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Original Research Article

Antibiotic Resistance Patterns of Osteomyelitis-Causing Bacteria: A Cross-Sectional Study from a Tertiary Hospital

Bharat Patel[1], Darshil Parikh[2], Krunal Patel[3], Jitendra Chaudhary[4]

[1]Associate Professor, Department of Orthopaedic, SAL Institute of Medical Sciences, Ahmedabad, Gujarat, India

[2]Assistant Professor, Department of Orthopaedic, SAL Institute of Medical Sciences, Ahmedabad, Gujarat, India

[3]Senior Resident, Department of Orthopaedic, SAL Institute of Medical Sciences, Ahmedabad, Gujarat, India

[4]Assistant Professor, Department of Orthopaedic, SAL Institute of Medical Sciences, Ahmedabad, Gujarat, India

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Corresponding author: Dr. Bharat Patel
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Abstract

Osteomyelitis is a bone and bone marrow infection that is thought to be one of the most challenging to cure because of its wide range of pathophysiologies and clinical manifestations. In this study, patients who attend a tertiary care institution in Gujarat, India, for a year (January to December 2024) will have their microbiological profile of osteomyelitis and associated patterns of antibiotic susceptibility evaluated. There were 58/105 (55.2%) bacterial isolates found in aerobic culture. Furthermore, the most frequent isolate was Staphylococcus aureus, while Escherichia coli accounted for the majority of isolates that developed on culture among Gram-negative bacilli (22.4%).

Keywords: Surgery, Infection, Marrow, Bone, Osteomyelitis.

Introduction

The Greek terms "osteon," which means bone, and "muelinos," which means marrow, are the source of the phrase "osteomyelitis," which refers to a significant infection of the bone and bone marrow [1]. The disease can spread locally from a contaminated nidus after surgery or trauma, or it can spread hematogenously or as a result of vascular insufficiency, particularly in diabetic patients [2]. Symptoms that the patients may exhibit include discomfort, fever, chills, edema, and redness around the site of infection, purulent discharge, sinus, and fistula [3, 4]. Inflammatory alterations in the bone are the hallmark of acute osteomyelitis, which typically manifests two weeks following a bone infection.

Conversely, bone necrosis and/or the development of a sizable region of devascularized dead bone known as the "sequestrum" are hallmarks of chronic osteomyelitis, which manifests six or more weeks following bone infection [5]. Osteomyelitis is one of the most challenging infections to treat because of its wide range of pathophysiology and clinical manifestations. Staphylococcus aureus is the most frequent cause of hematogenous osteomyelitis in both adults and children [6,7]. Additional causes include aerobic Gram-negative bacilli (GNB) like Escherichia coli, Pseudomonas species, and Enterobacter species; anaerobic GNB such Peptostreptococcus, Bacteroides, and Clostridium species; coagulase-negative Staphylococcus; Streptococcus (beta-hemolytic); and Enterococci. In people with weakened immune systems,

Although they are less frequently found, Mycobacterium tuberculosis, nontuberculous mycobacteria, Candida species, and fungus such Blastomyces, Coccidioides, Cryptococcus, and Aspergillus are also considered pathogens [7, 8]. Bone biopsy combined with tissue culture and histopathologic analysis is the gold standard for diagnosing osteomyelitis [3]. The assessment of such patients must include radiographic imaging, such as technetium-99 bone scintigraphy, magnetic resonance imaging (MRI), and plain radiography [7]. Nowadays, treating the illness has grown difficult due to the rise of multidrug-resistant bacteria, like methicillin-resistant S. aureus. The primary goal of the current study was to evaluate the microbiological profile of osteomyelitis and associated patterns of antibiotic susceptibility in patients who were enrolled in a tertiary care facility. India.

Materials and Methods

The study included 105 patients (indoor and outdoor) who were provisionally diagnosed with osteomyelitis between January 1 and December 31, 2024, and who came to the orthopedics department complaining of pain, fever, swelling, and redness around the infected site, purulent discharge, and fistula or sinus. Tissue, pus, discharge, or bone biopsied material from the diseased site were gathered and sent to the microbiology department for processing (culture, antimicrobial susceptibility testing, and microscopic inspection).

Every sample was inoculated onto blood agar and MacConkey agar plates. For 24 to 48 hours, the plates were incubated in an aerobic environment. Antimicrobial susceptibility testing was performed using an automated Vitek 2 Compact system (bioMerieux, Inc., Durham, NC, USA) once isolates were identified. The most recent criteria from the Clinical and Laboratory Standards Institute (CLSI) were followed for interpreting minimum inhibitory concentrations (MICs). Gender, age, infecting organisms, and susceptibility pattern were among the data gathered from patient records. Since the current study is retrospective in nature, the patients' formal agreement was not obtained, and their identifying information was eliminated prior to data analysis in order to preserve their anonymity.

Results

The orthopedics department gathered 105 specimens from osteomyelitis cases; of them, 58 (55.2%) tested positive by culture (and/or microscopy). There were 47 (44.8%) culture-negative specimens, including four that were suspected of having skin flora contamination but were not deemed significant; these were tested again with appropriate specimen collection and were later determined to be negative. There were more males (86/105, 81.9%) than females, and most cases were in the 40–60 age range. In most cases, the most common organism recovered was S. aureus [21/58 (36.2%)]. Methicillin resistance was found in nine (42%) of the 21 S. aureus samples. Escherichia coli was the most common organism recovered from GNB, accounting for 13/58 (22.4%) cases. Others were Pseudomonas aeruginosa and Acinetobacter baumannii. Klebsiella pneumoniae, Proteus mirabilis, Enterococcus, Streptococcus pyogenes, Enterobacter cloacae, and Citrobacter freundii. Figure 1 summarizes the number of bacterial isolates from osteomyelitis cases. The antimicrobial susceptibility profile of the most frequently isolated bacterium in our study is reported in Table 1.

Discussion

The frequency of the catastrophic disease osteomyelitis is estimated to be 21.8 cases per 100,000 person-years, while the precise figure is difficult to determine [9]. According to published studies, about one in every 675 hospital admissions, or approximately 50,000 osteomyelitis cases, occur each year in the United States [7]. The condition is reported to be more prevalent in young children and older individuals, but no age group is immune.

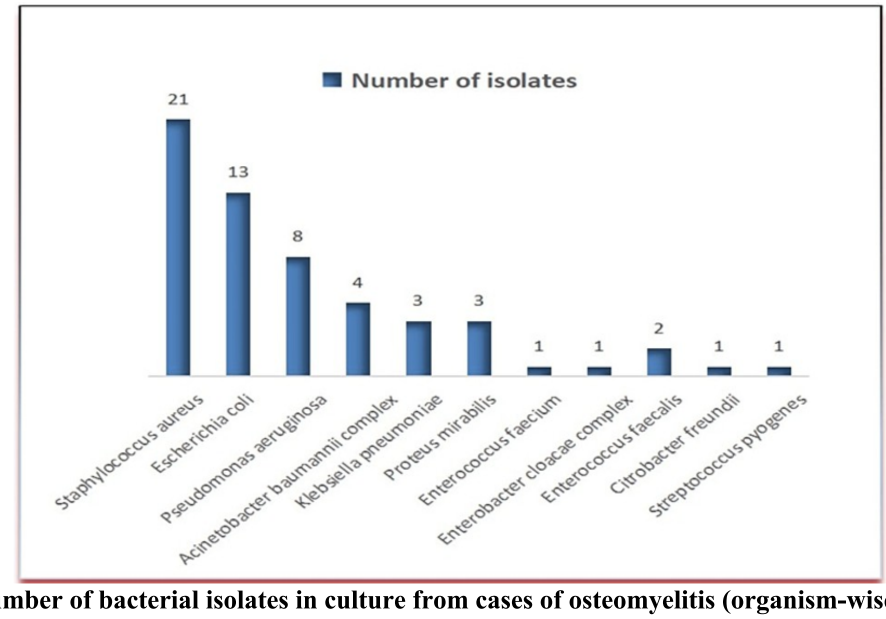

Figure 1: Number of bacterial isolates in culture from cases of osteomyelitis (organism-wise distribution)

Table 1: Antimicrobial susceptibility pattern in frequently isolated pathogens in cases of osteomyeliti

Antimicrobial agent	*Staphylococcus aureus*		*Escherichia coli*		*Pseudomonas aeruginosa*		*Acinetobacter baumannii*	
	Susceptible (S %)	**Not susceptible (I + R %)**	**Susceptible (S%)**	**Not susceptible (I + R %)**	**Susceptible (S %)**	**Not susceptible (I + R %)**	**Susceptible (S %)**	**Not susceptible (I + R %)**
Oxacillin	58	42	-	-	-	-	-	**-**
Erythromycin	52	48	-	-	-	-	-	**-**
Clindamycin	95	5	-	-	-	-	-	**-**
Vancomycin	100	0	-	-	-	-	-	**-**
Linezolid	100	0	-	-	-	-	-	**-**
Gentamicin	84	16	80	20	-	-	28	**72**
Ciprofloxacin	10	90	50	50	63	37	-	**-**
Levofloxacin	57	43	-	-	54	46	71	**29**
Ampicillin	-	-	20	80	-	-	-	**-**
Ceftriaxone	-	-	34	66	-	-	-	**-**
Ceftazidime	-	-	-	-	55	45	57	**43**
Piperacillin-Tazobactam	-	-	70	30	63	37	42	**58**
Imipenem	-	-	90	10	72	28	42	**58**
Meropenem	-	-	90	10	72	28	42	**58**
Amikacin	-	-	100	0	63	37	28	**72**
Tigecycline	-	-	100	0	-	-	71	**29**
Minocycline	-	-	-	-	-	-	71	**29**
Colistin*	**-**	**-**	**100**	**0**	**63**	**37**	**71**	**29**

Adults are more likely to develop hematogenous osteomyelitis in the vertebral bodies, followed by the long bones, pelvis, and clavicle [3]. Children's long bones are the most commonly afflicted. Males are more typically affected than females, according to our study and other osteomyelitis-related publications [7].

The disease is typically managed through a multidisciplinary approach that includes antibiotics, infected tissue debridement, reaming, bone troughing, bone fenestration, Masquelet technique, segmental resection with callus distraction, bone grafting, and amputation, depending on the stage of the disease [17]. In a recent work, Fang et al. employed vancomycin and superparamagnetic iron oxide nanoparticles to treat osteomyelitis in rat disease models. The study concluded that magnetic nanoparticles improved treatment efficiency by causing hyperthermia, resulting in biofilm elimination [18]. The treatment should be directed at halting the progression of this devastating disease and its complications.

The current literature suggests a high percentage of chronic osteomyelitis cases being culture-negative ranging between 28% and 50% [10-12]. Our study being retrospective, we could not differentiate between acute and chronic osteomyelitis cases, but culture positivity (55.2%) was similar to other studies published previously [11,12]. In general, Gram-negative organisms as a group were isolated predominantly compared to the Gram-positive organism group in our study, similar to the study done by Vijayakumar et al. [13]. Discussing the specific organism, S. aureus was the most common isolated organism in our study. This finding was supported in a review done by Urish et al., in which the authors mentioned that across all mechanisms leading to osteomyelitis, S. aureus is the most common organism [9,14-16]. S. aureus is known to express receptors, called adhesins, which can help in the adhesion with the bone matrix, including laminin, fibronectin, bone sialoglycoprotein, and collagen [7]. Collagen-binding adhesin permits its connection to bone cartilage, but fibronectin-binding adhesin is required for bacterial attachment to surgically implanted bone devices [7]. A notable feature of S. aureus is its ability to persist intracellularly after being ingested by cultured osteoblasts [2, 7]. Methicillin resistance was found in nine of 21 S. aureus isolates [9/21 (42%)], which is cause for concern. As a result, proper antimicrobial stewardship training and application are critical in order for clinicians to commence targeted therapy as soon as possible.

Conclusion

Osteomyelitis is a diverse illness with a dramatic presentation that, if left untreated, can lead to fatal complications. Methicillin resistance is increasing, which is a cause for concern. Even if the clinical diagnosis of osteomyelitis is evident, the microbiological workup for etiological diagnosis of osteomyelitis cases is still not a common practice in many hospitals, and this has to change.

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