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

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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 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 patients 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.

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Keywords: Bacterial meningitis, craniotomy, cerebrospinal fluid leakage.

1. INTRODUCTION

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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

22 microorganisms [4]. In practice, meningitis following surgical procedures for the central
23 nervous system can be considered as bacterial infection, until the opposite is proved.
24 Development of bacterial meningitis following neurological surgeries is different from
25 meningitis acquired from community; its dominant pathogens are gram negative bacteria (*K.*
26 *pneumoniae*, *P. aeruginosa* and *A. baumannii*). Meningitis symptoms usually begin in the
27 first week after surgery and caution is required in the case of high fever, focal neurological
28 symptoms, cerebrospinal fluid leakage, and increased leukocyte and decreased
29 cerebrospinal fluid glucose. The only definitive diagnosis of bacterial meningitis is positive
30 culture of the cerebrospinal fluid (gram staining is negative in 70% of cases) [5]. Strong
31 clinical suspicion is required for meningitis in patients with clinical fever, neck stiffness, and
32 reduced post-operative alertness. Delay in diagnosis or treatment can cause disability or
33 death [6]. For this reason, the cerebrospinal fluid of patients suspected of meningitis should
34 be sent to gram staining and culturing, and broad-spectrum antibiotics should be initiated; if
35 the culture is negative, the steroid dose should be increased [5]. Considering the above, this
36 study tends to examine the prevalence of bacterial meningitis following craniotomy and its
37 associated risk factors in patients undergoing craniotomy in the Shahid Bahonar Hospital in
38 2016. Age, gender, drug addiction, number of blood units received during hospital stay,
39 conditions of surgery (emergency or elective), cultured bacteria type (gram positive or gram
40 negative), the underlying conditions, the score that the patient takes in the APACHE scoring
41 system, associated infection, mechanical ventilation time, time of admission to ICU, spinal
42 cord fluid leakage, repeated surgery, presence of surgical attendant, GCS and
43 hospitalization time will be investigated separately. Finally, their relationship with prevalence
44 of bacterial meningitis after craniotomy is examined, the results of which can help to select
45 appropriate antibiotics and use more effective therapeutic strategies and better management
46 of operating room conditions in order to reduce meningitis.

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48 2. MATERIALS AND METHODS

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50 This was a descriptive-analytic cross-sectional study on records of patients who underwent
51 emergency or elective craniotomy in Shahid Bahonar Hospital of Kerman in 2016. All
52 patients undergoing brain surgery within one year (2016) were included through census. In
53 these patients, meningitis was diagnosed based on the presence of fever 48 hours after
54 craniotomy, associated with implications of bacterial meningitis in the cerebrospinal fluid
55 included: white blood cell count > 100 / cells/ μ L with a percentage of neutrophils greater than
56 80 percent, increased protein concentrations > 50 mg/dL, decreased concentration of glucose
57 < 40 mg/dl (with a CSF: serum glucose ratio of ≤ 0.4); lactic acid > 3.5 mmol/lit and smear and
58 culture of bacteria would be considered, if positive. Age, gender, drug addiction, number of
59 blood units received during hospital stay, conditions of surgery (emergency or elective),
60 cultured bacteria type (gram positive or gram negative), the underlying conditions, the score
61 that the patient takes in the APACHE scoring system, associated infection, mechanical
62 ventilation time, time of admission to ICU, CSF leakage, repeated surgery, presence of
63 surgical attendant, GCS and hospitalization time were investigated separately. Data
64 registration form was designed based on the variables and was completed based on the
65 patient records. All records of the patients who underwent brain surgery in Shahid Bahonar
66 Hospital in Kerman within a year (2016) were enrolled by census method. Prevalence of
67 each of the risk factors was determined with a confidence interval of 95%. Multivariate
68 logistic regression was used to find out the relationship between each risk factor with
69 meningitis risk. Data was analyzed by SPSS software version 16. For comparison, Chi-
70 square test or Fisher's exact test was used. In order to compare the quantitative variables
71 between the two groups, independent T-test was used; Mann-Whitney-U test was used if
72 data was non-parametric.

73 3. RESULTS

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75 Of 146 patients who underwent craniotomy in Shahid Bahonar Hospital Kerman in 2016, 13
76 (8.9%) cases developed bacterial meningitis. Comparison of nominal and quantitative
77 variables is presented in Table 1.

78 According to Table 1, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in
79 2016, 77 cases had elective surgery and 69 patients underwent emergency surgery. Of 77
80 cases undergoing elective surgery, 5 (6.5%) developed bacterial meningitis. Of patients who
81 underwent emergency surgery, 8 cases (11.6%) developed bacterial meningitis; there was
82 no significant difference in prevalence of bacterial meningitis between the two groups of
83 patients undergoing emergency and elective craniotomy.

84 43 cases of 146 patients were female and 103 patients were male. Two of 43 female patients
85 (4.7%) and 11 of 103 male patients (10.7%) developed bacterial meningitis. There was no
86 significant difference in prevalence of bacterial meningitis between male and female
87 patients.

88 13 cases of 146 patients undergoing craniotomy developing bacterial meningitis aged
89 50.76 ± 5.2 and other patients aged 45.27 ± 1.9 , which indicated no significant difference.

90 35 cases of 146 patients were opium addicted and 111 patients were not addicted. Five of
91 addicted patients (4.5%) developed bacterial meningitis and 111 of non-addicted patients
92 (7.2%) developed bacterial meningitis. There was no significant difference.

93 71 cases had underlying disease and 75 patients had no underlying disease. Four of
94 patients with underlying disease (5.6%) developed bacterial meningitis and 9 of other
95 patients (12%) developed bacterial meningitis. There was no significant difference.

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

99 13 patients developed bacterial meningitis; 5 of them had positive culture of cerebrospinal
100 fluid.

101 17 cases of 146 patients undergoing craniotomy, had associated infection; 9 of them
102 (52.9%) developed bacterial meningitis. Of 125 cases who had no associated infection, 4
103 (3.1%) developed meningitis; bacterial meningitis was significantly higher in patients with
104 associated infection.

105 The mean of APACHE score was 17 ± 1.62 in the group with bacterial meningitis and
106 11.36 ± 0.53 in other patients, and this difference was not significant.

107 Mechanical ventilation time was 37.23 ± 8.50 days in the group with bacterial meningitis and
108 5.38 ± 0.86 days in other patients. Mechanical ventilation time was significantly higher in the
109 group with bacterial meningitis.

110 ICU admission time was 37.92 ± 8.55 days in the group with bacterial meningitis and
111 6.87 ± 0.88 days in other patients; ICU admission time was significantly higher in the group
112 with bacterial meningitis.

113 4 of 146 patients undergoing craniotomy had cerebrospinal fluid leakage and none of them
 114 developed bacterial meningitis; there was no significant difference in prevalence of bacterial
 115 meningitis in terms of cerebrospinal fluid leakage.

116 13 cases, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in 2016, 39
 117 cases had repeated surgery; 9 of them (23.1%) developed bacterial meningitis. Of cases
 118 who had not repeated surgery, 4 developed meningitis; bacterial meningitis was significantly
 119 higher in patients with repeated surgery.

120 93 patients were operated on in the presence of a neurosurgeon attendant; 8 of them (8.6%)
 121 developed bacterial meningitis. Of other patients, 5 (9.4%) developed meningitis; there was
 122 no significant difference in prevalence of bacterial meningitis in patients undergoing
 123 craniotomy in terms of the presence of neurosurgeon attendant.

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

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

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

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4. DISCUSSION AND CONCLUSION

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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 [7]. In another study in Italy, the incidence of meningitis after head and neck surgery was 1.4% [8]. In another study, the incidence of meningitis was 5.5%, most of which were due to gram-positive cocci [9]. 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 [10]. In another study, the incidence of meningitis was 2.7%; the most common organisms were *S. aureus*, *A. Baumannii* and *P. aeruginosa*, [11]. In a study in Iran, this prevalence was 4.7%, which is higher than that of the developed countries [5]. 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 [12]. 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 [13]. Another study done in 2015 found that patients with unhealthy body mass index were at

167 greater risk for cerebrospinal fluid leakage and meningitis. Moreover, older patients had a
168 higher cerebrospinal fluid leakage. The length of lumbar drainage was associated with
169 infection. In this study, BMI was the most important predictor of cerebrospinal fluid leakage
170 and infection. Other risk factors include age, intraoperative cerebrospinal fluid leakage,
171 duration of lumbar drain, and combined brain surgeries [14].

172 **Disclaimer regarding Consent and Ethical Approval:**

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

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