

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

## 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 who 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, one case of S. epidermidis, one case of streptococcus, one case of S.aureus and one case of pseudomonas 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, multivariate logistic regression, 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

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

48

## 49 **2. MATERIAL AND METHODS**

50

51 This was a descriptive-analytic cross-sectional study on records of patients who underwent  
52 emergency or elective craniotomy in Shahid Bahonar Hospital of Kerman in 2016. All  
53 patients undergoing brain surgery within one year (2016) were included through census. In  
54 these patients, meningitis was diagnosed based on the presence of fever 48 hours after  
55 craniotomy, associated with implications of bacterial meningitis in the cerebrospinal fluid.  
56 These findings included: white blood cell count  $> 1000$  /microL with a percentage of  
57 neutrophils greater than 80 percent, increased protein concentrations  $> 50$  mg/dL, decreased  
58 concentration of glucose  $< 40$  mg/dl (with a CSF:serum glucose ratio of  $\leq 0.4$ ); lactic acid  $> 3.5$   
59 mmol/lit and smear and culture of bacteria would be considered, if positive. Age, gender,  
60 drug addiction, number of blood units received during hospital stay, conditions of surgery  
61 (emergency or elective), cultured bacteria type (gram positive or gram negative), the  
62 underlying conditions, the score that the patient takes in the APACHE scoring system,  
63 associated infection, mechanical ventilation time, time of admission to ICU, CSF leakage,  
64 repeated surgery, presence of surgical attendant, GCS and hospitalization time were  
65 investigated separately. Data registration form was designed based on the variables and was  
66 completed based on the patient records. All records of the patients who underwent brain  
67 surgery in Shahid Bahonar Hospital in Kerman within a year (2016) were enrolled by census  
68 method. Prevalence of each of the risk factors was determined with a confidence interval of  
69 95%. Multivariate logistic regression was used to find out the relationship between each risk  
70 factor with meningitis risk. Data was analyzed by SPSS software version 16. For comparison,  
71 Chi-square test or Fisher's exact test was used. In order to compare the quantitative  
72 variables between the two groups, independent T-test was used; Mann-Whitney-U test was  
73 used if data was non-parametric.

74 **3. RESULTS**

75

76 Of 146 patients who underwent craniotomy in Shahid Bahonar Hospital Kerman in 2016, 13  
77 (8.9%) cases developed bacterial meningitis. Comparison of nominal and quantitative  
78 variables is presented in Tables1-16 separately.

79 **Table 1. Comparison of prevalence of bacterial meningitis among patients undergoing**  
80 **craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of surgery type**

<b>Meningitis Surgery type</b>	<b>Yes</b>	<b>No</b>	<b>Total</b>
Elective	5 (6.5%)	72 (93.5%)	77
Emergency	8 (11.6%)	61 (88.4%)	69
Total	13	133	146

81  $P=0.28$

82

83 According to Table 1, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in  
84 2016, 77 cases had elective surgery and 69 patients underwent emergency surgery. Of 77  
85 cases undergoing elective surgery, 5 (6.5%) developed bacterial meningitis. Of patients who  
86 underwent emergency surgery, 8 cases (11.6%) developed bacterial meningitis; there was  
87 no significant difference in prevalence of bacterial meningitis between the two groups of  
88 patients undergoing emergency and elective craniotomy.

89 **Table 2. Comparison of prevalence of bacterial meningitis among patients undergoing**  
90 **craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of gender**

<b>Meningitis Gender</b>	<b>Yes</b>	<b>No</b>	<b>Total</b>
Female	2 (4.7%)	41 (95.3%)	43
Male	11 (10.7%)	92 (89.3%)	103
Total	13 (8.9%)	133 (91.1%)	146

91  $P=0.346$

92

93 According to Table 2, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in  
94 2016, 43 cases were female and 103 patients were male. Two of 43 female patients (4.7%)  
95 and 11 of 103 male patients (10.7%) developed bacterial meningitis. There was no  
96 significant difference in prevalence of bacterial meningitis between male and female patients.

97 **Table 3. Comparison of mean of age between the group with bacterial meningitis and**  
98 **other patients undergoing craniotomy in Shahid Bahonar Hospital of Kerman in 2016**

<b>Meningitis</b>	<b>Age</b>	
	<b>Mean</b>	<b>Std.</b>
Yes	50.76	5.2
No	45.27	1.9

99  $P=0.384$

100 According to Table 3, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in  
101 2016, 13 cases developing bacterial meningitis aged  $50.76 \pm 5.2$  and other patients aged  
102  $45.27 \pm 1.9$ , which indicated no significant difference.

103 **Table 4. Comparison of prevalence of bacterial meningitis among patients undergoing**  
104 **craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of drug addiction**

<b>Meningitis Addiction</b>	<b>Yes</b>	<b>No</b>	<b>Total</b>
Yes	54 (14.3%)	30 (85.7%)	35
No	8 (7.2%)	103 (92.8%)	111

Total	13	133	146
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105  $P=0.302\%$

106

107 According to Table 4, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in  
 108 2016, 35 cases were addicted and 111 patients were not addicted. Five of addicted  
 109 patients(14.3%) developed bacterial meningitis and 111 of non-addicted patients (7.2%)  
 110 developed bacterial meningitis. There was no significant difference.

111 **Table 5. Comparison of prevalence of bacterial meningitis among patients undergoing**  
 112 **craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of underlying**  
 113 **diseases**

Meningitis Underlying disease	Yes	No	Total
Yes	4 (5.6%)	67 (94.2%)	71
No	9 (12%)	66 (88%)	75
Total	13	133	146

114  $P=0.177$

115

116 According to Table 5, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in  
 117 2016, 71 cases had underlying disease and 75 patients had no underlying disease. Four  
 118 of patients with underlying disease (5.6%) developed bacterial meningitis and 9 of other  
 119 patients (12%) developed bacterial meningitis. There was no significant difference.

120 **Table 6. Comparing the mean of the number of blood units received between the**  
 121 **group with bacterial meningitis and other patients undergoing craniotomy in Shahid**  
 122 **Bahonar Hospital of Kerman in 2016**

Meningitis	Number of blood units received	
	Mean	Std.
Yes	2.85	0.64
No	1.21	0.22

123  $P=0.025$

124

125 According to Table 6, the number of the blood units received was  $2.85 \pm 0.64$  in the group  
 126 with bacterial meningitis and  $1.21 \pm 0.22$  in other groups; there was a significant difference  
 127 between the two groups in terms of the number of blood units received.

128 **Table 7. Comparison of prevalence of positive culture of cerebrospinal fluid in terms of**  
 129 **bacterium among patients undergoing craniotomy in Shahid Bahonar Hospital of**  
 130 **Kerman in 2016**

Meningitis Positive culture	Yes	No	Total
Yes	5	0	5
No	8 (5.6%)	133 (94.4%)	141
Total	13	133	146

131

132 According to Table 7, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in  
 133 2016, 13 cases developed bacterial meningitis; 5 of them had positive culture of  
 134 cerebrospinal fluid.

135 **Table 8. Comparison of prevalence of bacterial meningitis among patients undergoing**  
 136 **craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of associated**  
 137 **infection**

<b>Meningitis Associated infection</b>	<b>Yes</b>	<b>No</b>	<b>Total</b>
Yes	9 (52.9%)	8 (47.1%)	17
No	4 (3.1%)	125 (96.9%)	129
Total	13	133	146

138  $P<0.01$

139

140 According to Table 8, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in  
141 2016, 17 cases had associated infection; 9 of them (52.9%) developed bacterial meningitis.  
142 Of 125 cases who had no associated infection, 4 (3.1%) developed meningitis; bacterial  
143 meningitis was significantly higher in patients with associated infection.

144

145 **Table 9. Comparing the mean of APACHE score between the group with bacterial**  
146 **meningitis and other patients undergoing craniotomy in Shahid Bahonar Hospital of**  
147 **Kerman in 2016**

<b>Meningitis</b>	<b>APACHE score</b>	
	<b>Mean</b>	<b>Std.</b>
Yes	17	1.62
No	11.36	0.53

148  $P=0.099$

149

150 According to Table 9, the mean of APACHE score was  $17\pm 1.62$  in the group with bacterial  
151 meningitis and  $11.36\pm 0.53$  in other patients, and this difference was not significant.

152 **Table 10. comparing the mean of mechanical ventilation between the group with**  
153 **bacterial meningitis and other patients undergoing craniotomy in Shahid Bahonar**  
154 **Hospital of Kerman in 2016**

<b>Meningitis</b>	<b>Mechanical ventilation time</b>	
	<b>Mean</b>	<b>Std.</b>
Yes	37.23	8.50
No	5.38	0.86

155  $P=0.01$

156

157 According to Table 10, mechanical ventilation time was  $37.23\pm 8.50$  days in the group with  
158 bacterial meningitis and  $5.38\pm 0.86$  days in other patients. Mechanical ventilation time was  
159 significantly higher in the group with bacterial meningitis.

160 **Table 11. Comparing the mean of ICU admission time between the group with**  
161 **bacterial meningitis and other patients undergoing craniotomy in Shahid Bahonar**  
162 **Hospital of Kerman in 2016**

<b>Meningitis</b>	<b>ICU admission time</b>	
	<b>Mean</b>	<b>Std.</b>
Yes	37.92	8.55
No	6.87	0.88

163  $P<0.001$

164

165 According to Table 11, ICU admission time was  $37.92\pm 8.55$  days in the group with bacterial  
166 meningitis and  $6.87\pm 0.88$  days in other patients; ICU admission time was significantly higher  
167 in the group with bacterial meningitis.

168 **Table 12. comparison of prevalence of bacterial meningitis among patients**  
 169 **undergoing craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of**  
 170 **cerebrospinal fluid leakage**

<b>Meningitis Cerebrospinal fluid leakage</b>	<b>Yes</b>	<b>No</b>	<b>Total</b>
Yes	0 (0%)	4 (100%)	4
No	13 (9.2%)	129 (90.8%)	142
Total	13	133	146

171  $P=1.00$

172

173 According to Table 12, 4 of 146 patients undergoing craniotomy had cerebrospinal fluid  
 174 leakage and none of them developed bacterial meningitis; there was no significant difference  
 175 in prevalence of bacterial meningitis in terms of cerebrospinal fluid leakage.

176 **Table 13. Comparison of prevalence of bacterial meningitis among patients**  
 177 **undergoing craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of**  
 178 **repeated surgery**

<b>Meningitis Repeated surgery</b>	<b>Yes</b>	<b>No</b>	<b>Total</b>
Yes	9 (23.1%)	30 (76.9%)	39
No	4 (3.7%)	103 (96.3%)	107
Total	13	133	146

179  $P<0.01$

180

181 According to Table 13, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in  
 182 2016, 39 cases had repeated surgery; 9 of them (23.1%) developed bacterial meningitis. Of  
 183 cases who had not repeated surgery, 4 developed meningitis; bacterial meningitis was  
 184 significantly higher in patients with repeated surgery.

185 **Table 14. Comparison of prevalence of bacterial meningitis among patients**  
 186 **undergoing craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of**  
 187 **presence of neurosurgeon attendant**

<b>Meningitis Presence of attendant</b>	<b>Yes</b>	<b>No</b>	<b>Total</b>
Yes	8 (8.6%)	85 (91.4%)	93
No	5 (9.4%)	48 (90.6%)	53
Total	13 (8.9%)	133 (91.1%)	146

188  $P=1.00$

189

190 According to Table 14, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in  
 191 2016, 93 cases were operated on in the presence of a neurosurgeon attendant; 8 of them  
 192 (8.6%) developed bacterial meningitis. Of other patients, 5 (9.4%) developed meningitis;  
 193 there was no significant difference in prevalence of bacterial meningitis in patients  
 194 undergoing craniotomy in terms of the presence of neurosurgeon attendant.

195 **Table 15. Comparing the mean of CGS between the group with bacterial meningitis**  
 196 **and other patients undergoing craniotomy in Shahid Bahonar Hospital of Kerman in**  
 197 **2016**

<b>Meningitis</b>	<b>GSC</b>	
	<b>Mean</b>	<b>Std.</b>
Yes	9.85	1.21
No	12.65	0.32

198  $P=0.012$

199  
200 According to Table 15, GCS was  $9.85 \pm 1.21$  in the group with bacterial meningitis and  
201  $12.65 \pm 0.32$  in other patients; mean of GCS was significantly lower in the group with bacterial  
202 meningitis than other patients.

203 **Table 16. comparing the prevalence of bacterial meningitis in patients undergoing**  
204 **craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of hospitalization**  
205 **time**

Meningitis	Hospitalization time	
	Mean	Std.
Yes	45.61	8.39
No	13.45	1.28

206  $P < 0.001$

207  
208 According to Table 16, hospitalization time was  $45.61 \pm 8.39$  in the group with bacterial  
209 meningitis and  $13.45 \pm 1.28$  in other patients; hospitalization time was significantly higher in  
210 the group with bacterial meningitis than other patients.

#### 211 212 **4. DISCUSSION AND CONCLUSION**

213  
214 In general, 146 patients who underwent craniotomy in Shahid Bahonar Hospital of Kerman in  
215 2016 were enrolled in this study; 13 cases (8.9%) developed bacterial meningitis, 5 of them  
216 had positive CSF culture for bacteria; one case of acinetobacter Bomani, S. epidermidis, one  
217 case of streptococcus, one case of S. aureus and one case of pseudomonas aeruginosa  
218 were reported. Various statistics have been reported for the prevalence of meningitis  
219 following craniotomy. In a study conducted in Brazil, the incidence of meningitis was 8.9%  
220 and gram negative bacilli were the most common causes of infection. Among the risk factors  
221 for infection, only repeated surgical procedures were significant [7]. In another study in Italy,  
222 the incidence of meningitis after head and neck surgery was 1.4% [8]. In another study, the  
223 incidence of meningitis was 5.5%, most of which were due to gram-positive cocci [9]. In a  
224 study in India, the incidence of infection was 2.1% with a mortality rate of 5%; the most  
225 common organism in this study was gram-negative bacilli [10]. In another study, the  
226 incidence of meningitis was 2.7%; the most common organisms were Staphylococcus  
227 aureus and Acinetobacter [11]. In a study in Iran, this prevalence was 4.7%, which is higher  
228 than that of the developed countries [5]. According to the results obtained in this study, there  
229 was a significant relationship between the prevalence of bacterial meningitis after  
230 craniotomy and the amount of received blood, associated infection, hospitalization time, ICU  
231 admission time, duration of mechanical ventilation, repeated craniotomy and GCS. According  
232 to results of this study, the prevalence of bacterial meningitis increased with the increase in  
233 the number of received blood units, the presence of associated infection, the increase in  
234 duration of stay in hospital and ICU, increased duration of mechanical ventilation, repeated  
235 craniotomy and lower GCS. The results showed that patients with diabetes and those who  
236 have cerebrospinal shunts have a higher risk for meningitis [12]. The study, which was  
237 conducted in 2015, reported the risk factors for post-operative neurosurgery infections as  
238 monitoring after intracranial surgeries, ventricular drainage, cerebrospinal fluid leakage, long  
239 procedures, foreign objects, multiple surgeries, and shunt infections and emergency  
240 procedures [1]. Another study showed that postoperative cerebrospinal fluid fistula increases  
241 the risk of meningitis [13]. Another study done in 2015 found that patients with unhealthy  
242 body mass index were at greater risk for cerebrospinal fluid leakage and meningitis.  
243 Moreover, older patients had a higher cerebrospinal fluid leakage. The length of lumbar  
244 drainage was associated with infection. In this study, BMI was the most important predictor

245 of cerebrospinal fluid leakage and infection. Other risk factors include age, intraoperative  
246 cerebrospinal fluid leakage,duration of lumbar drain, and combined brain surgeries [14].

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UNDER PEER REVIEW