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Clinical and Microbiological Evaluation of Osteomyelitis

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Objective: To investigate clinical aspects and aetiological agents of osteomyelitis with special emphasis on anaerobic infection.

Setting: Basrah University Teaching Hospital, Iraq.

Design: A prospective study.

Methods : Aerobic and anaerobic cultures were made for all cases. The inoculation of operative material on culture media was performed by the bedside.

Results: The study included 134 patients with osteomyelitis. The cases were divided clinically into 4 main groups: haematogenous, exogenous, postoperative and mastoiditis. *Staphylococcus aureus* was the most common causative agent in haematogenous osteomyelitis whereas *Pseudomonas sp*. were the most common causative organisms in postoperative and mastoiditis groups of bone infection. The total number of isolated bacteria was 224, of which 50 (22%) were anaerobes. These anaerobes were isolated from 39 (29%) of 134 patients. The anaerobic organisms were found most frequently in the cases of chronic mastoiditis (57%) and erogenous osteomyelitis (40%).

Conclusion: High prevalence rate of anaerobic bone infection was found specially in chronic cases. Thus, conventional treatment measures may not be beneficial and special type of management should be applied for these cases. Anaerobic culture is also recommended for all cases with osteomyelitis.

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The route of bone infection of osteomyelitis is of three types: haematogenous, direct inoculation, or postoperative. Pyogenic haematogenous osteomyelitis is the most frequent type in children[1]. While many types of micro-organisms including viruses and fungi may cause osteomyelitis, it is usually bacterial in origin[2].

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In developed countries, acute osteomyelitis is uncommon. In developing countries the disease still exists and the morbidity appears worse in the lower socioeconomic groups[3]. In studies of osteomyelitis, *Staphylococcus aureus* has continued to be the most common pathogen isolated from patients with infected bone. Aerobic and facultative Gram negative bacteria, however, have emerged as significant pathogens in patients with chronic osteomyelitis, osteomyelitis following injury and osteomyelitis associated with an adjacent septic focus[4].

Anaerobic bacteria have received increasing recognition as potential pathogens in a variety of infections, but only few authors have noted their role in osteomyelitis. Anyhow, the incidence of anaerobic osteomyelitis is greater than was previously believed[4,5].

However there is a lot of evidence of continuing detection of anaerobic pathogens in osteomyelitis, in particular of those previously considered to have little or no pathogenic significance. Anaerobes became a major problem since they are able to multiply in the devitalized tissue with low oxygen or blood supply specially in the sequestra.

Therefore, this study was performed to investigate the causative agents in different types of osteomyelitis with special reference to anaerobes.

METHOD

This study was conducted at Basrah university teaching hospital starting from 15th November 1992 to the 10th of August 1993. The cases involved in the study were 134 patients with osteomyelitis. The clinical diagnosis of osteomyelitis was supported by radiographs and positive cultures of suitable specimens.

The specimens were taken at the time of operation. The vital point was that, in every case the inoculation of the specimens was done immediately in the operating theater (bedside inoculation) and incubated under aerobic and anaerobic conditions without using transport media. The proper and rapid cultivation method led to good results particularly in isolation of strict anaerobic bacteria.

The following media were employed for the isolation of aerobic bacteria: blood agar, chocolate agar (for incubation under 5-10% $C0_2$) and MacConkey's agar. Blood agar, phenyl ethanol agar, bacteroides bile esculin agar and egg yolk agar were used for anaerobic culture. GasPak anaerobic jar (BBL) was used for anaerobic incubation.

RESULTS

The study included 134 cases which were divided clinically into 4 main groups of osteomyelitis: haematogenous, exogenous, postoperative and mastoiditis.

Haematogenous osteomyelitis

There were a total number of 44 cases of which 29 were males and 15 were females. Male to female ratio was 1.9: 1. The age of patients ranged from 3 to 74 years. The most commonly affected age group was 7-9 years (Fig.1). The socioeconomic status was poor in 37 (84%) patients. As shown in Table 1, trauma was found to be the most.common predisposing factor

(57%). The most common site involved by infection was the tibia (27) followed by the femur (10) .

Figure 1. Age and sex distribution of patients with hematogenous osteomyelitis (at onset of illness)

Among this group, thirty six cases (81%) showed positive bacterial cultures, while in 8 cases (19%) no bacteria were isolated. The cultures were pure in 30 (83%) cases while in 6 (17%) cases revealed a mixed growth. *Staphylococcus aureus* was the most common causative pathogen (45.2%) (Table 2). Two anaerobic organisms (*Peptostreptococcus anaerobius* and *Fusobacterium nucleatum*) were isolated from one case with acute osteomyelitis.

Table 1. **Predisposing factors and causative organisms of haematogenous osteomyelitis.**

Predisposing factor	No. (%)	Organism	(No.)
Trauma	25 (57)		
Sickle cell anaemia	4 (9)	Salmonella sp.	(2)
		S. aureus	(1)
		Klebsiella sp.	(1)
Diabetes mellitus with trauma	1 (2.2)	E. coli	(1)
		Diptheroids	(1)
Closed fracture with diabetes mellitus	1 (2.2)	Enterobacteriaceae sp.	(1)
Uraemia	1 (2.2)	Klebsiella sp.	(1)
Leukaemia	1 (2.2)	Haemophilus influenzae	(1)
Intravenous line in coeliac disease	1 (2.2)	Negative culture	
No predisposing factor is found	10 (23)		
Total	44 (100)		

Exogenous osteomyelitis

The total number of cases were 62. The most frequent predisposing factor was compound fracture (46). All cases showed positive bacterial cultures. The cultures were pure in 50% of cases. Pseudomonas species and Klebsiella species were the most common isolates (17.5% each) followed by Proteus species (12.9%) Table 2.

Table 2. **Bacterial isolates from 134 cases with pyogenic osteomyelitis according to type of infection.**

Organisms	*No. (%) of isolates from indicated type of osteomyelitis* *Hematogenous*	*Exogenous*	*Postop*	*Mastoid*
A-Aerobic organisms:				
Staphylococcus aureus	19 (45.2)	6 (4.55)	4 (11.8)	
Beta-hemolytic Streptococcus Gr.A	3 (7.2)	1 (0.75)		
Coagulase negative Staphylococci	1 (2.4)	11 (8.4)	5 (14.7)	2(12.5)
Streptococcus viridans		2 (1.5)		
Streptococcus pneumoniae		1 (0.75)		
Streptococcus faecalis		1 (0.75)		
Haemophilus influenzae	1 (2.4)	1 (0.75)		
Moraxella catarrhalis		1 (0.75)		
Lactobacilli		1 (0.75)		
Diphtheroids	2 (4.7)			
Brucella species	1 (2.4)			
Pseudomonas aeruginosa	1 (2.4)	22 (16.7)	8 (23.6)	4(25)
Pseudomonas stutzeri	1 (2.4)			
Pseudomonas cepacia		1 (0.75)		
Escherichia coli	2 (4.7)	4 (3)	1 (2.9)	1(6.25)
Klebsiella species	3 (7.2)	23(17.5)	4 (11.8)	1(6.25)
Salmonella species	2 (4.7)			
Proteus specie		17 (12.9)	3 (8.8)	3(18.7)
Providencia rettgeri	1 (2.4)			
Morganella norgani		2 (1.5)		
Enterobacter cloacae		1 (0.75)		
Enterobacter species			1 (2.9)	
Providencia alcalifaciens		1 (0.75)		
Serratia species		1 (0.75)		
Other Enterobacteriaceae species			2 (5.9)	
Fungus		1 (0.75)		
B- Anaerobic organisms:				
Bacteroides fragilis		7 (5.3)	2 (5.9)	1(6.25)
Bacteroides melaninogenicus		6 (4.55)	2 (5.9)	2(12.5)
Peptostreptococcus micros		4 (3)		
Peptosterptococcus magnus	1 (2.4)			1(6.25)
Peptostreptococcus anaerobius	2 (4.7)	4 (3)	1 (2.9)	
Fusobacterium nucleatum	1 (2.4)	3 (2.3)		
Fusobacterium mortiferum	1 (2.4)			
Other Fusobacterium species		2 (l.5)		1(6.25)
Propionibacterium acnes		2 (l.5)	1 (2.9)	
Actinomyces israelii		3 (2.3)		
Clostridium perfringens		1 (0.75)		
Eubacterium species		1 (0.75)		
Veillonella species		1 (0.75)		
Total	42 (100)	132(100)	34(100)	16(100)

The anaerobic bacteria were isolated from 25 (40%) cases. All cases of anaerobic infection yielded mixed growth with aerobic bacteria except in one case. The anaerobic isolates constituted 34 out of 132 isolates (26%).

Postoperative osteomyelitis

The total number of cases was 21. The commonest operative procedure leading to osteomyelitis was extramedullary internal fixation (12), followed by hip replacement (4), intramedullary internal fixation (3), osteotomy (1) and application of bone cement (1) .

All cases included in this group yielded positive bacterial cultures. The isolated organisms were pure in 13 of cultures, while 8 of them revealed mixed growth as shown in Table 2.

The anaerobic organisms were isolated from 6 patients (28.6%). The anaerobic isolates constituted 18% of the total number of isolates. Five cases yielded anaerobes mixed with aerobic organisms, while one case yielded pure anaerobic isolate.

Mastoiditis

There were 7 cases in this group and all of them were chronic. All cases yielded positive bacterial cultures. The growth was pure in 2 of cultures, while 5 yielded mixed growth.

Pseudomonas aeruginosa was the most frequent isolate (25%). The anaerobic organisms were isolated from 4 patients (57%), as one patient was infected with two anaerobic organisms. The anaerobic isolates constituted 31% of the total number of isolates.

DISCUSSION

Staphylococcus aureus was found to be the most common causative agent (45.2%) among cases of haematogenous osteomyelitis in the present study. However, this incidence is less than that reported in previous studies in which the incidence was 61-96% of cases[1,6-12]. This may be related to isolation of many anaerobic bacteria in the present study that may have been regarded as negative cultures in previous reports.

Beta-hemolytic Streptococcus group-A was found to be the second most frequent isolate (7.2%) among haematogenous group. This is in agreement with that reported in most previous studies[9,10,13].

Eight isolates (19%) of Enterobacteriaceae were recovered from the cases of haematogenous osteomyelitis. This somewhat coincides with that obtained by Okoroma and Agbo[11] who found an incidence of 22.5%.

Pseudomonas and Klebsiella species were the most common isolates (17.5%) in the cases of erogenous osteomyelitis. Lower incidence of these organisms was reported in a previous study[14].

Pseudomonas aeruginosa was the most common pathogen among postoperative osteomyelitis and chronic mastoiditis cases. The high incidence of Pseudomonas and Klebsiella species among cases of exogenous and postoperative osteomyelitis is most likely due to the faulty dressing technique where these pathogens could be transmitted from patient to another. On the other hand, the high incidence of *Pseudomonas aeruginosa* among chronic mastoiditis cases may be attributed to the misuse of antibiotic ear drops. The ear drops could transmit these bacteria from skin of the external ear into the middle ear through a perforated tympanic membrane and then these bacteria can settle into the mastoid bone.

Coagulase negative Staphylococci were found to be the second most common isolate (14.7%) among cases of postoperative bone infection. Stevens[15] reported a slightly lower incidence (11%) of the same organisms.

Figure 2. Profile of anaerobic microorganisms prevalence among cases of osteomyelitis

With regard to the present study, anaerobic organisms were isolated from 39 of 134 patients (29%) as shown in Fig 2. Raff and Melo[16] reviewed large series of cases published between 1936 and 1976. They found that only 12 of 1603 cases (0.74%) has anaerobic bone infection. Kelly et al[17] reported 257 cases with osteomyelitis, of which 7 cases (2.7%) were infected with anaerobic organisms. In several large series that were reported and including a total of 1958 patients with osteomyelitis, no cases were attributed to anaerobic organisms. However, there were a large number of negative cultures among these studies but they did not mention a possibility of anaerobic osteomyelitis among these cases[1,6-12,18-21]. The failure of isolation of anaerobes in the previous studies of bone infection might be related to disuse of optimal cultivation techniques for anaerobes and/or the anaerobic cultivation was not performed routinely for every case with osteomyelitis.

On the other hand, Lewis et al[4] reported a higher incidence of anaerobic osteomyelitis than that obtained in the present study. They studied 58 cases with osteomyelitis, of which 23 (39.6%) had anaerobic bone infection. This high incidence of anaerobic osteomyelitis which was obtained in their study was thought to be due to the selection of resistant chronic cases that were referred to that hospital.

Hall et al[22] reported a lower incidence of anaerobic osteomyelitis than that in the present study. They investigated 182 patients with osteomyelitis, of whom 40 (22%) had anaerobic bone infection.

CONCLUSION

From this study, we conclude that anaerobes may play a significant role in producing a resistant chronic osteomyelitis that does not yield to the normal treatment measures. Therefore, we advocate routine culture for anaerobes in osteomyelitis.

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