Clinical Neurology and Neurosurgery 139 (2015) 41–45

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

The characteristics of post-neurosurgical bacterial meningitis in elective neurosurgery in 2012: A single institute study

Runfa Tian[a,e,f,1], Shuyu Hao[a,e,f,1], Zonggang Hou[a,e,f], Zhixian Gao[a,e,f], Baiyun Liu[a,b,c,d,e,f,*]

[a] Department of Neurosurgery, Beijing Tian Tan Hospital, Capital Medical University, Beijing, China
[b] Nerve Injury and Repair Center of Beijing Institute for Brain Disorders, Beijing, China
[c] Neurotrauma Laboratory, Beijing Neurosurgical Institute, Capital Medical University, Beijing, China
[d] Department of Neurotrauma, General Hospital of Armed Police Forces, Beijing, China
[e] China National Clinical Research Center for Neurological Diseases, Beijing, China
[f] Beijing Key Laboratory of Central Nervous System Injury, Beijing, China

ARTICLE INFO

Article history:
Received 9 January 2015
Received in revised form 10 August 2015
Accepted 2 September 2015
Available online 5 September 2015

Keywords:
Bacterial meningitis
Characteristics
Post-neurosurgical
Season
Single entire year

ABSTRACT

Objective: Most post-neurosurgical meningitis research has been focused on large cohorts with numerous cases followed over several years. However, the characteristics of post-neurosurgical meningitis in an entire single year are still unclear, and knowledge of these characteristics might influence the selection of appropriate antibiotics and therapeutic strategies for the successful management of this disease. Our aim is to obtain a better understanding of post-neurosurgical meningitis over a single entire year.
Materials and methods: Patients with positive meningitis cultures after neurosurgical operations in our hospital during the entire year of 2012 were included in the analysis. We report demographic characteristics, morbidity during different seasons, clinical and bacteriological profiles, sensitivity to antibiotics and causes of the post-neurosurgical meningitis infections in our cohort.
Results: Of the 6407 patients who underwent neurosurgical procedures during the study period, 146 developed post-neurosurgical meningitis and the overall incidence of meningitis was 2.28%. The incidence of meningitis was significantly higher in patients who underwent surgery in the autumn and winter than spring or summer ($p = 0.000$). The most common organisms causing meningitis were Gram-positive bacteria, followed by the *Klebsiella* and *Baumannii* species. Compound sulfamethoxazole (52.6%) and vancomycin (10.5%) were the most active antibiotics against Gram-positive bacteria strains, whereas meropenem (43.8%) and polymyxin (18.8%) were active against Gram-negative bacillus strains.
Conclusions: Post-neurosurgical meningitis usually occurs in the autumn and winter of the year in our hospital. Gram-positive organisms, which are sensitive to compound sulfamethoxazole and vancomycin, are the most common causative pathogens of post-neurosurgical meningitis in the northern mainland of China.

1. Introduction

Nosocomial infections are the most common causes of morbidity and mortality in patients with neurosurgical operations. Among the nosocomial infections, meningitis is the most dreaded infection and can lead to a variety of complications, including death. The diagnosis of meningitis requires a high degree of clinical suspicion and an examination of the cerebrospinal fluid (CSF). Post-neurosurgical meningitis is associated with increases in the duration of hospital stay and in the total cost of illness. Moreover, the management of post-neurosurgical bacterial meningitis is a therapeutic dilemma because of the associated neurosurgical procedures are complicated, diagnostic confirmation is difficult, and the appropriate antibiotics must be selected [1–3].

The reported incidence of post-neurosurgical meningitis is quite variable (0.5–8%) [4,5]. The epidemiology of bacterial meningitis can be altered by several factors, including the various time periods of study, geographic distribution, age, race, underlying medical and/or neurosurgical conditions, means of contraction, status of

* Corresponding author at: Department of Neurosurgery, Beijing Tian Tan Hospital, Capital Medical University, Tiantan Xili 6, Dongcheng District, Beijing 100050, China.
E-mail address: liubaiyun1212@163.com (B. Liu).
[1] These authors contributed equally to this work.

http://dx.doi.org/10.1016/j.clineuro.2015.09.002
0303-8467/

vaccination, and use of antibiotics in the community [1]. Most of the post-neurosurgical meningitis study has been conducted with large cohorts with numerous cases followed over several years. However, the characteristics of meningitis after neurosurgery in an entire single year are still unclear, which might influence the therapeutic strategies of post-neurosurgical meningitis. In this article, we report the demographic characteristics, morbidity in the different seasons, clinical and bacteriological profiles, sensitivity to antibiotics and the causes of the post-neurosurgical meningitis at the department of neurosurgery, Beijing Tian Tan Hospital, Capital Medical University, Beijing, China over the entire year of 2012 (2012.1.1–2012.12.31) to obtain a better understanding of postoperative meningitis after neurosurgery in a single year.

2. Methods

2.1. Subjects

This study was approved by the Research Ethics Committee of Beijing Tian Tan Hospital. This was a retrospective study, and the cohort included all patients who underwent various neurosurgical procedures in our hospital over a period of a single year. Our hospital is one of the largest neurosurgical centers in the northern mainland of China, with 6000–7000 routine neurosurgical operations each year.

2.2. Data Collection

Only patients with a positive culture for meningitis were included in this study for the analysis. The case records and a computerized log containing records of all of the infections (culture reports) occurring in the department of neurosurgery in our hospital were reviewed. A CSF analysis was performed, unless contraindicated, in all of the patients with clinical features of meningism. The demographic characteristics, morbidity in the different seasons, and the causative organism, along with the antibiotic sensitivity profile of the organism and the infection's causes were analyzed. The antibiotic sensitivity pattern of the organism was also analyzed.

2.3. Patient management

Perioperative patient management protocol: All patients who are scheduled for elective surgery are first examined for any condition that precludes surgery. This involves a preoperative fitness clearance from the anesthetists. The antibiotics used are dependent on the prevalent pattern of antibiotic sensitivity. Strict precautions are taken throughout to ensure that there is no perioperative breach in sterility [6]. In this study, the analysis of the antibiotic's susceptibility was based on the National Committee for Clinical and Laboratory Standards/Clinical and Laboratory Standards (NCCLS/CLS) methods. Intermediate and resistant isolates were considered nonsusceptible [7]. As a rule, we follow a policy of CSF analysis (unless contraindicated) before starting empiric antibiotics. In the study period, vancomycin plus a 3rd- or 4th-generation cephalosporin were the initial empiric antibiotics used in the treatment of patients with suspected bacterial meningitis in our hospital, and the antimicrobial regimen was adjusted subsequently after the culture results were made available.

2.4. Statistical analysis

Statistical analysis was performed using SPSS (SPSS for Windows, Version 18.0, SPSS Inc., Chicago, IL, USA). The incidence of meningitis in the different seasons and the bacteria were compared using the Chi-square test. A $p < 0.05$ was considered statistically significant.

Table 1
The demographic and operation characteristics of the cases.

Subgroup	Number (%)
Age (years)	
Median (range)	37.5 (3–68)
Gender (%)	
Male	85 (58.2%)
Female	61 (41.8%)
Incision type (%)	
Type I (sterile incision)	107 (73.3%)
Type II (infected incision)	39 (26.7%)
Operation time (%)	
≤4 h	61 (41.8%)
>4 h	85 (58.2%)
Incision drainage (%)	
Yes	54 (37.0%)
No	92 (63.0%)
Respirator assistant time (%)	
0	140 (95.9%)
1 d	5 (3.4%)
>1 d	1 (0.7%)
Tracheal incision (%)	
Yes	13 (8.9%)
No	133 (91.1%)
Lung infection (%)	
Yes	17 (11.6%)
No	129 (88.4%)
CSF leakage (%)	
Yes	12 (82.2%)
No	134 (91.8%)
Incision infection (%)	
Yes	13 (8.9%)
No	133 (91.1%)
Cerebral ventricle punctures (%)	
Yes	6 (4.1%)
No	140 (95.9%)
Lumbar drainage (%)	
Yes	18 (12.3%)
No	128 (87.7%)
V-P shunt (%)	
Yes	7 (4.8%)
No	139 (95.2%)

3. Results

3.1. Demographic and operation characteristics

During the study period, 6407 patients underwent neurosurgical procedures, and the demographic and surgical characteristics of the meningitis cases are shown in Table 1. There were a total of 146 patients who developed post-neurosurgical meningitis. The overall incidence of post-neurosurgical meningitis was 2.28%, and the patients had a median age of 37.5 years. Four patients died during the study period, and the overall mortality was 2.76%, which includes the mortality caused by *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa* and *Faecium-chryseobacterium meningosepticum* infections. All 13 of the patients with tracheal incisions suffered lung infections during their hospitalization, including three of the four deceased cases in our cohort.

3.2. Incidence and organisms of meningitis in different seasons

The incidence and the organisms causing postoperative meningitis in neurosurgery in the different seasons are shown in Table 2. There were approximately 1670 operations in spring, summer and autumn, and because of the Chinese Spring Festival and other major winter festivals, the number of surgical operations was lower in the