

Trauma Induced Chronic Osteomyelitis: Specimens from Sinus Tract or Bone?

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Abstract

Background: The choice of an accurate microorganism isolation from chronic osteomyelitis has been a big conflict between clinicians during the time. The aim of this study is to compare specimens from sinus tract and bone, for an accurate treatment of trauma induced chronic osteomyelitis (CO). **Materials and Methods:** A total of 139 patients with trauma induced CO, were entered to the study. The specimens were taken from both sinus tract and bone. All specimens were cultured by Karby Bauer method. finally isolated microorganisms from sinus tract and bone specimens, were compared. **Results:** The overall concordance between sinus tract and bone cultures was 46%. There was 17% false negative results in sinus tract specimens, but only 5.6% of the bone specimens had false negative results. In all cases, which the microorganisms were found in the sinus tract, they were isolated from the bone also. **Conclusion:** This study suggests that bone specimens are more reliable in diagnosis of trauma induced CO. Culture result of sinus tract specimen is reliable, except for *Staphylococcus epidermidis*, *Proteus*, and *Candida albicans*; In other conditions antibiotic therapy can be started based on sinus tract culture, until the bone culture becomes ready. [GMJ. 2013;2(4):146-51]

Keywords: Bone diseases; Diagnosis; Infectious diseases; Osteomyelitis; Trauma.

Introduction

The infection of bone, called osteomyelitis, has a high burden for societies, because of its huge costs for treatment and rehabilitation and also its high morbidity and sequelae [1,2]. Acute osteomyelitis reveals in days to 1-2 weeks and may be cured with antibiotic therapy which is less likely not to be treated [1], but chronic osteomyelitis (CO) is identified as a relapsing and persistent infection which

longs over months to years and the term of "cure" is less likely to apply for CO, due to its high recurrence even after proper treatment [3]. Most reasons which are related to failure of treatment are associated with antibiotics penetration failure to dead tissue of CO and existence of certain microorganisms with lower levels of metabolism with a non-permeable biofilm. Therefore, most of clinicians manage CO by several treatment strategies; antibiotic treatment may not have the efficacy to com-

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pletely cure; therefore, a surgical debridement should be added to the protocol [4]. On the other hand, sustained eradication of the infection is due to accurate identification of causative agents [5] and also long time antimicrobial therapy must be done for at least 4–6 weeks [6]. Accurate pathogen identification is needed, to prevent unnecessary antibiotic therapy and to prevent relapsing. In addition, epidemiological and clinical results of several types of CO are important, in terms of any antibiotic resistance, secondary therapy efforts, therapeutic failures, and the sequelae [3].

Tissue specimen selection which is used for an accurate microorganism isolation has been a big conflict between clinicians during the times since the successful treatment of the patients with CO depends on targeting the underlying cause [7]. Most experts believe that bone culture results are the gold standard for the diagnosis of the CO pathogen, but some of the others rely on sinus tract cultures. Maybe the etiology of the CO can affect the concordance rate between these two types of specimens. Already, many studies have been done on hematogenous osteomyelitis [7-8] but there were a few studies on trauma induced osteomyelitis, especially the chronic ones.

The aim of this study was to compare the concordance of sinus tract and bone specimen cultures in the CO patients with the local spread of infection following trauma.

Materials and Methods

This cross-sectional study was done on patients with definite diagnosis of CO who had a history of trauma in the same location. Patients with CO who came to inpatient clinics of one private center, Sasan hospital, and a referral educational center, Baqiyatallah hospital, Tehran, Iran During January 1st to December 30th 2012 were included in this study. The local ethics committee of Baqiyatallah University of medical sciences approved the study protocol. All participants were given written informed consent forms after the study protocol were presented to them.

Osteomyelitis diagnosis has been confirmed by clinical imaging and laboratory data. The patients with hematogenous osteomyelitis,

diabetic foot osteomyelitis and bed sore osteomyelitis were excluded from the study. All patients underwent surgical treatments like curtage and debridement. In all patients, the specimens were taken from both sinus tract and infected bone site. At least 8 samples were taken from both sinus tract and infected bone, intraoperatively. Both sinus tract and bone specimens were cultured and tested by disc diffusion (by Karby Bauer method) [9]. For assurance about culture results, tuberculosis (TB) cultures were read after 40 days, fungus cases after three weeks and rest of the microorganisms were examined after at least 12 days. False negative cultures were described as those which had no growth in specimens but diagnosed with osteomyelitis according to the other findings (imaging and laboratory data).

All mentioned substances have been provided by a domestic manufacturer (Padtan® Co., Tehran, Iran).

The main objective of the present study is to determine the discordance between the results of sinus tract and bone specimens and valorization of them. The Other objectives are to determine the culture results, polymicrobial and monomicrobial cultures. These amount of discordance included 4 categories: First, those specimens which had no growth in the sinus tract but they had growth in the bone cultures, second, the specimens which had *Staphylococcus epidermidis* growth in the sinus tract and no growth or the growth of other microorganisms in the bone, third, the specimens which had monomicrobial culture result in one and polymicrobial culture result in the other one, and fourth, the specimens which had polymicrobial or monomicrobial cultures in both sinus tract and bone specimens but the microorganisms were not completely the same.

The statistical package of social science, version 16.0 (SPSS, Chicago, Illinois, USA) was used for data analysis. Statistical significance was noted for $P \leq 0.05$. Independent sample t-test was applied for comparison of quantitative variables. Statistical significance of false negativity and false positivity rate differences between groups was determined by Chi Square analysis

Results

One hundred and thirty nine patients with confirmed CO were included in this study. All patients were male (100%) with the average age of 44.7 ± 6.0 years old. The average duration of CO disease was 17.8 ± 10.3 years in these patients. The cause of 88% of COs was penetrating trauma, and the remaining were blunt trauma (12%).

The culture results of the sinus tract specimens were positive in 74.9% cases and were positive in 94.4% of bone specimens ($P < 0.05$). The details of growth of microorganisms were represented in Table-1. The overall percentage of the microorganisms' prevalence is more than 100% in Table-1 because of polymicrobial samples.

The most common microorganisms were *Staphylococcus aureus* (*S. aureus*) and *Escherichia coli*, in both kinds of specimens. The overall concordance between sinus tract and bone cultures was 46%. There was 23% incomplete concordance between bone and sinus tract cultures; monomicrobial cultures

were obtained from the sinus tract but polymicrobial cultures were extracted from the bone while there was overlap between isolated pathogens. Table-2 demonstrated the concordance between the bone and the sinus tract specimens.

There was 14% false positive cultures among sinus tract specimens while 81% of them were *Staphylococcus epidermidis* and 19% of them were the other microorganisms like *Proteus* and *Candida albicans*, which only grew in the sinus tract but not in the bone. False negative results of sinus tract cultures was 17%. In false negative results of sinus tract specimens, there were monomicrobial or polymicrobial cultures in the bone cultures.

There were false negative results in 5.6% of the bone specimens, but there was no false positive culture among bone specimens. Two bacteria species did not grow in any cases of the sinus tract specimens (false negative of sinus tract cultures) and were only isolated from bone specimens, *Staphylococcus saprophyticus* and *Pseudomonas saprophyticus*. There was significant difference between false negativity and false positivity rate of bone and sinus tract specimens ($P < 0.05$). In all specimens, while the prevalent microorganisms were found in the sinus tract specimens, they were also isolated in the bone specimens, even in monomicrobial or polymicrobial cultures (Table-2). Two patients with CO were infected by *Citrobacter* and *Morganella* and the microorganisms were presented in both sinus and bone specimens. The patient who had the culture with *citrobacter* also had the growth of *Pseudomonas* in the bone, but the only microorganism in the sinus tract specimen was *citrobacter*; the patient with the culture of the *morganella* had monomicrobial culture in both kinds of specimens.

Discussion

This study which was done on trauma induced CO to determine the proper antibiotic therapy regimen confirmed that sampling from infected bone is more reliable than sampling from sinus tract.

Mackowiak *et al.* in a retrospective study on the sinus tract and bone sample cultures of 40

Table 1. Evaluating the concordance between the specimens from the sinus tract or bone in trauma induced osteomyelitis; the culture results of bone and sinus tract specimens.

Microorganism	Sinus tract (N=139)	Bone (N=139)
<i>Staphylococcus aureus</i> (%)	29.4	34.5
<i>Escherichia coli</i> (%)	25.1	27.3
<i>Enterococcus</i> (%)	7.9	15.1
<i>Pseudomonas aerogina</i> (%)	8.6	13.6
<i>Klebsiella</i> (%)	5	7.9
<i>Acinetobacter</i> (%)	4.3	5.7
<i>Streptococcus</i> (%)	3.5	3.5
<i>Staphylococcus epidermidis</i> * (%)	11.5	2.1
Others (%)	8.6	3.5
Monomicrobial (%)	61	65.5
Polymicrobial* (%)	39	34.1
No growth* (%)	25.1	13.7

* Sinus tract specimen has higher rate.

Table 2. Evaluating the concordance between the specimens from the sinus tract or bone in trauma induced osteomyelitis; the concordance between bone and sinus tract specimens cultures.

Sinus tract culture	Bone culture
Staphylococcus aureus	- 100% Presence in bone culture (Monomicrobial or polymicrobial)
Eschrichia coli	-100% Presence in bone culture (Monomicrobial or polymicrobial)
Enterococcus	-100% Presence in bone culture (Monomicrobial or polymicrobial)
Pseudomonas aerogina	-100% Presence in bone culture (Monomicrobial or polymicrobial)
Klebsiella	-100% Presence in bone culture (Monomicrobial or polymicrobial)
Acinetobacter	-100% Presence in bone culture (Monomicrobial or polymicrobial)
Streptococcus	-100% Presence in bone culture (Monomicrobial or polymicrobial)
Staphylococcus epidermidis	- 81% No growth - 19% Presence in bone culture (Monomicrobial or polymicrobial)
Poly microbial	- 84% Polymicrobial - 16% Monomicrobial
No growth	- 22% No growth - 76% Monomicrobial* - 2% Polymicrobial

*Staphylococcus saprophyticus, Pseudomonas saprophyticus, Citrobacter, Staphylococcus aureus, Eschrichia coli, Enterococcus, Klebsiella or Streptococcus.

patients with CO, concluded that bone biopsies are the ideal specimens for microbiological diagnosis [8]. Several studies also came up with the same findings [1,3,7], but bone sampling is a difficult procedure and so currently less invasive ways such as sinus tract, wound and other soft tissue samples were under more investigations to establish easier microbial diagnosis. These studies came up with a high concordance rate of bone and non-bone samples [10-12]. Many experts disagree with non bone sampling in CO and the conflict about the site of sampling has remained unsolvable yet.

In the present study, the prevalence of several

microorganisms which have grown in cultures media (*S. aureus*, *Eschrichia coli*, *enterococcus*, *Pseudomonas aerogina*, *Klebsiella*, *Acinetobacter*, *streptococcus*) were similar to previous studies, but we had 25.1% of patients with CO who had no bacterial growth in their sinus tract cultures, and 17% of the sinus tract cultures had false negative results which had monomicrobial or polymicrobial growth in their bone cultures.

The overall concordance between bone and sinus tract cultures was 46% in our study, which is similar to the previous studies suggesting bone specimens for identifying CO's pathogens [7-8] but there is a major difference between this study and other similar ones; in the previous studies the main problem has been finding different pathogens in sinus tract specimen and bone specimens in one case, but in this study even if there was a pathogen among the prevalent microorganisms in the sinus tract, it also existed in bone samples, but in 17% of the patients with CO, the prevalent microorganisms were extracted from the bone specimens while there was no growth in sinus tract culture. The main causes of this low concordance in our study were the false negative results, also the cases which had the growth of pathogens which seemed to be as a result of contamination with the normal flora of the skin (e.g. *Staphylococcus epidermidis*, *Proteus* and *Candida albicans*) which did not grow in the bone samples (14% false positive), and another cause is the cases those had incomplete concordance between sinus tract and bone specimens (23%).

In a previous study, *Proteus* and *Klebsiella* have been reported as false positive results in 100% of the sinus tract samples [7] and the present study found similar results; 100% of *Proteus* and *Candida albicans* infections were false positive (19% of false positive cultures from sinus tract) and the remaining false positive cultures from the sinus tract were *Staphylococcus epidermidis* (81% of false positive cultures from sinus tract). In 8.1% of the patients both types of specimens and in 5.6% of the participants the bone specimen cultures were falsely negative while diagnosis of the CO according to the other findings, like physical examinations, laboratory data and imaging

was prominent. These results can be caused by prior antibiotic consumption by the patients, and according to previous studies TB or fungal cultures should also be suspected [7,11], hence, we kept all non growth cultures for 40 days to evaluate TB or fungal suspected cultures.

In the present study, all the patients had a history of trauma to the CO location and we had polymicrobial cultures, three times more than those studies which had evaluated the osteomyelitis of hematogenous infection [8]. Another similar study was done by Zuluaga *et al.* that has reported that the polymicrobial cultures is more prevalent in trauma induced osteomyelitis [3]. Therefore the bone culture results are much reliable for diagnosis of trauma induced CO, as polymicrobial cultures is more frequent in bone cultures, and isolation of different microorganisms is more probable. In most patients who had polymicrobial bone cultures only one microorganism was isolated from their sinus tract samples. On the other hand, in patients who had polymicrobial cultures (except those who in their sinus tract culture *Staphylococcus epidermis*, *Proteus* and *Candida albicans* were grown or who had no growth) the microorganism which grew in the sinus tract culture also grew in the bone culture and we can say that any growth of the microorganisms in sinus tract culture, except *Staphylococcus epidermis*, *Proteus* and *Candida albicans* is reliable and the antibiotic therapy can be started against that microorganism until the bone result is ready. Also, we can use antibiotic cement against that pathogen during operative surgery until the bone sampling is

done. According to the latest studies, the use of antibiotics before sampling did not appear to be effective on the patterns of susceptibility or concordance between bone and non-bone specimens [3]; however, we did not design a study with stratified subgroups with antibiotic positive drug history and antibiotic negative drug history since our population was not large enough to find significant differences, so, a prospective analysis would be necessary to overcome this limitations.

Conclusion

We concluded that bone culture is necessary in every patient with CO following trauma. Sinus tract culture can have high rates of false positive and false negative results and also can cause ignorance of the polymicrobial cultures. Before operative surgery we can start antibiotic therapy against the prevalent causative agents of the CO which was found in the sinus tract and after preparing bone culture, antibiotic therapy can be continued according to bone culture results.

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Conflicts of Interest

None declared.

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