Diagnostic Brain Medicine

CLINICAL RESEAPCH

Etiological Characteristics and Related Factors of Intracranial Infection after Craniocerebral Trauma Surgery

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Keywords

Craniocerebral trauma, Intracranial infection, Etiological characteristic, Risk factors

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Abstract

Objective To explore etiological characteristics and related factors contributing to intracranial infection after craniocerebral trauma surgery. **Methods** According to whether postoperative intracranial infection occurred, 293 cases of patients with craniocerebral trauma admitted to our hospital from March 2016 to October 2019 were divided into observation group (n = 78) and control group (n = 215). The pathologic features and related risk factors of intracranial infection after traumatic brain injury were observed and analyzed from secretion culture of all patients. **Results** There were 97 strains of pathogens in the blood culture of the observation group,with Pseudomonas aeruginosa and Escherichia coli accounting for 24.74% and 18.56%, respectively (P<0.05). The postoperative prevention of antibiotic use, postoperative albumin level and postoperative use of hormones were all independent risk factors for intracranial infection after craniocerebral trauma (P<0.05). **Conclusion** Traumatic brain injury in patients with intracranial infection was influenced by a variety of factors. Medical workers should minimize the operation time to prevent cerebrospinal fluid incision leakage, postoperative catheter drainage, postoperative preventive use of antibiotics. Moreover, improving postoperative albumin and reducing the use of hormones after surgery, carefully paying more attention to patients more attention are all important in lowering the possibility of developing intracranial infection.

Introduction

The currrent research at our hospital was carried out after obtaining the approval of the medical ethics committee of the hospital. The 293 patients with craniocerebral trauma admitted to the hospital from March 2016 to October 2019 were taken as the research objects. According to whether they showed postoperative intracranial infection, they were divided into an observation group (78 cases) and a control group (215 cases). Clinical data of patients were collected with the consent from patients and their family. The general clinical data of the two groups of patients were compared, see Table 1 for details. There were no significant differences in age composition, disease course, ratios of males to females, or body mass index (P>0.05).

Table 1: Comparison of general clinical data between the two groups

	Observation group（n=78）	Control group（n=215）	Statistical value	P Value
Age（¯x±s，years old）	45.38±5.61	45.81±5.27	0.6067	0.5445
Sex ratio [n(%)]			0.2724	0.6017
Male	46（58.97）	124（57.67）		
Female	37（47.44）	114（53.02）		
Body mass（¯x±s，kg/m²）	23.21±2.17	23.40±2.03	0.6951	0.4876
Course of disease(¯x±s ,days）	8.26±5.09	8.94±5.29	0.9822	0.3268

Inclusion and exclusion criteria

Inclusion criteria: ①A clear history of craniocerebral trauma; ②After surgery, patients showed headache, high fever, stiff neck, or projectile vomiting, etc.; ③The blood test showed white blood cells>10*109/L; ④Cerebrospinal fluid showed white blood cells>0.01* 109/L, of which glucose quantitative examination <400mg/L, multinucleated cells>50%, protein quantitative>450mg/L; ⑤The presence of abscess was confirmed by brain imaging examination. The control group had to meet the ① of the inclusion criteria, while the observation group needs to meet the above 6 items.

Exclusion criteria: ①The presence of intracranial arteriovenous malformations, nervous system tumors, hypertensive encephalopathy, or intracranial aneurysms, etc.; ②Serious infections before surgery; ③Patients after ventricle-abdominal cavity separation; ④Patients without mental illness.

Research design

Local disinfection was performed on all patients with secretions to collect 3-5ml of secretions, which was placed in a sterile container for immediate inspection. Two consecutive cultures of pathogenic bacteria were considered positive. Clinical data of patients, such as age, gender, operation time, catheter drainage, cerebrospinal fluid incision leakage, postoperative preventive use of antibiotics, postoperative albumin level and postoperative hormone use, etc., were collected, quantified and assigned values, for the comparison and analysis of the risk factors to the occurrence of intracranial infection to patients undergoing craniocerebral trauma surgery.

Statistical analysis

The data of this study were statistically analyzed using SPSS20.5 software. In univariate analysis, count data and grade data were respectively subjected to chi-square test and rank-sum test. The t test was used for measurement data. P<0.05 defined a statistical difference. Multivariate analysis was performed adopting logistic regression analysis.

Results

Pathogenic bacteria identified from the observation group and their composition

In the observation group, 97 strains of pathogenic bacteria were identified in the co-cultured secretion of the patients, of which Pseudomonas aeruginosa and Escherichia coli accounted for 24.74% and 18.56%, respectively. See Table 2 for details.

Table 2: Pathogenic bacteria identified from the observation group and their composition

Pathogenic bacteria	Numbers of strain	Composition ratio
Streptococcus pneumoniae	6	6.19
Staphylococcus epidermidis	7	7.22
Perfringens	3	3.09
Staphylococcus aureus	13	13.40
Haemophilus influenzae	8	8.25
Klebsiella pneumoniae	6	6.19
Escherichia Coli	18	18.56
Enterobacter cloacae	5	5.15
Pseudomonas aeruginosa	24	24.74
Acinetobacter baumannii	7	7.21

Analysis of resistance of Pseudomonas aeruginosa and Escherichia coli to common drugs

Pseudomonas aeruginosa showed high resistant to amoxicillin, cefotaxime, and ceftriaxone, while it was noticeably sensitive to cefoperazone, sulbactam, levofloxacin, and meropenem. Escherichia coli showed high resistant to amoxicillin Cilin, cefotaxime, and cefazolin and a strong sensitivity to compound trimethoprim, cefoperazone and sulbactam, levofloxacin and meropenem.

Table 3: Analysis of resistance of Pseudomonas aeruginosa and Escherichia coli to common drugs

Antibacterial drugs	Pseudomonas aeruginosa		Escherichia coli	
	Number of strain	Resistance rate	Number of strain	Resistance rate
Compound trimethoprim	14	58.33	1	5.56
Ciprofloxacin	5	20.83	5	27.78
Ampicillin	15	62.50	10	55.56
Amoxicillin	20	83.33	16	88.89
Ceftriaxone	19	79.17	12	66.67
Gentamicin	10	41.67	10	55.56
Cefoxitin	6	25.00	5	27.78
Levofloxacin	1	4.17	1	5.56
Meropenem	0	0.00	0	0.00
Cefoperazone/Sulbactm	1	4.17	0	0.00
Cefepime	5	20.83	6	33.33
Cefotaxime	21	87.50	14	77.78

Cefazolin	17	70.83	13	72.22

Comparative analysis of related factors of intracranial infection in the two groups of patients

Comparison results of the related factors of intracranial infection in the two groups of patients were shown in Table 4. It was found that operation time, catheter drainage, cerebrospinal fluid incision leakage, postoperative preventive use of antibiotics, postoperative albumin level and postoperative use of hormones were all related factors contributing to craniocerebral infection after craniocerebral trauma surgery ($P < 0.05$).

Table 4: Comparative analysis of related factors of intracranial infection in the two groups of patients

Related factors		Observation group (n=78)	Control group (n=215)	Statistical value	P value
Age (years old)	< 45	31 (39.74)	87 (41.86)	0.0396	0.8423
	≥45	47 (60.26)	125 (57.14)		
Operation time	< 3h	24 (30.77)	108 (50.23)	8.7586	0.0031
	≥3h	54 (69.23)	107 (49.77)		
Catheterization	Yes	28 (35.90)	150 (69.77)	27.5368	< 0.0001
	No	50 (64.10)	65 (30.23)		
Consciousness disorder	Yes	12 (15.38)	27 (12.56)	1.0758	0.2996
	No	66 (84.62)	188 (87.44)		
Hypotension	Yes	21 (26.92)	40 (18.60)	2.4025	0.1211
	No	57 (73.08)	175 (81.40)		
cerebrospinal fluid incision leakage	Yes	10 (12.82)	8 (3.72)	8.2194	0.0041
	No	68 (87.18)	207 (96.28)		
Postoperative preventive use of antibiotics	Yes	19 (24.36)	172 (80.00)	78.0832	< 0.0001
	No	59 (75.64)	43 (20.00)		
Postoperative albumin	< 35g/L	41 (52.56)	48 (22.33)	24.7458	< 0.0001

	≥35g/L	37（47.44）	167（77.67）		
Postoperative use of hormones	Yes	42（53.85）	86（40.00）	4.4603	0.0347
	No	36（46.15）	129（60.00）		

Analysis of independent risk factors for traumatic brain injury patients with postoperative craniocerebral infection traumatic brain injury

Through logistic analysis, we found that operation time, catheter drainage, cerebrospinal fluid incision leakage, postoperative preventive use of antibiotics, postoperative albumin level and postoperative hormone use were all independent risk factors for leading tocraniocerebral infection after craniocerebral trauma surgery. (P<0.05). See Table 5.

Table 5: Analysis of independent risk factors for traumatic brain injury patients with postoperative craniocerebral infection traumatic brain injury

Related factors	Regression coefficients	wald	P value	OR value
operation time	1.37	11.37	0.00	3.68
Intubation and drainage	2.67	10.76	0.00	9.64
cerebrospinal fluid incision leakage	0.94	7.28	0.01	3.68
Preventive use of antibiotics after surgery	1.14	5.36	0.01	3.27
Postoperative albumin	1.64	7.67	0.02	4.73
Use of hormones after surgery	1.22	1.69	0.00	3.55

Discussion

Surgical operation is a main treatment for managing craniocerebral injury. However, the attenuation of surgical treatment to the injury condition is also accompanied with various complications, commonly such as hydrocephalus, cerebral edema, encephalocele, intracranial hypertension, and intracranial infection or the interaction of some of these complications, greatly affecting the prognosis of the patients [6~9]. Intracranial infection is a more significant complication. According to statistics, the incidence of intracranial infection is as high as 14%, commonly occurring at 4 to 10 days after surgery, and its mortality rate reached 25-42%. The possible reasons are summarized as follows: ①Severe condition of patient's after traumatic brain injury, especially for those with a low GCS score. In this circumstance, the normal physiological function and immunity of patients will decline significantly, and they are often accompanied by increased infection, coma and vomiting at varying degrees; ② After craniocerebral damage, the intracranial hypertension may cause dehiscence of local wounds, which is prone to develop infection; ③ Liquefied necrotic edema brain tissues provide pathogens invading the brain. At the same time, surgical treatment will destroy the blood-brain barrier in the skull, allowing the pathogenic bacteria to enter the skull through various open channels and cause infection [10-13]. Therefore, clarifying the etiological characteristics and risk factors of intracranial infection after craniocerebral trauma is highly significant for an effective treatment.

In this study, 293 patients with craniocerebral trauma admitted to our hospital from March 2013 to October 2016 were included. First, blood of the patients with craniocerebral trauma were collected and cultured to identify pathogens. We detected 97 strains of pathogenic bacteria from the secretions of patients with intracranial infection, among which Pseudomonas aeruginosa and Escherichia coli accounted for 24.74% and 18.56%, respectively. This study observed that operation time, catheter drainage, cerebrospinal fluid incision leakage, postoperative preventive use of antibiotics, postoperative albumin level, and postoperative hormone use were all independent factors causing craniocerebral infections after craniocerebral trauma surgery. To be more specific, as the operation time increases, the damaged area of the brain is exposed to bacteria for a longer time, thus, the chance of infection will be increased significantly. Previously, studies showed [14~15] that the chance of developing postoperative body infection exceeds 47% when the operation time of more than 4 hours. It is believed that the operation time is positively correlated with the incidence of intracranial infection. For catheter drainage, after cranial trauma surgery, commonly, a drainage tube is required to be placed in the subdural and epidural residual cavity to fully drain the residual blood. Reports found [16-18] that the cause of infection is mainly related to factors such as insufficient drainage and bacterial contamination of the drainage port. Moreover, for cerebrospinal fluid incision leakage, when cerebrospinal fluid leakage occurs, an accumulation of fluid under the scalp is easily to breed a large number of bacteria, eventually leading to the occurrence of intracranial infection. Postoperative preventive use of antibiotics is another risk factor. As the body resistance of patients with traumatic brain injury is significantly reduced, bacteria can easily enter the skull through various open channels and induce infection. Therefore, based on the characteristics of common pathogens of intracranial infection, prophylactic antibiotic treatment can significantly reduce the infection rate [19]. Protein is the main component of human antibodies, and antibodies participate in the body's humoral immunity, killing bacteria and viruses invading the body. Low level of protein is accompanied with reduced antibodies to resist the invasion of bacteria and viruses. Therefore, after craniocerebral trauma surgery, the serum albumin level should be closely monitored to determine the immune resistance of the body [20]. Inflammation is a natural process of anti-infection, and glucocorticoids have the immunosuppressive effect that limits the inflammatory response, leading to a decline in the body's immunity and spreading the infection.

In summary, this study analyzed the related factors of intracranial infection after craniocerebral trauma surgery, and found the operation time, catheter drainage, cerebrospinal fluid incision leakage, postoperative preventive use of antibiotics, postoperative albumin level and postoperative factors such as the use of hormones are all independent risk factors that contribute to intracranial infection after craniocerebral trauma surgery. Therefore, attention should be paid to patients who show the above risk factors. According to the pathogenic characteristics discovered in this study, providing appropriate and targeted antimicrobial treatment can effectively control the infection and facilitate a better recovery.

Declaration of conflict-of-interest

The authors declare no conflict-of –interest.

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