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Original Article

# Clinical characteristics, treatments, and outcomes of hematogenous pyogenic vertebral osteomyelitis, 12-year experience from a tertiary hospital in central Taiwan

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## KEYWORDS

Osteomyelitis;  
Spondylitis;  
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**Abstract** *Background:* In Taiwan, studies about hematogenous pyogenic vertebral osteomyelitis (HPVO) are limited. We conducted a retrospective study to evaluate the clinical presentations, treatment, and outcomes of patients with the diagnosis of HPVO.

*Method:* This 12.5-year retrospective study included patients with a diagnosis of HPVO. Medical records of all HPVO patients were thoroughly reviewed and their clinical data were analyzed by the SPSS software.

*Result:* 414 HPVO cases were included and the mean age was  $61.6 \pm 13.4$  years. The mean duration of symptoms was  $29 \pm 35.3$  days and pain over the affected site was reported by most patients (86.0%). Gram-positive bacteria, especially *Staphylococcus aureus* ( $162/399 = 40.6\%$ ), were the main HPVO pathogens. *Escherichia coli* ( $42/399 = 10.5\%$ ) was the most common gram-negative isolate. Surgery was performed in 68.8% of cases and the mean duration of total antibiotic treatment was  $104.7 \pm 77.7$  days. All-cause mortality and recurrence rates were 6.3% and 18.8%, respectively. In multivariate analysis, polymicrobial infection (OR: 4.154, 95% CI: 1.039–16.604,  $p = 0.044$ ), multiple vertebral body involvement (OR:

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2.202, 95% CI: 1.088–4.457,  $p = 0.028$ ), abscess formation treated with antibiotics alone (OR: 2.912, 95% CI: 1.064–7.966,  $p = 0.037$ ), and the duration of antimicrobial treatment less than 4 weeks (OR: 3.737, 95% CI: 1.195–11.683,  $p = 0.023$ ) were associated with HPVO recurrence. **Conclusion:** In Taiwan, HPVO mainly affected the elderly and *S. aureus* remained the most common HPVO pathogen. In patients with risk factors associated with HPVO recurrence, a longer duration ( $\geq 6$  weeks) of antimicrobial therapy is suggested.

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## Introduction

Vertebral osteomyelitis (VO) is an important medical issue and its incidence is increasing in recent years.<sup>1,2</sup> According to its causative agents, VO can be categorized into pyogenic, granulomatous (tuberculous,<sup>3</sup> brucellosis, fungal), and parasitic subtypes. In most cases of pyogenic vertebral osteomyelitis (PVO), the hematogenous spreading of the bacteria from a distant site is the major route in causing infection.<sup>4</sup> Among the culture-proven PVO cases, Gram-positive cocci (GPCs), especially *Staphylococcus aureus*, account for the majority of causative pathogens (26–93%). However, 5–56% of PVO cases are caused by Gram-negative bacilli (GNBs) and 9% by polymicrobial infections.<sup>5,6</sup> Despite relatively few GNB PVO cases, such infection has attracted significant attention recently because of an increasing trend of antimicrobial resistance among these pathogens.<sup>7</sup> Moreover, in the cases where the causative pathogens could not be identified, the so-called culture-negative PVO had been very rarely addressed in the literature.<sup>8</sup> There had been some studies reporting the PVO in Taiwan for the past decades, but only one of them focused on the comparison of the clinical features and the outcomes between GPC-related PVO and GNB-related ones.<sup>9–15</sup> The goals of this study were to evaluate the differences of clinical presentations, treatments, and outcomes among the hematogenous PVO (HPVO) cases caused by GPCs, GNBs, polymicrobial agents, and culture-negative HPVO in Taiwan.

## Materials and methods

### Study setting and duration

From December 2002 through May 2014, we retrospectively conducted an observational cohort study at China Medical University Hospital (CMUH), a tertiary hospital in central Taiwan, for patients with a discharge diagnosis of vertebral osteomyelitis, discitis, infectious spondylitis, or infectious spondylodiscitis. The electronic medical records of all patients were reviewed and analyzed. The study was approved by the CMUH institutional review board (CMUH104-REC2-173).

### Inclusion and exclusion criteria

Patients were excluded if there was a non-hematogenous source of vertebral infection, which included (1) previously

placed artificial implants, (2) received laminectomy within 1 year prior to the VO diagnosis, (3) any spine penetrating trauma, or (4) the presence of decubitus ulcer at the same level of VO.<sup>16</sup> Only adult patients ( $\geq 18$  years) who received antibiotics treatment  $\geq 14$  days and had completed electronic medical record were included.

### Definitions

The diagnosis of HPVO was categorized into 3 types. Definite hematogenous vertebral osteomyelitis (D-VO) was diagnosed when a microorganism(s) was isolated from the spine or para-spinal tissues.<sup>8</sup> Probable hematogenous vertebral osteomyelitis (P-VO) was defined as a patient had compatible clinical signs/symptoms and specific radiologic features (either magnetic resonance imaging [MRI], computed tomography [CT] or bone scan) of vertebral infection accompanied with a positive blood culture which was performed at the time of diagnosis of HPVO; in the case of common skin contaminants, at least 2 sets of positive blood cultures were required.<sup>8,17,18</sup> Culture-negative hematogenous vertebral osteomyelitis (CN-VO) was defined as the patients had compatible clinical signs/symptoms and featured radiologic findings, but no causative agent(s) was isolated.<sup>7</sup>

Comorbidity were classified according to the McCabe classification (category 1: non-fatal diseases, such as diabetes mellitus and intravenous drug users; category 2: ultimately fatal diseases, such as liver cirrhosis, end stage renal disease and malignancy; category 3: rapidly fatal diseases, such as leukemia).<sup>19</sup> Preexisting or synchronous infection was defined as a documented infection at site other than spine within 1 month prior to or at the diagnosis of VO.<sup>15</sup> Onset-to-diagnosis duration was defined as the time elapsed between documented symptom(s) to the diagnosis of HPVO. Multiple vertebral bodies involvement was defined as involvement  $\geq 3$  vertebral bodies.<sup>4,16,20</sup> If a surgical procedure was performed within 2 weeks after HPVO diagnosis, it was defined as immediate operation; otherwise, it was defined as delayed operation.

Outcomes of patients were evaluated using following definitions. Recurrence was defined as patients who had any recurrent symptoms and signs (such as fever, pain on the affect site, and abnormal inflammatory markers in the absence of other causes) within 6 months after completion of antibiotic treatment and received a second course of antibiotics.<sup>21</sup> Recovery was defined as survival and disappearance of all signs and symptoms of infection in the

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