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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.

10

11 *Keywords: Bacterial meningitis, craniotomy, multivariate logistic*
12 *regression, cerebrospinal fluid leakage.*

13 **1. INTRODUCTION**

14

15 Postoperative infections of the central nervous system are
16 uncommon; but when they occur, they are followed by serious
17 and bad consequences [1]. Postoperative meningitis is a serious
18 complication which occurs after surgical interventions in the
19 nervous system [2]. Although post-craniotomy meningitis is a rare
20 complication of neurological surgeries, it can cause significant
21 disabilities if diagnosis or treatment is incorrect. Meningitis
22 increases the length of hospitalization and is more dangerous
23 than most common complications of neurological surgeries [3].
24 Meningitis is inflammation of protective meninges that covers the
25 brain and spinal cord. This inflammation can be bacterial-viral or
26 caused by other microorganisms [4]. In practice, meningitis
27 following surgical procedures for the central nervous system can
28 be considered as bacterial infection, until the opposite is proved.
29 Development of bacterial meningitis following neurological
30 surgeries is different from meningitis acquired from community; its
31 dominant pathogens are gram negative bacteria (Klebsiella,
32 Pseudomonas and Acinetobacter). Meningitis symptoms usually
33 begin in the first week after surgery and caution is required in the
34 case of high fever, focal neurological symptoms, cerebrospinal
35 fluid leakage, and increased leukocyte and decreased
36 cerebrospinal fluid glucose. The only definitive diagnosis of
37 bacterial meningitis is positive culture of the cerebrospinal fluid
38 (gram staining is negative in 70% of cases) [5]. Strong clinical
39 suspicion is required for meningitis in patients with clinical fever,

40 neck stiffness, and reduced post-operative alertness. Delay in
41 diagnosis or treatment can cause disability or death [6]. For this
42 reason, the cerebrospinal fluid of patients suspected of meningitis
43 should be sent to gram staining and culturing, and broad-
44 spectrum antibiotics should be initiated; if the culture is negative,
45 the steroid dose should be increased [5]. Considering the above,
46 this study tends to examine the prevalence of bacterial meningitis
47 following craniotomy and its associated risk factors in patients
48 undergoing craniotomy in the Shahid Bahonar Hospital in
49 2016. Age, gender, drug addiction, number of blood units received
50 during hospital stay, conditions of surgery (emergency or
51 elective), cultured bacteria type (gram positive or gram negative),
52 the underlying conditions, the score that the patient takes in the
53 APACHE scoring system, associated infection, mechanical
54 ventilation time, time of admission to ICU, spinal cord fluid
55 leakage, repeated surgery, presence of surgical attendant, GCS
56 and hospitalization time will be investigated separately. Finally,
57 their relationship with prevalence of bacterial meningitis after
58 craniotomy is examined, the results of which can help to select
59 appropriate antibiotics and use more effective therapeutic
60 strategies and better management of operating room conditions in
61 order to reduce meningitis.

62

63 **2. MATERIALS AND METHODS**

64

65 This was a descriptive-analytic cross-sectional study on records of
66 patients who underwent emergency or elective craniotomy in
67 Shahid Bahonar Hospital of Kerman in 2016. All patients
68 undergoing brain surgery within one year (2016) were included
69 through census. In these patients, meningitis was diagnosed
70 based on the presence of fever 48 hours after craniotomy,
71 associated with implications of bacterial meningitis in the
72 cerebrospinal fluid. These findings included: white blood cell count
73 > 1000 /microL with a percentage of neutrophils greater than 80
74 percent, increased protein concentrations >50 mg/dL, decreased
75 concentration of glucose <40 mg/dl (with a CSF:serum glucose
76 ratio of ≤ 0.4); lactic acid >3.5 mmol/lit and smear and culture of

77 bacteria would be considered, if positive. Age, gender, drug
78 addiction, number of blood units received during hospital stay,
79 conditions of surgery (emergency or elective), cultured bacteria
80 type (gram positive or gram negative), the underlying conditions,
81 the score that the patient takes in the APACHE scoring system,
82 associated infection, mechanical ventilation time, time of
83 admission to ICU, CSF leakage, repeated surgery, presence of
84 surgical attendant, GCS and hospitalization time were
85 investigated separately. Data registration form was designed
86 based on the variables and was completed based on the patient
87 records. All records of the patients who underwent brain surgery
88 in Shahid Bahonar Hospital in Kerman within a year (2016) were
89 enrolled by census method. Prevalence of each of the risk factors
90 was determined with a confidence interval of 95%. Multivariate
91 logistic regression was used to find out the relationship between
92 each risk factor with meningitis risk. Data was analyzed by SPSS
93 software version 16. For comparison, Chi-square test or Fisher's
94 exact test was used. In order to compare the quantitative
95 variables between the two groups, independent T-test was used;
96 Mann-Whitney-U test was used if data was non-parametric.

97 3. RESULTS

98
99 Of 146 patients who underwent craniotomy in Shahid Bahonar Hospital Kerman in 2016, 13
100 (8.9%) cases developed bacterial meningitis. Comparison of nominal and quantitative
101 variables is presented in Tables 1-16 separately.

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

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

104 *P=0.28*

105
106 According to Table 1, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in
107 2016, 77 cases had elective surgery and 69 patients underwent emergency surgery. Of 77
108 cases undergoing elective surgery, 5 (6.5%) developed bacterial meningitis. Of patients who
109 underwent emergency surgery, 8 cases (11.6%) developed bacterial meningitis; there was
110 no significant difference in prevalence of bacterial meningitis between the two groups of
111 patients undergoing emergency and elective craniotomy.

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

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

114 $P=0.346$

115

116 According to Table 2, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in
 117 2016, 43 cases were female and 103 patients were male. Two of 43 female patients (4.7%)
 118 and 11 of 103 male patients (10.7%) developed bacterial meningitis. There was no
 119 significant difference in prevalence of bacterial meningitis between male and female patients.

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

Meningitis	Age	
	Mean	Std.
Yes	50.76	5.2
No	45.27	1.9

122 $P=0.384$

123 According to Table 3, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in
 124 2016, 13 cases developing bacterial meningitis aged 50.76 ± 5.2 and other patients aged
 125 45.27 ± 1.9 , which indicated no significant difference.

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

Meningitis Addiction	Yes	No	Total
Yes	54 (14.3%)	30 (85.7%)	35
No	8 (7.2%)	103 (92.8%)	111
Total	13	133	146

128 $P=0.302\%$

129

130 According to Table 4, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in
 131 2016, 35 cases were addicted and 111 patients were not addicted. Five of addicted
 132 patients (14.3%) developed bacterial meningitis and 111 of non-addicted patients (7.2%)
 133 developed bacterial meningitis. There was no significant difference.

134 **Table 5. Comparison of prevalence of bacterial meningitis among patients undergoing**
 135 **craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of underlying**
 136 **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

137 $P=0.177$

138

139 According to Table 5, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in
 140 2016, 71 cases had underlying disease and 75 patients had no underlying disease. Four
 141 of patients with underlying disease (5.6%) developed bacterial meningitis and 9 of other
 142 patients (12%) developed bacterial meningitis. There was no significant difference.

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

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

146 $P=0.025$

147

148 According to Table 6, the number of the blood units received was 2.85 ± 0.64 in the group
 149 with bacterial meningitis and 1.21 ± 0.22 in other groups; there was a significant difference
 150 between the two groups in terms of the number of blood units received.

151 **Table 7. Comparison of prevalence of positive culture of cerebrospinal fluid in terms of**
 152 **bacterium among patients undergoing craniotomy in Shahid Bahonar Hospital of**
 153 **Kerman in 2016**

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

154

155 According to Table 7, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in
 156 2016, 13 cases developed bacterial meningitis; 5 of them had positive culture of
 157 cerebrospinal fluid.

158 **Table 8. Comparison of prevalence of bacterial meningitis among patients undergoing**
 159 **craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of associated**
 160 **infection**

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

161 $P<0.01$

162

163 According to Table 8, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in
 164 2016, 17 cases had associated infection; 9 of them (52.9%) developed bacterial meningitis.
 165 Of 125 cases who had no associated infection, 4 (3.1%) developed meningitis; bacterial
 166 meningitis was significantly higher in patients with associated infection.

167

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

Meningitis	APACHE score	
	Mean	Std.
Yes	17	1.62
No	11.36	0.53

171 $P=0.099$

172

173 According to Table 9, the mean of APACHE score was 17 ± 1.62 in the group with bacterial
 174 meningitis and 11.36 ± 0.53 in other patients, and this difference was not significant.

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

Meningitis	Mechanical ventilation time	
	Mean	Std.
Yes	37.23	8.50
No	5.38	0.86

178 $P=0.01$

179
 180 According to Table 10, mechanical ventilation time was 37.23 ± 8.50 days in the group with
 181 bacterial meningitis and 5.38 ± 0.86 days in other patients. Mechanical ventilation time was
 182 significantly higher in the group with bacterial meningitis.

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

Meningitis	ICU admission time	
	Mean	Std.
Yes	37.92	8.55
No	6.87	0.88

186 $P<0.001$

187
 188 According to Table 11, ICU admission time was 37.92 ± 8.55 days in the group with bacterial
 189 meningitis and 6.87 ± 0.88 days in other patients; ICU admission time was significantly higher
 190 in the group with bacterial meningitis.

191 **Table 12. comparison of prevalence of bacterial meningitis among patients**
 192 **undergoing craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of**
 193 **cerebrospinal fluid leakage**

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

194 $P=1.00$

195
 196 According to Table 12, 4 of 146 patients undergoing craniotomy had cerebrospinal fluid
 197 leakage and none of them developed bacterial meningitis; there was no significant difference
 198 in prevalence of bacterial meningitis in terms of cerebrospinal fluid leakage.

199 **Table 13. Comparison of prevalence of bacterial meningitis among patients**
 200 **undergoing craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of**
 201 **repeated surgery**

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

202 $P<0.01$

203

204 According to Table 13, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in
 205 2016, 39 cases had repeated surgery; 9 of them (23.1%) developed bacterial meningitis. Of
 206 cases who had not repeated surgery, 4 developed meningitis; bacterial meningitis was
 207 significantly higher in patients with repeated surgery.

208 **Table 14. Comparison of prevalence of bacterial meningitis among patients**
 209 **undergoing craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of**
 210 **presence of neurosurgeon attendant**

Meningitis Presence of attendant	Yes	No	Total
	Yes	8 (8.6%)	
No	5 (9.4%)	48 (90.6%)	53
Total	13 (8.9%)	133 (91.1%)	146

211 $P=1.00$

212
 213 According to Table 14, of 146 patients undergoing craniotomy in Shahid Bahonar hospital in
 214 2016, 93 cases were operated on in the presence of a neurosurgeon attendant; 8 of them
 215 (8.6%) developed bacterial meningitis. Of other patients, 5 (9.4%) developed meningitis;
 216 there was no significant difference in prevalence of bacterial meningitis in patients
 217 undergoing craniotomy in terms of the presence of neurosurgeon attendant.

218 **Table 15. Comparing the mean of CGS between the group with bacterial meningitis**
 219 **and other patients undergoing craniotomy in Shahid Bahonar Hospital of Kerman in**
 220 **2016**

Meningitis	GSC	
	Mean	Std.
Yes	9.85	1.21
No	12.65	0.32

221 $P=0.012$

222
 223 According to Table 15, GCS was 9.85 ± 1.21 in the group with bacterial meningitis and
 224 12.65 ± 0.32 in other patients; mean of GCS was significantly lower in the group with bacterial
 225 meningitis than other patients.

226 **Table 16. comparing the prevalence of bacterial meningitis in patients undergoing**
 227 **craniotomy in Shahid Bahonar Hospital of Kerman in 2016 in terms of hospitalization**
 228 **time**

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

229 $P<0.001$

230
 231 According to Table 16, hospitalization time was 45.61 ± 8.39 in the group with bacterial
 232 meningitis and 13.45 ± 1.28 in other patients; hospitalization time was significantly higher in
 233 the group with bacterial meningitis than other patients.

234
 235 **4. DISCUSSION AND CONCLUSION**

236
 237 In general, 146 patients who underwent craniotomy in Shahid
 238 Bahonar Hospital of Kerman in 2016 were enrolled in this study;

239 13 cases (8.9%) developed bacterial meningitis, 5 of them had
240 positive CSF culture for bacteria; one case of acinetobacter
241 Bomani, S. epidermidis, one case of streptococcus, one case of
242 S.aureus and one case of pseudomonas aeruginosa were
243 reported. Various statistics have been reported for the prevalence
244 of meningitis following craniotomy. In a study conducted in Brazil,
245 the incidence of meningitis was 8.9% and gram negative bacilli
246 were the most common causes of infection. Among the risk
247 factors for infection, only repeated surgical procedures were
248 significant [7]. In another study in Italy, the incidence of meningitis
249 after head and neck surgery was 1.4% [8]. In another study, the
250 incidence of meningitis was 5.5%, most of which were due to
251 gram-positive cocci [9]. In a study in India, the incidence of
252 infection was 2.1% with a mortality rate of 5%; the most common
253 organism in this study was gram-negative bacilli [10]. In another
254 study, the incidence of meningitis was 2.7%; the most common
255 organisms were Staphylococcus aureus and Acinetobacter [11].
256 In a study in Iran, this prevalence was 4.7%, which is higher than
257 that of the developed countries [5]. According to the results
258 obtained in this study, there was a significant relationship between
259 the prevalence of bacterial meningitis after craniotomy and the
260 amount of received blood, associated infection, hospitalization
261 time, ICU admission time, duration of mechanical
262 ventilation, repeated craniotomy and GCS. According to results of
263 this study, the prevalence of bacterial meningitis increased with
264 the increase in the number of received blood units, the presence
265 of associated infection, the increase in duration of stay in hospital
266 and ICU, increased duration of mechanical ventilation, repeated
267 craniotomy and lower GCS. The results showed that patients
268 with diabetes and those who have cerebrospinal shunts have a
269 higher risk for meningitis [12]. The study, which was conducted in
270 2015, reported the risk factors for post-operative neurosurgery
271 infections as monitoring after intracranial surgeries, ventricular
272 drainage, cerebrospinal fluid leakage, long procedures, foreign
273 objects, multiple surgeries, and shunt infections and emergency
274 procedures [1]. Another study showed that postoperative
275 cerebrospinal fluid fistula increases the risk of meningitis [13].
276 Another study done in 2015 found that patients with unhealthy

277 body mass index were at greater risk for cerebrospinal fluid
278 leakage and meningitis. Moreover, older patients had a higher
279 cerebrospinal fluid leakage. The length of lumbar drainage was
280 associated with infection. In this study, BMI was the most
281 important predictor of cerebrospinal fluid leakage and infection.
282 Other risk factors include age, intraoperative cerebrospinal fluid
283 leakage, duration of lumbar drain, and combined brain surgeries
284 [14].

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UNDER PEER REVIEW