated infection, the increase in duration of stay in hospital and ICU, increased duration of mechanical ventilation, repeated craniotomy and lower GCS. The results showed that patients with diabetes and those who have cerebrospinal shunts have a higher risk for meningitis [17]. The study, which was conducted in 2015, reported the risk factors for post-operative neurosurgery infections as monitoring after intracranial surgeries, ventricular drainage, cerebrospinal fluid leakage, long procedures, foreign objects, multiple surgeries, and shunt infections and emergency procedures [1]. Another study showed that postoperative cerebrospinal fluid fistula increases the risk of meningitis [18]. Another study done in 2015 found that patients with unhealthy body mass index were at greater risk for cerebrospinal fluid leakage and meningitis. Moreover, older patients had a higher cerebrospinal fluid leakage. The length of lumbar drainage was associated with infection. In this study, BMI was the most important predictor of cerebrospinal fluid leakage and infection. Other risk factors include age, intraoperative cerebrospinal fluid leakage, duration of lumbar drain, and combined brain surgeries [19].

CONSENT AND ETHICAL APPROVAL

As per university standard guideline participant consent and ethical approval has been collected and preserved by the authors.

ACKNOWLEDGMENT

We sincerely express our gratitude to Professor Nouzar Nakhaee, epidemiologist and faculty member of Kerman University of medical sciences for performing the static analysis of present study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle3.com/review-history/46723