Clinical Characteristics and Therapeutic Outcomes of Adult Enterococcal Meningitis

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Abstract

Enterococcal meningitis in adults has rarely been reported. The aim of this retrospective study was to examine the clinical characteristics and therapeutic outcomes of adults with enterococcal meningitis. Thirteen adult patients with supratentorial enterococcal meningitis were enrolled from 2000 to 2012. Laboratory data derived from cerebrospinal fluid, clinical features and therapeutic outcomes were analyzed. There were eight males and five females, aged 19 to 82 years. The isolated pathogens cultured from cerebrospinal fluid specimens were all *Enterococcus faecalis*. Eleven patients had post-neurosurgical enterococcal meningitis, and two had the spontaneous form. Fever and consciousness disturbance were the most common clinical features, followed by leukocytosis, hydrocephalus, septic shock, seizure and headache. Six patients had an immunocompromised status including diabetes, malignancy and liver cirrhosis. Five patients who had undergone neurosurgical procedures had enterococcal meningitis mixed with other pathogens. The overall mortality rate was 38.5%. The majority of patients received vancomycin combined with a third-generation cephalosporin. Enterococcal meningitis should be considered especially in patients who undergo neurosurgical procedures and subsequently present with the clinical features of meningitis including fever, altered consciousness, and hydrocephalus. Despite therapeutic efforts, the mortality rate was high in the patients with enterococcal meningitis. Therefore, early recognition and appropriate antimicrobial treatment are important for these patients. (J Intern Med Taiwan 2014; 25: 424-431)

Key Words: Enterococcal meningitis, Adult, Antibiotic, Outcome

Introduction

Enterococcus species are generally considered to be harmless and are found in the normal bowel microbiota of humans[1]. However, enterococci have emerged as a significant cause of nosocomial infections such as urinary tract infections, post-surgical site wound infections, intra-abdominal or intra-pelvic abscesses, and bacterial endocarditis in recent years[1]. Enterococcal meningitis is an uncommon form of bacterial meningitis. Neurosurgical procedures and nosocomial infections are important predisposing factors associated with enterococcal meningitis[2-5], and very few cases occur as a spontaneous infection. Enterococcal meningitis has a high mortality rate, with reported rates ranging

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from 10% to 58%[5], which has been reported to be associated with neurosurgical conditions such as shunt devices, cerebrospinal fluid (CSF) leakage, or head trauma[4,5]. The aim of this study was to analyze the clinical characteristics and therapeutic outcomes of patients with enterococcal meningitis in Taiwan.

Methods

Subjects

We retrospectively reviewed all patients with adult bacterial meningitis admitted to Kaohsiung Chang Gung Memorial Hospital over a period of 13 years (2000-2012). The clinical medical records and microbiological data of CSF and blood were reviewed. Kaohsiung Chang Gung Memorial Hospital is the largest medical center in southern Taiwan, and the facility is a 2,482-bed acute-care teaching hospital which serves as a primary and tertiary care center. In this study, the criteria for a definite diagnosis of adult bacterial meningitis were as follow: i) age ≧17 years; ii) positive CSF culture in patients with clinical presentations of acute bacterial meningitis including fever, headache, altered consciousness and seizure; and iii) at least one of the following CSF parameters: 1. a leukocyte count ≥ 10 cells/mm^3 with predominant polymorphonuclear cells; 2. a CSF lactate concentration > 3.5 mmol/L (31.5 mg/dL); 3. a glucose ratio (CSF glucose/serum glucose) < 0.4 or CSF glucose concentration < 2.5 mmol/L (45 mg/dL) if no simultaneous blood glucose was determined[3,4].

In this study, nosocomial meningitis was defined as a positive bacterial infection not present on hospital admission, clinical evidence of an infection no sooner than 48 hours after admission, or clinical evidence of meningitis within one month after discharge from the hospital where the patient received an invasive neurosurgical procedure. Otherwise, the patient was considered as having a "community-acquired" infection. The patients who developed meningitis related to head trauma with skull fractures or neurosurgical procedures were classified as having "post-neurosurgical" meningitis. Otherwise, the patients who demonstrated no clear distinctive disease characteristics and who had not undergone any invasive procedures were classified as having "spontaneous" meningitis. "Mixed-infection" was defined as at least two bacterial organisms isolated concomitantly from the initial CSF culture[2].

The analysis of antibiotic susceptibility was based on the American National Committee for Clinical Laboratory Standards (NCCLS) or Clinical and Laboratory Standards Institute (CLSI) methods. During the study period, vancomycin plus a third- or fourth-generation cephalosporin were the initial empiric antibiotics used to treat patients with suspected adult bacterial meningitis in our hospital, and the antimicrobial regimen was subsequently adjusted after the culture results were available.

Results

Characteristics and demographic data of the subjects

During the study period, a total of 13 patients with enterococcal meningitis were recruited, including 8 males and 5 females with a mean age of 59 years (range 19-82 years; SD = 17.809). Eight patients had a single pathogen (*Enterococcus faecalis*), and 5 patients had *Enterococcus faecalis* mixed with other pathogens (Table 1). Of these 13 patients, 2 (patients 5 and 8) had spontaneous meningitis and the other 11 had the post-neurosurgical form. Patients 1-4, 6, 7 and 9-13 were considered to have nosocomial meningitis because their infections occurred during hospitalization for neurosurgical procedures.

Of the clinical presentations, fever (13 patients) and consciousness disturbance (13 patients) were the most common, followed by leukocytosis (8 patients), hydrocephalus (7 patients), septic shock (3 patients), seizures (2 patients) and headache (1 patient). Among

Table 1. Basic clinical data in 13 patients with *Enterococcal faecalis* meningitis

Patient	Age (years)/ sex	Underlying conditions	Infection pattern	Conscious-ness level (GCS)	Clinical manifestations	Mixed with other microorganism	Treatment (daily dosage) (duration of treatment, days)	Outcome	Resistant
1	71/F	V-P shunt, DM, old stroke, parkinsonism	Nosocomial	11	Fever, consciousness disturbance, hydrocephalus	-	AMP (12gm/d) (27)	Lived	Gentamicin
2	19/M	Traumatic ICH, craniectomy and V-P shunt	Nosocomial	14	Fever, consciousness disturbance, abdominal pain	-	VA (2gm/d)+ ROC (4gm/d) (46)	Lived	None
3	77/M	Right thalamic hemorrhage with IVH, V-P shunt, CAD	Nosocomial	6	Fever, consciousness disturbance, seizure, hydrocephalus	-	VA (2gm/d) (15)	Died	Gentamicin
4	50/M	Left frontal SDH and ICH, craniectomy, Hodgkin's lymphoma, DM	Nosocomial	3	Fever, consciousness disturbance	-	AMP (12gm/d) (11)	Died	Gentamicin
5	78/F	Head trauma, urosepsis	Spontaneous	14	Fever, consciousness disturbance, headache	-	VA (2gm/d)+ GM (160mg/d) (30)	Lived	None
6	66/F	Spinal surgery	Nosocomial	2	Fever, consciousness disturbance	-	VA (2gm/d) +MEP (2gm/d) (3)	Died	Gentamicin
7	56/M	Liver cirrhosis, EVD	Nosocomial	8	Fever, consciousness disturbance, hydrocephalus	-	LZD (1.2gm/d) (30)	Died	Gentamicin
8	82/M	Liver cirrhosis, urosepsis, hypertension, CAD	Spontaneous	9	Fever, Consciousness disturbance	-	VA (1gm/d) +ROC (4gm/d) (15)	Lived	Gentamicin
9	48/F	Acoustic neuroma, craniectomy	Nosocomial	5	Fever, consciousness disturbance, hydrocephalus	*Pseudomonas aeruginosa*	CEF(6gm/d) + AMP(8gm/d) (26)	Lived	None
10	64/F	ICH, craniectomy and V-P shunt, DM	Nosocomial	3	Fever, consciousness disturbance, hydrocephalus	*Escherichia coli, Enterobacter cloacae*	VA(2gm/d)+CAZ (6gm/d) (14)	Died	Ampicillin
11	40/M	Aneurysm with SAH, craniectomy and V-P shunt	Nosocomial	12	Fever, consciousness disturbance, seizure, hydrocephalus	*Klebsiella oxytoca Escherichia coli Pseudomonas aeruginosa*	VA(2mg/d)+CAZ (6gm/d)+ metronidazole (2gm/d) (44)	Lived	None
12	68/M	ICH, V-P shunt	Nosocomial	7	Fever, consciousness disturbance, hydrocephalus	*Acinetobacter junii*	VA(2mg/d)+CAZ (6gm/d) (34)	Lived	Gentamicin
13	48/M	ICH, craniectomy, V-P shunt	Nosocomial	6	Fever, consciousness disturbance,	*Candida tropicallis Escherichia coli Acinetobacter bauamnnii*	AMP(8gm/d)+ Fluconazole (800mg/d) (23)	Lived	Gentamicin

Abbreviation: F: female; M: male; V-P , ventriculo-peritoneal shunt; DM, diabetes mellitus; ICH, intra-cranial hemorrhage; IVH, intraventricular hemorrhage; CAD, coronary artery disease; EVD, external ventricular drainage; SDH, subdural hemorrhage; GCS, Glasgow coma scale; AMP, ampicillin; VA, Vancomycin; ROC, ceftriaxone; GM, gentamicin; MEP, meropenem; LZD, Linezolid; CEF, Cefepime; CAZ, cefazidime

the associated conditions, 10 patients (patients 1-4, 7, 9-13) had undergone neurosurgical procedures including a ventriculo-peritoneal shunt (V-P shunt), external ventricular device (EVD), craniotomy and craniectomy. Patient 6 had bilateral retroperitoneal abscesses post laminectomy and lumbar anterior interbody fusion. Three patients (patients 1, 4 and 10) had diabetes mellitus, 2 patients (patients 7 and 8) had liver cirrhosis, and 1 patient (patient 4) had Hodgkin's lymphoma.

Table 2 shows the basic laboratory data of the 13 adult patients with enterococcal meningitis. Peripheral leukocytosis was found in 8 patients. The levels of CSF glucose ranged from 6 - 100 mg/dL. Total protein ranged from 7.8 - 434.0 mg/dL. The levels of CSF lactate ranged from 14.4 – 132.1 mg/dL. The leukocyte count in the CSF ranged from 8 - 25280 cells/mm^3.

The causative pathogen isolated from the CSF cultures of all 13 patients was *Enterococcus faecalis*, and 5 patients had mixed infections. Other causative pathogens isolated from the patients with mixed infections included *Pseudomonas aeruginosa*, *Escherichia coli*, *Enterobacter cloacae*, *Klebsiella oxytoca*, *Acinetobacter species* (*Acinetobacter junii*, *Acinetobacter baumannii*), *Bacteroides distaonis*, *B. uniformis*, *Candida tropicalis*, oxacillin resistant *Staphylococcus aureus*, and *S. maltophilia* (Table 1). According to culture results, three patients were sequentially with other bacteria. (patients 9,11,12) In patient 9, pathogen isolated from the CSF cultures were *Pseudomonas aeruginosa* (resistant to Aztreonam) then *Enterococcus faecalis.* In patient 11, pathogen isolated from the CSF cultures were *Klebsiella oxytoca* and *Escherichia coli* (resistant to trimethoprim-sulfamethoxazole) then *Pseudomonas aeruginosa* and *Enterococcus faecalis.* In patient 12, pathogen isolated from the CSF cultures were *Acinetobacter junii* then *Enterococcus faecalis* (resistant to gentamicin). There were two patients with enterococcal meningitis simultaneously. In patient 10, pathogen isolated from the CSF cultures were *Enterococcus faecalis* (resistant to ampicillin) and *Escherichia coli* (resistant to gentamicin,

Table 2. Basic laboratory data in 13 patients with *Enterococcal faecalis* meningitis

Patient	Bacteremia	Peripheral leukocytosis	CSF				Follow up CSF			
			Glucose (Blood glucose) (mg/dL)	Total protein (mg/dL)	Lactate (mg/dL)	Leukocyte (cell/mm^3)	Glucose (Blood glucose) (mg/dL)	Total protein (mg/dL)	Lactate (mg/dL)	Leukocyte (cell/mm^3)
1	(-)	(+)	59(175)	79.0	84.9	155	87(144)	89.0	31.1	160
2	(-)	(+)	76(110)	7.8	14.4	11	58(92)	27.0	10.7	2
3	(-)	(+)	78(NA)	158.0	77.2	188	46(119)	136.0	49.0	35
4	(-)	(-)	100(335)	262.6	61.0	40	91(194)	64.0	40.1	21
5	(+)	(+)	7(162)	331.0	132.1	340	14(148)	157.0	71.8	228
6	(-)	(+)	32(109)	187.0	48.0	120	NA			
7	(-)	(-)	68(123)	58.0	43.7	8	67(169)	49.0	60.2	15
8	(-)	(+)	30(111)	434.0	118	230	48(112)	56.0	18.4	0
9	(-)	(+)	81(174)	29.0	18.3	12	106(163)	44.9	15.5	3
10	(-)	(-)	68(248)	54.8	23.6	69	128(333)	43.5	52.3	950
11	(-)	(-)	38(125)	125.0	49.1	175	55(112)	115	33.1	44
12	(-)	(-)	56(NA)	122.0	29.4	55	NA			
13	(-)	(+)	6(137)	271.0	ND	25280	NA			

(–): negative; (+): positive; NA: not available; CSF: cerebrospinal fluid.

trimethoprim-sulfamethoxazole and piperacillin) then *Enterobacter cloacae* (resistant to unasyn, piperacillin and tazocin). In patient 13, pathogen isolated from the CSF cultures were *Enterococcus faecalis* (resistant to gentamicin), *Escherichia coli and Acinetobacter bauamnnii* then *Candida tropicallis.*

Blood cultures were performed for all 13 patients, and bacteremia was found in 3 patients (patients 1, 5, and 13). One patient (patient 5) had enterococcal bacteremia. Two patients (patients 5 and 8) also had urinary tract infections with urine cultures presenting with *Enterococcus* species.

The antibiotics included dosage and duration used to treatment these 13 patients are listed in Table 1. The majority of patients received vancomycin combined with other antibiotics. Five patients received vancomycin combined with a third-generation cephalosporin, 1 patient received vancomycin combined with meropenem, and 1 patient received vancomycin combined with gentamicin. Four patients received ampicillin or penicillin, 2 of whom received penicillin or ampicillin alone, 1 in combination with gentamicin, and 1 in combination with a third-generation cephalosporin. Only patient 7 received linezolid under the impression of nosocomial menigitis. The 56-year-old male was a patient of liver cirrhosis and he suffered from three meningitis episodes in Dec 2003, Feb 2004 and June 2004. This time, he was admitted for fever and consciousness disturbance in July 2004. Cefepime combined with vancomycin were first prescribed. After complete treatment, we stopped all antibiotic later. However, sudden onset of consciousness disturbance happened again (his consciousness declined from obey order to withdraw to pain) before discharge. We prescribed linezoid for the patient and the clinical condition was improved initially. (he could obey order again). In spite of linezoid treatment, he expired 18 days for multiple organ failure included jaundice, thrombocytopenia and hepatitis.

Discussion

Although enterococci are increasingly important pathogens outside the central nervous system (CNS), it is an infrequent cause of bacterial meningitis. In the current study, 85% of the patients had received neurosurgical procedures, and 15% of the patients had spontaneous enterococcal meningitis. The overall mortality rate was 38.5%, and 45.4% in the patients who had received neurosurgical procedures. Neurosurgical procedures and nosocomial infections are important predisposing factors related to enterococcal meningitis[2-5]. The route of infection for post-surgical enterococcal meningitis may be direct invasion of the subarachnoid space during the neurosurgical procedure[5,6]. Because of the high rate of nosocomial meningitis in our patients, the infections may have been due to colonization or contamination of the implanted neurosurgical devices.

Only 1 patient had enterococcal bacteremia, however 2 patients had positive urine cultures. In a previous report[5], spontaneous enterococcal meningitis was found to develop as a complication of bacteremic enterococcal infections arising from sources such as endocarditis, urinary tract infection, and catheter infection. In addition, patients with spontaneous enterococcal meningitis may have systemic diseases or a poor immune status such as cardiovascular or pulmonary disease, chronic renal failure, and diabetes[5-7]. In our series, 6 patients had an immunocompromised status including diabetes, malignancy and liver cirrhosis.

Enterococci have a high frequency of association with other mixed microbial infections. Whereas mixed infections are commonly found in focal suppuration of the CNS[8,9], they have rarely been reported in adult bacterial meningitis. CNS shunt devices, head trauma, or CSF leakage have been reported to be the most important predisposing factors for mixed enterococcal meningitis[5,10]. In a previous report [2], head trauma and/or neurosurgical

procedures with or without the placement of CNS devices were found to contribute to the development of mixed infections in adults with bacterial meningitis. In their study[2], 7 patients (58.3%) with enterococcal meningitis had mixed infections, of whom 6 had experienced head trauma or neurosurgical procedures. In the current study, all 5 patients with enterococcal meningitis mixed with other pathogens had received neurosurgical procedures.

As in previous reports[5,10], the presence of mixed infections was not associated with a worse outcome. In our study, overall mortality rate was 5/13 (38.5%). The mortality rate was 4/8 (50%) in single infection group and the mortality rate was 1/5 (20%) in mixed infection group. Mixed infection group actually had better survival rate in our series, but there were no statistically significant. This may be because the patients with mixed infections were less immunocompromised, had an early diagnosis of a mixed infection in the therapeutic course, a short duration to the initiation of treatment, or early removal of the EVD or V-P shunt to decrease the risk of colonization of the device.

The usual presentation of enterococcal meningitis is rapid onset of fever, consciousness disturbance, and signs of meningeal irritation. However, seizures, coma, septic shock, focal neurological deficit, or petechial rash are very unusual findings. In our patients with enterococcal meningitis, the clinical manifestations were fever, consciousness disturbance and epileptic seizures. The clinical features were not correlated with the clinical outcomes in this study, which may be due to the small number of patients. Further large-scale studies are necessary to analyze the risk factors for outcomes in enterococcal meningitis.

An increasing incidence of enterococcal meningitis caused by resistant strains to penicillin, ampicillin, vancomycin and aminoglycoside has been reported[2,5,7,12-14]. Among our 13 patients, 1 had ampicillin resistance and 8 had gentamicin resistance, but none of the patients had vancomycin resistance. However, there were one patient received linezolid treatment, 3 patient received ampicillin treatment and 9 received vancomycin treatment. Resistance was important when choosing the proper antibiotics. However, this is not easy in clinical practice. In a review article, there were 117 patients with enterococcal meningitis without vancomycin resistant but only 49 patients received ampicillin therapy[5]. In our study, we choose the priority of vancomycin might be related to older age in two spontaneous enterococcal meningitis patients (78-year-old and 82-year-old; one had liver cirrhosis and one had head injury history) and 6 were nosocomial enterococcal meningitis with post neurosurgical intervention. One patient was treated with linezolid for recurrent meningitis after one months vancomycin treatment in previous meningitis episode. We choose antibiotic according to the past history, age , comorbidity and the studies reported that vancomycin resistance may be related to nosocomial infections, neurosurgical procedures and previous antibiotic therapy[5,13-15]. The optimal therapy for vancomycin-resistant enterococcal meningitis has not been established. However, monotherapy or combination therapy using antibiotics such as linezolid, chloramphenicol, rifampicin, daptomycin, quinupristin-dalfopristin either intravenously or intrathecally in patients with vancomycin-resistant enterococcal meningitis has been reported[5,13-15]. Despite the complexity of the implicated pathogens and the high incidence of the emergence of multi-antibiotic-resistant strains that may result in a therapeutic challenge in the choice of the initial antibiotics, the patients may survive with appropriate antibiotic therapy. We suggest that the best initial antibiotic treatment is vancomycin combined with a third-generation cephalosporin, then shifting to appropriate antibiotics after the susceptibility results have been obtained.

Conclusion

Enterococcal meningitis should be considered especially in patients who undergo neurosurgical procedures and subsequently present with the clinical features of meningitis including fever, altered consciousness, and hydrocephalus. Despite therapeutic efforts, the mortality rate was high in the patients with enterococcal meningitis. Therefore, early recognition and appropriate antimicrobial treatment are important for these patients.

References

1. Moellering RC, Jr. Emergence of Enterococcus as a significant pathogen. Clin Infect Dis 1992; 14: 1173-6.
2. Chang WN, Lu CH, Huang CR, Chuang YC. Mixed infection in adult bacterial meningitis. Infection 2000; 28: 8-12.
3. Chang WN, Lu CH, Huang CR, et al. Changing epidemiology of adult bacterial meningitis in southern taiwan: a hospital-based study. Infection 2008; 36: 15-22.
4. Durand ML, Calderwood SB, Weber DJ, et al. Acute bacterial meningitis in adults. A review of 493 episodes. N Engl J Med 1993; 328: 21-8.
5. Pintado V, Cabellos C, Moreno S, Meseguer MA, Ayats J, Viladrich PF. Enterococcal meningitis: a clinical study of 39 cases and review of the literature. Medicine (Baltimore) 2003; 82: 346-64.
6. Stevenson KB, Murray EW, Sarubbi FA. Enterococcal meningitis: report of four cases and review. Clin Infect Dis 1994; 18: 233-9.
7. Jang TN, Fung CP, Liu CY, Wang FD, Liu IM. Enterococcal meningitis: analysis of twelve cases. J Formos Med Assoc 1995; 94: 391-5.
8. Lakshmi V, Rao RR, Dinakar I. Bacteriology of brain abscess--observations on 50 cases. J Med Microbiol 1993; 38: 187-90.
9. Pit S, Jamal F, Cheah FK. Microbiology of cerebral abscess: a four-year study in Malaysia. J Trop Med Hyg 1993; 96: 191-6.
10. Guardado R, Asensi V, Torres JM, et al. Post-surgical enterococcal meningitis: clinical and epidemiological study of 20 cases. Scand J Infect Dis 2006; 38: 584-8.
11. Mancebo J, Domingo P, Blanch L, Coll P, Net A, Nolla J. Post-neurosurgical and spontaneous gram-negative bacillary meningitis in adults. Scand J Infect Dis 1986; 18: 533-8.
12. Goldbloom AA, Goldfarb ML, Schlachman M. Primary enterococcic (Streptococcus faecalis) meningitis; cure effected with combined penicillin and streptomycin therapy. J Am Med Assoc 1952; 148: 1026-7.
13. Khan FY, Elshafi SS. Enterococcus gallinarum meningitis: a case report and literature review. J Infect Dev Ctries 2011; 5: 231-4.
14. Knoll BM, Hellmann M, Kotton CN. Vancomycin-resistant Enterococcus faecium meningitis in adults: case series and review of the literature. Scand J Infect Dis 2013; 45: 131-9.
15. van Overbeek EC, Janknegt R, Ter Berg HW, Top J, Sportel E, Heddema ER. Failure of vancomycin treatment for meningitis caused by vancomycin-susceptible Enterococcus faecium. Scand J Infect Dis 2010; 42: 794-6.

成人腸球菌腦膜炎的臨床表現及治療結果

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摘 要

成人發生的腸球菌腦膜炎(Enterococcal meningitis)很少被報導。這一篇回溯性的研究，是想了解成人腸球菌引起的腦膜炎的臨床表現及治療效果。從2000年到2012年共收集了13位天幕上的腸球菌性腦膜炎。我們蒐集並分析病患的臨床表現、腦脊髓液及血液的資料以及治療的效果。病患共有8位男性，5位女性。年齡分佈從19歲到82歲。從腦脊髓液培養出來的細菌皆為糞腸球菌(Enterococcus faecalis)。其中，11位病患有神經外科開刀的病史；兩位病患是自發性腦膜炎。發燒及意識混亂為其主要臨床表現，其次依序為白血球增加、水腦、敗血性休克、癲癇及頭痛。共有六位病患有免疫不全的狀態，包括糖尿病、惡性腫瘤或是肝硬化。在11位接受神經外科開刀病患之中，有5位除了腸球菌之外還有培養出其他細菌。整體的死亡率是38.5%。主要的治療方式為萬古黴素(vancomycin)合併第三代的頭孢菌素(cephalosporin)。臨床上，遇到接受過神經外科手術的病患，以發燒、意識變化，以及腦水腫來表現時，要注意是否為腸球菌腦膜炎。儘管接受治療，腸球菌性腦膜炎的死亡率還是很高。因此，早期發現及正確的抗生素治療對這些病患很重要。