ORIGINAL ARTICLE INFECTIOUS DISEASES

Which tissues are best for microbiological diagnosis in patients with pyogenic vertebral osteomyelitis undergoing needle biopsy?

C.-J. Kim[1], S.-J. Kang[2], P. G. Choe[1], W. B. Park[1], H.-C. Jang[2], S.-I. Jung[2], K.-H. Song[1], E. S. Kim[1], H. B. Kim[1], M-d Oh[1], K.-H. Park[2] and N. J. Kim[1]

1) *Department of Internal Medicine, Seoul National University College of Medicine, Seoul and* 2) *Department of Infectious Disease, Chonnam National University Medical School, Gwang-ju, Republic of Korea*

Abstract

Identification of the causative microorganism is important in the management of pyogenic vertebral osteomyelitis (PVO). The aim of this study was to investigate whether culture positive rates differ between needle biopsy sites in patients with PVO, and which tissues are best for microbiological diagnosis. Between January 2005 and December 2013, we conducted a retrospective cohort study of PVO patients who had soft-tissue abscesses (paraspinal or psoas abscesses) and who received needle biopsy for microbiological diagnosis. Needle biopsy sites were classified into two anatomical categories: vertebral bodies, or soft tissues (intervertebral discs, paraspinal abscesses, or psoas abscesses). A generalized estimating equation model was developed to identify factors associated with tissue-culture positivity. During the study period a total of 136 tissues were obtained by needle biopsy from 128 PVO patients with soft-tissue abscesses. The culture positive rates of vertebral bodies and soft tissues were 39.7% (29/73), and 63.5% (40/63), respectively ($p < 0.05$). In a multivariate analysis, male gender (adjusted odds ratio (aOR) 2.24, 95% CI 1.00–5.02), higher C-reactive protein (aOR 1.07, 95% CI 1.01–1.15), positive blood culture (aOR 2.57, 95% CI 1.01–6.59), and soft tissues as biopsy site compared with vertebral bodies (aOR 2.28, 95% CI 1.08–4.78) were independent factors associated with tissue culture positivity. Soft tissues were the best sites for microbiological diagnosis in PVO patients undergoing needle biopsy.

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Corresponding authors: N. J. Kim, Department of Internal Medicine, Seoul National University College of Medicine, 101 Daehak-ro Jongno-gu, Seoul, 110-744, Republic of Korea
K.-H. Park, Department of Infectious Diseases, Chonnam National University Medical School, 671 Jebong-Ro Dong-Gu, Gwang-ju, 501-757, Republic of Korea
E-mails: iammedkid@naver.com **(K.-H. Park),** molder@unitel.co.kr **(N.J. Kim)**
Current address: C.-J. Kim: Department of Internal Medicine, Ewha Womans University Mokdong Hospital, Seoul, Republic of Korea

Introduction

Pyogenic vertebral osteomyelitis (PVO) is an infectious disease of the vertebrae or paravertebral structures caused by a variety of bacteria. Because long-term antibiotic treatment is essential, and antibiotic choice depends on susceptibility tests, it is important to identify the causative microorganism. Blood cultures and/or tissue cultures are recommended for this purpose. Several factors influence culture positivity rates [1–5]. Paravertebral abscesses, elevated C-reactive protein (CRP), and elevated erythrocyte sedimentation rate were associated with higher culture positivity, whereas previous antibiotic exposure was associated with negative results of culture in some studies [2,4–8].

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Tissue culture specimens can be obtained by needle or surgical biopsy. The microbiological yield of surgical biopsy is higher than that of needle biopsy [3,9,10]. However surgical biopsy requires anaesthesia and incision of the skin, and percutaneous needle biopsy is known to be safe [11–13]. For these reasons, needle biopsy is generally preferred to surgical biopsy as the initial diagnostic approach.

Tissues for microbiological diagnosis can be obtained by needle biopsy from vertebral bodies, intervertebral discs and soft-tissue abscesses (paraspinal abscesses or psoas abscesses). As tissue-culture positivity rates could differ between biopsy sites it would be better to choose biopsy sites which have higher culture positivity rates when performing needle biopsies in patients with PVO. Little is known about which tissues are the best biopsy sites for microbiological diagnosis in PVO [4,14–16].

The primary objective of this study was to investigate factors associated with culture positivity of tissues obtained by needle biopsy in patients with PVO. We also compared the rates of culture positivity of tissue specimens obtained from vertebral bodies and soft tissues, as a secondary objective, to determine which tissues are most suitable for microbiological diagnosis.

Methods

We conducted a retrospective cohort study at three university-affiliated teaching hospitals from January 2005 through December 2013. All of the study hospitals were tertiary referral centres and had 900–1700 beds.

Patients with PVO who had soft-tissue abscesses (paraspinal abscesses and/or psoas abscesses) and had undergone needle biopsy for tissue culture were investigated. PVO was diagnosed when the causative microorganism was isolated from spinal or paraspinal tissues, or if there were compatible clinical signs or symptoms and radiological evidence of vertebral infection. Compatible signs or symptoms were defined as pain, fever, or neurological manifestations. Characteristic radiographic changes included decreased signal intensity in the vertebral body and disc and loss of end plate on T1-weighted images, and increased signal intensity of the disc and vertebral body on T2-weighted images on magnetic resonance imaging.

Needle biopsy sites were classified into two anatomical categories: vertebral bodies, or soft tissues (intervertebral discs, paraspinal abscesses or psoas abscesses). Patients <18 years, or who had undergone surgical biopsy for tissue culture were excluded, as were patients with vertebral osteomyelitis caused by *Mycobacterium tuberculosis* or fungi. Patients who had been exposed to antibiotics in the 2 weeks before obtaining tissue by needle biopsy were also excluded. When coagulase-negative staphylococci grew in tissue culture they were considered the true pathogen if one or both of the following criteria was met: the same organism grew in blood culture, or the same organism grew in two or more spinal tissue specimens.

We collected data about baseline characteristics (age, gender), underlying diseases, spinal surgery and procedures within the year before diagnosis of pyogenic spondylitis, clinical characteristics (pain, fever, neurological deficit), laboratory data (white blood cell counts, CRP levels) and radiographic data (vertebral region involved, presence and location of abscess).

Statistical analysis

The Mann–Whitney *U* test was used to compare continuous variables, and the chi-squared test was used to compare categorical variables. If the expected number of instances of a given outcome was <5, Fisher's exact test was used. Multivariate analysis was performed to investigate the factors influencing tissue culture positivity in patients with PVO. Because needle biopsies were performed at two anatomical sites in a proportion of patients, a generalized estimating equation model was used to take account of a possible clustering effect of multiple specimens from the same patient. We entered all variables that were statistically significant in univariate analysis into the generalized estimating equation model. All *P* values were two-tailed, and $P < 0.05$ was considered statistically significant. Statistical analysis was performed using the SPSS program (version 20.0, SPSS Inc., Chicago, IL, USA).

Results

During the study period 567 patients >18 years were diagnosed as having pyogenic vertebral osteomyelitis. Of these, 439 were excluded for the following reasons: antibiotic exposure before obtaining a tissue specimen (n = 201), percutaneous needle biopsy not performed (n = 179) and absence of abscess (n = 59). Ultimately a total of 136 tissues from 128 PVO patients with soft-tissue abscesses were included in the analysis. In 120 of the patients, tissues were obtained from one anatomical category, and in eight patients they were obtained from two anatomical categories. Of the tissues used for culture, 53.7% (73/136) and 46.3% (63/136) were obtained from vertebral bodies and from soft tissues, respectively. Intervertebral discs, paraspinal abscess and psoas abscess comprised 27.0%, 54.0% and 19.0% of the 63 soft tissues, respectively.

The culture positive rates of vertebral bodies and soft tissues were 39.7% (29/73) and 63.5% (40/63), respectively (p 0.006). Among soft tissues, the culture positive rates of intervertebral discs, paraspinal abscesses and psoas abscesses were 52.9% (9/17), 70.6% (24/34) and 58.3% (7/12), respectively (for disc versus abscess p 0.290). Of the tissues obtained from two

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