



Risk factors for meningitis after craniotomy in patients with subarachnoid hemorrhage due to anterior circulation aneurysms rupture



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ABSTRACT

Objectives: Postoperative meningitis is a serious complication occurring after neurosurgical interventions. However, few investigations have focused specifically on the risk factors that predispose patients to meningitis after major craniotomy. This study identified the risk factors for postoperative meningitis after neurovascular surgery, and investigated the relationship between postoperative meningitis and clinical outcome.

Patients and methods: A total of 148 consecutive patients with subarachnoid hemorrhage (SAH) who underwent clipping surgery through a pterional approach within 72 h between January 2007 and September 2011 were retrospectively analyzed. The treatment strategy of our hospital for patients with SAH was based on the findings of digital subtraction angiography in the acute phase. Coil embolization was firstly considered, and clipping through craniotomy if indicated was performed as soon as possible. Prophylactic antibiotics were administered before beginning craniotomy and for at least 3 days after. Hydrocortisone was used to prevent hyponatremia if allowed by the medical condition of the patient. Intrathecal administration of nicardipine hydrochloride was given if required for vasospasm treatment. Meningitis was clinically diagnosed from the blood samplings and cerebrospinal fluid (CSF) examinations. Data were collected from the electronic and paper charts. The status of modified Rankin scale (mRS) 0–2 at discharge was defined as favorable outcome.

Results: A total of 14 patients (9.5%) had meningitis during this study period. Symptomatic vasospasm was detected in 33 patients (22.3%), and 12 patients (8.1%) had permanent neurological deficits caused by vasospasm. Overall, 109 patients (73.6%) had favorable outcome. The longer duration of drainage placement, presence of CSF leakage, and intrathecal administration of vasodilatory agent showed significantly higher incidence of postoperative meningitis in univariate analysis ($p=0.0093$, 0.0017 , and 0.0090 , respectively). The proportion of favorable outcome patients at discharge (mRS 0–2) was significantly lower in patients with postoperative meningitis (35.7%) than in patients without it (77.6%) ($p=0.0004$). The duration of in-hospital stay was significantly longer in patients with postoperative meningitis (median 58.5, range 28–115 days) than in patients without it (median 38.5, range 19–149 days) ($p<0.001$). Multivariate logistic regression analysis showed that only presence of CSF leakage was associated with postoperative meningitis ($p=0.0299$).

Conclusion: Meningitis after surgery is still a serious complication that requires preventative intervention. The clinical outcome of patients with postoperative meningitis after neurovascular surgery is not still satisfactory.

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1. Introduction

Postoperative meningitis is a serious complication occurring after neurosurgical interventions. Comprehensive studies and reviews have examined the risk factors for neurosurgical site

Table 1
Characteristics of the patients (N = 148).^a

Age, years, median (range)	62.0 (29–85)
Female sex, no. (%)	100 (67.6)
DM, no. (%)	9 (6.1)
Tobacco use (ever), no. (%)	63 (42.6)
WFNS grade, no. (%)	
I	71 (48.0)
II	38 (25.7)
III	8 (5.4)
IV	26 (17.6)
V	50 (33.8)
Median surgical duration, hours:minutes	4:39
Early re-operation (≤ 2 weeks), no. (%)	6 (4.1)
Antibiotic prophylaxis prescription, days, median (range)	13 (0–23)
Sultamicillin, no. (%)	102 (68.9)
Cefazolin, no. (%)	9 (6.1)
Duration of CCD/CVD placement, days, median (range)	12 (4–21)
Steroid use, no. (%)	110 (74.3)
CSF leakage, no. (%)	80 (54.1)
Intrathecal administration of vasodilatory agent, no. (%)	26 (17.6)
Symptomatic vasospasms, no. (%)	
None	115 (77.7)
Temporary	21 (14.2)
Permanent	12 (8.1)
mRS at discharge, no. (%)	
0	54 (36.5)
1	41 (27.7)
2	14 (9.5)
3	20 (13.5)
4	13 (8.8)
5	4 (2.7)
6	2 (1.4)
In-hospital stay, days, median (range)	40.0 (10–149)
Meningitis, no. (%)	14 (9.5)

^a CCD/CVD, continuous cisternal and/or ventricle drainage; CSF, cerebrospinal fluid; DM, diabetes mellitus; mRS, modified Rankin scale; WFNS, World Federation of Neurosurgical Societies.

infection, including meningitis [1–9]. However, few investigations have focused specifically on the risk factors that predispose patients to meningitis after major craniotomy. Neurovascular surgery is a controversial risk factor [8,10]. The risk of the postoperative meningitis is unclear, a study has been reported that the postoperative meningitis has been observed in 11.3% of patients treated with neurovascular surgery [8], and another reported that postoperative meningitis was observed in only 1.4% of patients during the study period [10]. One of the reasons for this situation is the absence of assessment focused on patients undergoing neurovascular surgery, especially clipping surgery for acute subarachnoid hemorrhage (SAH).

This study investigated patients treated for SAH to clarify the risk factors for postoperative meningitis after neurovascular surgery, and to investigate the relationship between postoperative meningitis and clinical outcomes.

2. Subjects and methods

2.1. Patients

A total of 148 consecutive patients, 100 females and 48 males aged 29–85 years (median 62.0 years) with SAH who underwent clipping surgery through the pterional approach within 72 h of onset between January 2007 and September 2011 were retrospectively analyzed (Table 1). Patients who needed extracranial–intracranial bypass (25 cases) and/or external decompression surgery (12 cases) were not included. The location of aneurysms were anterior communicating artery 78, internal carotid artery 55, and middle cerebral artery 48 (43 cases were multiple cases). The transfusion of red blood cell was needed in 11 patients (5 intraoperatively and 6 after surgery). The treatment

strategy of our hospital for patients with SAH was based on the findings of digital subtraction angiography in the acute phase. Coil embolization was firstly considered, and clipping through craniotomy if indicated was performed as soon as possible. Prophylactic antibiotics were administered before beginning craniotomy and for at least 3 days after via intravenously [10]. Continuous cisternal and/or ventricle drainage (CCD/CVD) was routinely placed using by the normal drain (the antibiotic impregnated drain is not permitted in Japan. Hydrocortisone (1.2 g per day, from the next day of surgery to 14th day) was used to prevent hyponatremia if allowed by the medical condition of the patient [11,12]. Patients with suspected symptomatic vasospasm underwent magnetic resonance imaging and angiography for diagnosis. Intrathecal administration of nicardipine hydrochloride was given twice a day if required, when the patient show neurological deficit considered for vasospasm with neurological imaging findings until disappearance of the vasospasm [13]. Meningitis was clinically diagnosed from the peripheral leukocyte counts, C-reactive protein, fever, increased cell count, decreased glucose level in cerebrospinal fluid (CSF), and presence of positive CSF cultures.

2.2. Data collection

Data were collected from the electronic and paper charts. Use of the data was approved by the local Institutional Review Board. The following parameters were collected: previous diagnosis of diabetes mellitus (DM), tobacco use (ever), World Federation of Neurosurgical Societies (WFNS) grade, duration of surgery (defined as the time from incision until the end of anesthesia), early re-operation, adherence to perioperative antibiotic prophylaxis, CCD/CVD placement, steroid use, presence of CSF leakage, intrathecal administration of vasodilatory agents, symptomatic vasospasm, modified Rankin scale (mRS) at discharge, in-hospital stay, and meningitis (Table 1). Adherence to antibiotic prophylaxis perioperatively was defined as antibiotics administered within 60 min prior to the incision. The status of mRS 0–2 at discharge was defined as favorable outcome.

2.3. Statistical analysis

Data are expressed as the median and range. Bivariate associations between categorical study factors and the occurrence of meningitis were assessed using the Fisher exact test. Bivariate associations between continuous study factors and the occurrence of meningitis were assessed using the Wilcoxon rank-sum test. The probability of postoperative meningitis was modeled as a function of study factors using conditional logistic regression. Univariate conditional logistic regression was performed to identify the factors associated with occurrence of meningitis. The study factors with less than $p = 0.5$ in conditional univariate logistic regression analysis were entered into a conditional multivariate logistic regression and backwards eliminated according to both statistical and clinical judgments. Models were assessed for collinearity. Differences were considered significant at probability values of less than 0.05.

3. Results

A total of 14 (9.5%) of the 148 patients had meningitis during this study period. *Staphylococcus aureus* (12 cases) is the most commonly detected, and *Escherichia coli* and Streptococci are cultured in a case, respectively.

Favorable outcome was found in 109 patients (73.6%). Symptomatic vasospasm was detected in 33 patients (22.3%), and 12 patients (8.1%) had permanent neurological deficits caused by vasospasm. Median in-hospital stay was 40.0 (range 10–149) days.

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