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Bangladesh Journal of Medical Microbiology
January 2022, Volume 16, Number 1, Page 8-13
ISSN (Print) 2070-1810
ISSN (Online) 2072-3105

Original Article ***Open Access***

Bacteriological Etiologic Diagnosis, Mode of Infection and Management of Chronic Osteomyelitis: A Prospective Hospital-Based Study in Bangladesh

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Abstract

Background: There are different factors responsible for chronic osteomyelitis. **Objective:** The purpose of the present study was to find out the bacteriological aetiology of chronic osteomyelitis patients. **Methodology:** This prospective hospital-based study was conducted in the Department of Orthopaedic and Traumatology at Cox's Bazar Medical College Hospital, Cox's bazar, Bangladesh from January 2019 to June 2022 for a period of three and half years. Eligible patients for enrolment in the present study had to sustain an osseous infectious process confirmed by radiological findings lasting more than 2 weeks without acute symptomatology or few contributory laboratory results. The bacteriological aetiology were recorded and the antimicrobial sensitivity testing were performed by dis diffusion test. **Results:** A total number of 89 cases of osteomyelitis patients were recruited for this study. The mean age with the SD of study population was 11.5±7.89 years with the range of 1 to 42 years. Infected scabies was the most common cause osteomyelitis among the study population which was 42.0% cases in children group; however, there was no cases in adult group. Otitis media, rhinitis dental caries were also found among the children which were 25.0% cases, 5.0% cases, 18.0% cases respectively. Among adult group implant surgery was the most common cause of osteomyelitis which was 65.0% cases. Most common bacterial isolate was *Staphylococcus aureus* which was 29(32.6%) cases. Coagulase Negative *Staphylococcus (CoNS)* and *Proteus species* were the second most common isolated bacteria which was 17(19.1%) cases in each. Gram negative bacteria like *Escherichia coli* and *Pseudomonas species* were the most common isolated bacteria which were 11(12.4%) cases and 9(10.1%) cases respectively. **Conclusion:** In conclusion implant surgery is the most common cause of osteomyelitis and *Staphylococcus aureus* is the most common isolated bacteria.

Keywords: Bacteriological diagnosis, mode of infection; management; chronic osteomyelitis

Bangladesh Journal of Medical Microbiology, January 2022;16 (1):8-13

Introduction

Osteomyelitis is a bacterial infection of the bone associated with inflammation and bone destruction with an estimated incidence of approximately 8 per 100,000 children each year in high-income countries[1]. Osteomyelitis can be classified as acute, sub-acute and chronic[2-4]. Osteomyelitis can result from direct inoculation from a penetrating trauma or can spread from a contiguous site of infection, but the most common mechanism of infection in children is hematogenous inoculation of the bone during an episode of bacteremia[5]. Chronic osteomyelitis is a

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DOI: https://doi.org/10.3329/bjmm.v16i1.65789

common clinical disease and a challenging disorder, characterized by its long disease course, difficult early diagnosis and high disability rate. The clinical characteristics of chronic osteomyelitis are varied, and may be affected by geography, time, and pathogenic differences. Geographically, developing countries have a higher incidence of the disease than developed ones, likely caused by differences in economic foundation, lifestyle and healthcare level[6]. Over time, a shift has occurred from predominately hematogenous osteomyelitis several decades ago, to a predominance of chronic osteomyelitis that results from trauma, implant infection, and diabetes[7].

Despite advances in diagnostic and treatment modalities, bone and joint infections are a major cause of morbidity and disease burden worldwide[8]. Acute hematogenous osteomyelitis (AHO) is particularly common in children less than 5 years of age and typically affects the metaphysis because of the rich but slow blood flow of the growing bone. The microorganisms enter the bone via the nutrient artery and are lodged in the metaphyseal capillary loops where they begin to proliferate, resulting in the spread of inflammation. In neonates and children aged less than 18 months, the metaphyseal vessel loop and epiphyseal vessel are connected via transphyseal vessels traversing across the growth plate[9]. Therefore, spread of metaphyseal infection to the epiphysis and joints can occur via transphyseal vessels. In older children, the vascular connections between the metaphysis and epiphyses are obliterated, and the two blood systems (metaphyseal loops and epiphyseal vessels) are separated from each other.

Osteomyelitis of the proximal humerus or femur may also be associated with septic arthritis if the involved metaphysis is intracapsular. Boys are twice as likely to be affected as girls, and children aged <5 years accounted for more than 50% of cases of AHO9. Early diagnosis and appropriate treatment of osteomyelitis are imperative to avoid serious morbidity and permanent disability[10]. The purpose of the present study was to find out the bacteriological aetiology of chronic osteomyelitis patients.

Methodology

Study Population and Settings: This prospective hospital-based study was conducted in the Department of Orthopaedic and Traumatology at Cox's Bazar Medical College Hospital, Cox's bazar, Bangladesh from January 2019 to June 2022 for a period of three and half years. Cox's Bazar is the tourist city of Bangladesh which is more than 350 km away from the capital of Bangladesh. In this city the longest sea beach is situated and millions of people from all around the country are visited in every year. All the patients who were presented with the clinical features of osteomyelitis were selected as study population. The patients who were unwilling to participate in this study were excluded from this study.

Study Procedure: Eligible patients for enrolment in the present study had to sustain an osseous infectious process confirmed by radiological findings lasting more than 2 weeks without acute symptomatology or few contributory laboratory results. Analyses were based on clinical records, demographics (age and gender), body temperature, the bone involved, and laboratory data including bacterial cultures (from blood and bone samples), white blood cell (WBC) count, platelet count, erythrocyte sedimentation rate (ESR) and serum C-reactive protein (CRP). When realized, the bone aspirate sample was sent to the laboratory for Gram staining and immediate inoculation onto Columbia blood agar (incubated under anaerobic conditions), anaerobe 5% sheep blood agar (incubated under anaerobic conditions), chocolate agar (incubated in CO2-enriched atmosphere), and brain–heart broth. The media were incubated for 10 days. The bacteriological aetiology were recorded and the antimicrobial sensitivity testing were performed by dis diffusion test.

Statistical Analysis: Statistical analysis was performed by Windows based software named as Statistical Package for Social Science (SPSS), versions 25.0 (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Continuous data were expressed as mean, standard deviation, minimum and maximum. Categorical data were summarized in terms of frequency counts and percentages. Every efforts were made to obtain missing data.

Ethical consideration: All procedures of the present study were carried out in accordance with the principles for human investigations (i.e., Helsinki Declaration) and also with the ethical guidelines of the Institutional research ethics. Formal ethics approval was granted by the local ethics committee. Participants in the study were informed about the procedure and purpose of the study and confidentiality of information provided. All participants consented willingly to be a part of the study during the data collection periods. All data were collected anonymously and analysed using

the coding system.

Results

A total number of 89 cases of osteomyelitis patients were recruited for this study after fulfilling the inclusion and exclusion criteria. Majority of the study population were in the age group of 6 to 10 years of age group which was 28(31.5%) cases followed by the age group of 11 to 15 years, 20 to 30 years, 1 to 5 years and more than 30 years which were 15(16.8%) cases, 14(15.7%) cases, 12(13.5%) cases and 12(13.5%) cases respectively. The mean age with the SD of study population was 11.5±7.89 years with the range of 1 to 42 years (Table 1).

Table 1: Age Distribution among the Study Population (n=89)

Age Group	Frequency	Percent
1 to 5 years	12	13.5
6 to 10 Years	28	31.5
11 to 15 Years	15	16.8
16 to 20 Years	8	9.0
20 to 30 Years	14	15.7
>30 Years	12	13.5
Total	**89**	**100.0**
Mean±SD (Years)	11.5±7.89 (1 to 42)	

In this study male was predominant than female which was 55(61.8%) cases and the rest of 34(38.2%) cases were female. The male and female ratio was 1.6:1 (Figure I).

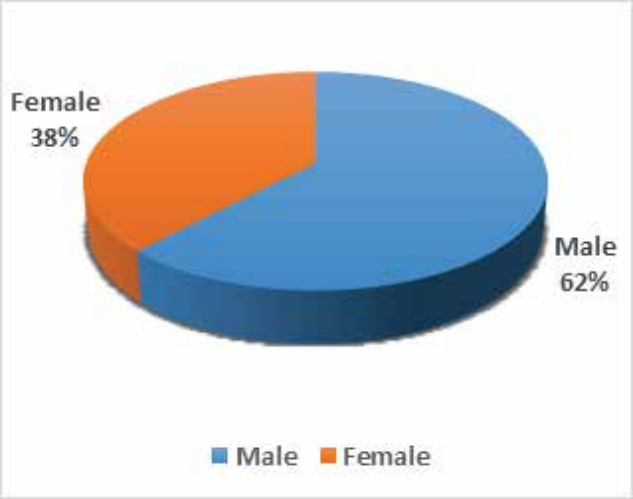

Figure I: Gender Distribution among the Study Population (n=89)

Majority of children were presented with involvement of proximal tibia which was 44(73.3%) cases followed by distal femur, proximal humerus which were 11(18.3%) cases and 4(6.7%) cases respectively. However, most of adults were presented with involvement of tibia which was 13(44.8%) cases followed by femur, humerus which were 6(20.7%) cases and 4(13.7%) cases respectively (Table 2).

Table 2: Common Site of Involvement of Osteomyelitis (n=89)

Category	Frequency	Percent
Children		
• Proximal Tibia	44	73.3
• Distal Femur	11	18.3
• Proximal Humerus	4	6.7
• Others	1	1.7
Total	**60**	**100.0**
Adult		
• Tibia	13	44.8
• Femur	6	20.7
• Radius and Ulnar	4	13.7
• Humerus	5	17.3
• Others	1	3.5
Total	**29**	**100.0**

Infected scabies was the most common cause osteomyelitis among the study population which was 42.0% cases in children group; however, there was no cases in adult group. Otitis media, rhinitis dental caries were also found among the children which were 25.0% cases, 5.0% cases, 18.0% cases respectively. Among adult group implant surgery was the most common cause of osteomyelitis which was 65.0% cases. However, there were 20.0% cases without any definitive cause (Table 3).

Table 3: Causes of Osteomyelitis among the Study Population (n=89)

Causes	Children	Adult
Infected Scabies	42.0%	0.0%
Otitis Media	25.0%	0.0%
Rhinitis	5.0%	0.0%
Dental Caries	18.0%	0.0%
Cellulitis	0.0%	12.0%
Implant Surgery	0.0%	65.0%
Cellulitis with DM	10.0%	3.0%
No Cause	0.0%	20.0%

Most common bacterial isolate was *Staphylococcus aureus* which was 29(32.6%) cases. Coagulase Negative *Staphylococcus (CoNS)* and *Proteus species* were the second most common isolated bacteria which was 17(19.1%) cases in each. Gram negative bacteria like

Escherichia coli and *Pseudomonas species* were the most common isolated bacteria which were 11(12.4%) cases and 9(10.1%) cases respectively (Table 4).

Table 4: Bacterial Aetiology of Osteomyelitis (n=89)

Name of Bacteria	Frequency	Percent
Staphylococcus aureus	29	32.6
CoNS	17	19.1
Streptococcus pyogenes	2	2.2
Escherichia coli	11	12.4
Haemophilus influenzae	3	3.4
Pseudomonas species	9	10.1
Proteus species	17	19.1
Others	1	1.1
Total	**89**	**100.0**

Coagulase Negative *Staphylococcus*

Chronic osteomyelitis was not treated with conservative management. However, all the cases (100.0%) were treated with early stage incision and drainage. Dead bone was treated with sequestration, sequestrectomy and saucerization in 72(62.0%) cases. However, Incision, drainage with multiple drill hole cortex of the bones was also done in 34(38.2%) cases (Table 5).

Table 5: Management of Study Population

Management	Frequency	Percent
Chronic Osteomyelitis		
• Conservative	0	0.0
• Early stage Incision and Drainage	89	100.0
Dead Bone: Sequestration, Sequestrectomy and Saucerization	72	62.0
Incision, drainage with multiple drill hole cortex of the bones	34	38.2

Antibiotic sensitivity pattern of major isolated bacteria had shown varied rate of sensitivity pattern to different antibiotics among gram negative and gram positive bacterial isolates (Table 6).

Discussion

The bacterial etiology of osteomyelitis varies with age[11]. The pathogen most often associated with AHO is *Staphylococcus aureus* in 80% of culture-positive cases, followed by group A *Streptococcus (GAS)*[12-15]. In neonates, *S aureus*, group B *Streptococcus*, and gram-negative enteric bacilli are usual pathogens. *Neisseria gonorrhoeae* must be considered in neonates and sexually active adolescents[16]. In the child with sickle cell anemia, in addition to *S aureus, Salmonella spp* frequently cause osteoarticular infections. In some countries, *Kingella kingae* is being recognized increasingly as a common etiology of pediatric osteoarticular infections, especially in children <5 years[17]. Data on the epidemiology of K kingae infection in the United States are limited. In one US study of 99 children with septic arthritis, the diagnosis of *K kingae* infection was made in 10 children aged ≤4 years; polymerase chain reaction (PCR) alone detected the pathogen in 8 cases[18].

Osteomyelitis caused by *Haemophilus influenzae* type b (Hib) is very rare in high-income countries since the widespread implementation of the vaccination program[19]; historically, Hib accounted for 10%-15% of cases of osteomyelitis in unvaccinated children less than 3 years in low-income countries. Likewise, children who are not immunized or who are incompletely immunized against *Streptococcus pneumoniae* have a greater risk of developing invasive disease like bacteremia, meningitis, pneumonia, and bone and joint infections[20].

AHO caused by community-associated methicillin-resistant *S aureus* (CA-MRSA) has become common in many countries. The prevalence of MRSA varies significantly with geography. In one US study, MRSA was implicated in 30% to 40% of pediatric osteoarticular infections[12]. A 2016 study conducted at one large US institution reported that acute musculoskeletal infections caused by MRSA rose from 11.8% in 2001-2002 to 34.8% in 2009-201017. In

Table 6: Antibiotic Sensitivity Pattern of Major Isolated Bacteria

Name of Bacteria	AMX	CEF	CIPRO	MERO	CLIN	GEN	ERY	PEN	VAN
Staphylococcus aureus	85	95	78	81	91	-	79	81	99
CoNS	69	77	62	51	-	61	36	21	83
Streptococcus pyogenes	67	81	71	91	57	12	20	31	-
Escherichia coli	91	45	21	56	-	56	23	81	-
Pseudomonas species	12	34	39	11	-	49	47	27	-
Proteus species	67	81	71	91	57	12	20	31	-

pediatric studies from Finland and Saudi Arabia, MRSA was not identified as an etiology, whereas CA-MRSA has emerged as a common pathogen causing skeletal infection in Romania and Greece. Most cases of AHO occur in children with no known risk factors depict the various microorganisms causing osteomyelitis in patients with specific risk factors.

There are some limitation of this study. This is a single cenre study. The sample size is small. The results doesn't reflect the real scenario.

Conclusion

In conclusion infected scabies is the most common cause osteomyelitis among the study population which is absent in adult group. Otitis media, rhinitis dental caries are also found among the children. Among adult group implant surgery is the most common cause of osteomyelitis. Most common bacterial isolate is *Staphylococcus aureus*. Coagulase Negative *Staphylococcus (CoNS)* and *Proteus species* are the second most common isolated bacteria. Gram negative bacteria like *Escherichia coli* and *Pseudomonas species* are the most common isolated bacteria. Further large scale study should be carried out to get the real pictures.

Acknowledgements
None
Conflict Of Interest
The authors have no conflicts of interest to disclose

Financial Disclosure
The author(s) received no specific funding for this work.

Authors' contributions
Ali MA conceived and designed the study, analyzed the data, interpreted the results, and wrote up the draft manuscript. Jahan SA, Harun-Ar-Rashid AKM contributed to the analysis of the data, interpretation of the results and critically reviewing the manuscript. Kamal MS, Hussain MA, Rahman MM involved in the manuscript review and editing. All authors read and approved the final manuscript.

Data Availability
Any inquiries regarding supporting data availability of this study should be directed to the corresponding author and are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate
Ethical approval for the study was obtained from the Institutional Review Board. As this was a prospective study the written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

How to cite this article
Ali MA, Jahan SA, Harun-Ar-Rashid AKM, Kamal MS, Hussain MA, Rahman MM. Bacteriological Etiologic Diagnosis, Mode of Infection and Management of Chronic Osteomyelitis: A Prospective Hospital-Based Study in Bangladesh. Bangladesh J Med Microbiol, 2022;16(1):8-13

Article Info
Received on: 7 October 2021
Accepted on: 24 December 2021
Published on: 1 January 2022

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