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An analytical study about the pattern of bacterial isolates in open fractures

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Abstract: Introduction: The dynamics of bacterial populations in soft tissue wounds and bone differ greatly over time. The primary goal in the management of open fracture is the prevention of the infection of the bone and soft tissue. To achieve this goal, the most widely accepted treatment protocols include early surgical debridement, irrigation of open wounds, administration of broad- spectrum antibiotics, and stabilization of fractures.In this study, we studied the pattern of bacterial isolates in all cases of open fractures of extremities that came to the local secondary & tertiary care hospitals.
Material and Methods: This Cross Sectional analytical study involved Prior Consent from the patients & was found to be within ethical standards. It was conducted in nine months. In the present study, 100 patients of all ages, both the sexes, with open fracture of all the grades as per Gustilo-Anderson classification, coming to Orthopaedic Outpatient Department and Emergency Dept of selected hospitals including ours were selected.
Results: Patients who were brought after 6 h showed maximum growth of bacterial isolates. Pre-debridement cultures were taken in all 100 patients, and the presence of growth of organism was found in 56% . Out of the positive 56 patients, 37 (66%) were found to have Gram-positive bacterial growth. Coagulase-negative *Staphylococcus aureus* was the most common Gram- positive bacteria isolated. Gram-negative bacteria were found in 19 (34%) cases, which showed different isolates occurring in same number.Post-debridement cultures showed growth in 34% patients with no growth in rest patients [Table 2]. Out of the 34 patients, Gram-positive bacteria were isolated in 18 patients and Gram-negative in rest 50%. Coagulase-negative S. aureus was the most common.
Conclusion: Predebridement cultures are of no importance in treating open fractures. Postdebridement cultures are important in formulating an antibiotic policy to be started in patients of open fractures as soon as possible. Gram-negative organisms are the most probable cause of infection in cases of open fracture. Our antibiotic policy should cover both Gram-positive and Gram-negative organisms with two antibiotic drug regimen if possible. Aminoglycosides are the most sensitive group of drugs in both Gram- positive and Gram-negative bacteria.

Keywords: Cross Sectional; Open Fractures; Bacterial Isolates; Gram Positive; Gram Negative.

1. Introduction

A The serious nature of open fractures has been understood since antiquity. Globally, the estimated incidence of long bone fractures is 11.5 per 100,000 people per year [1], occurs more in men than women, and has a bimodal age distribution, with the tibia being the most commonly affected bone. The incidence of these open fractures is high in our local setting due to unsafe modes of transport, particularly the upsurge in the use of motorcycles for public transport . Surgical Site Infection (SSI) is one of the most common complications of open fractures. Infected open fracture wounds have historically been dreaded because of the debilitating effect on the patient [1]. Open or compound fractures are fractures that communicate with the outside environment through a wound [2]. They are usually caused by high-energy trauma [3]. Open fractures continue to be a very common entity. Infection at a site of traumatic wounds is a common complication of open fractures. Handling open fractures requires a longer treatment time and high costs, especially if a chronic infection [4]. About 60-70% of contamination of the open fractures occurs at the time of injury [5]. Bacteria originate both from the skin and outside environment [6]. In some cases, the organism is not present at the time of injury, and the wound becomes infected later [7]. The dynamics of bacterial populations in soft tissue wounds and bone differ greatly over time [8]. The primary goal in the management of open fracture is the prevention of the infection of the bone and soft tissue. To achieve this goal, the most widely accepted treatment protocols include early surgical debridement, irrigation of open wounds, administration of broad- spectrum antibiotics, and stabilization of fractures [9].

In this study, we studied the pattern of bacterial isolates in all cases of open fractures of extremities that came to the local secondary & tertiary care hospitals.

2. Material and methods

This Analytical Cross sectional study involved Prior Consent from the patients & was found to be within ethical standards. It was conducted in 9 months among patients admitted to various health centres & tertiary medical care institutes in Raipur CG with open fractures.

In the present study, 100 patients of all ages, both the sexes, with open fracture of all the grades as per Gustilo-Anderson classification, [10] coming to Orthopaedic Outpatient Department and Emergency Dept of selected hospitals including ours were selected.

All patients with open fracture, who had taken definitive treatment before coming to selected hospitals or patients having diabetes mellitus or any immunosuppressive disease or any chronic Infection were excluded from the study. Patients who didn't wanted to be part of the study & Critically ill patients were excluded from the study.

All the patients meeting the inclusion criteria were selected to study bacterial flora in open fractures and their antibiotic sensitivity after taking written informed consent from the patients & Hospital Authorities. On arrival in the emergency /OPD, wound was examined, and the description of the wound was recorded, and then sequential swabs for aerobic culture and sensitivity were taken:

1. At the time of admission on first inspection of the wound.
2. After debridement on first dressing of the wound.
3. Third was taken if infection continued

Simple random sampling technique was used for patient selection . 100 Number of Patients included in the study.

Detailed Clinical Examination was done & all the patients went through Routine investigations.

Culture was taken immediately on the first inspection, and the patient was taken for emergency debridement because wounds were properly scrubbed and painted with antibacterial solution before debridement followed by thorough debridement and copious lavage, cultures were not taken at that time. If the wound was primarily closed on the day of debridement; then, on the first dressing of the wound if any discharge was present, culture was taken before applying any type of antibacterial solution or cleaning the wound with saline. Dressing was done in the dressing room.

All the culture and sensitivity reports were collected for the pattern of bacterial isolates and their sensitivity.

All the patients after the first debridement were given antibiotics in the form of amoxicillin, clavulanic acid, and aminoglycoside according to their body weight. Later on according to the culture and sensitivity reports, antibiotics were changed if needed.

Data was filled in Microsoft Excel & analysed using the Statistical Package for Social Sciences (SPSS) for Windows version 21 & a computer software Epi Info version 6.2 (Atlanta, Georgia, USA). Chi-square test was used to analyze nonparametric or categorical data. For analysis of ordinal scale data, Student's t-test was used. Karl–Pearson correlation coefficient was calculated to observe correlation between variables. P value of 0.05 and less was considered as statistically significant.

3. Results

100 cases of open fractures of upper and lower extremity were admitted and treated over a period of 9 months . Out of these 100 patients, 90 (90%) were male and 10 (10%) were female. Age of the patient ranged from of 4 to 79 years. A maximum number of patient 57% were found in the age group of 21-40 years. The most

common cause of open fractures in our vicinity was found to be road traffic accident, accounting for 78% cases .We found maximum cases 71% of open fractures in lower limb, among which tibia was the most common fractured bone with 40 (56.33%) cases. Nearly 63% patients were brought to hospital after 6 h from the time of injury [Table 1]. Patients who were brought after 6 h showed maximum growth of bacterial isolates.

Table 1

Time lapse (h)	Total cases	Pre-debridement	Post-debridement	Third culture
Before 6	37	7	8	4
After 6	63	48	26	9

Table 2. Overall bacterial growth pattern in different culture sample

Culture sample	No growth	Growth seen in	Gram-positive (%)	Gram-negative (%)
Pre-debridement (n=100)	44 patients (n=100)	56 patients (n=100)	37 (66%) (n=56)	19 (34%) (n=56)
Post-debridement (n=100)	66 patients (n=100)	34 patients (n=100)	18 (50%) (n=34)	18 (50%) (n=34)
3rd culture (n=07)	03 patients (n=07)	04 patients (n=07)	01 (25%) (n=04)	03 (75%) (n=04)

P value was calculated using Chi-square method and it came out to be 0.036, which is significant

Table 3. Culture analysis based on Gustilo-Anderson classification

Classificatn	Total patients	Pre-debridement culture	Post-debridement culture	Third culture
Open Grade I	10	3	0	0
Open Grade II	35	17	10	4
Open Grade IIIA	10	6	5	1
Open Grade IIIB	35	15	10	1
Open Grade IIIC	10	2	5	1

Pre-debridement cultures were taken in all 100 patients, and the presence of growth of organism was found in 56% [Table 2]. Out of the positive 56 patients, 37 (66%) were found to have Gram-positive bacterial growth. Coagulase-negative Staphylococcus aureus was the most common Gram- positive bacteria isolated. Gram-negative bacteria were found in 19 (34%) cases, which showed different isolates occurring in same number.

Post-debridement cultures showed growth in 34% patients with no growth in rest patients [Table 2]. Out of the 34 patients, Gram-positive bacteria were isolated in 18 patients and Gram- negative in rest 50%. Coagulase-negative S. aureus was the most common Gram-positive bacteria isolated with Acinetobacter calcoaceticus baumannii complex as the most common Gram-negative bacteria.

On analysis of all the pre- and post-debridement cultures, we found high growth of isolates in pre-debridement cultures and reduced in post-debridement cultures. We also found that in our study infection was common in open Grade II and open Grade IIIB fracture [Table 3].

4. Discussion

It has been observed that most open fracture infections are caused by Gram-negative rods and Gram-positive staphylococci, and so antibiotics should cover both types of organism [11]. However, recently, Methicillin- resistant S. aureus has been found to be associated with open lower limb fractures in some series. The optimal antibiotic regimen to combat the infection rate with open fracture is not clear from the literature [12]. It is important that, in the setting of open fracture, antibiotics should not be considered as prophylactic. As infection commonly occurs in open fractures not treated with antibiotics, their administration should, better, be viewed as therapeutic [13]. Many studies have shown all open fractures should be treated with combination of a first-generation cephalosporin and an aminoglycoside [14].

It has also been observed that a significant percentage of late infections occur with hospital-acquired organisms, suggesting that inoculation of pathogens occurs subsequent to the initial injury [11].

The constantly changing local wound ecology and sampling variations led to the proposition of different ideas by different authors in the orthopedic literature. Based on the types of organism causing infection compared with those on early wound cultures, several authors have proposed that many infections of open fracture wounds are nosocomial [7].

Wound contamination occurs with both Gram-positive and Gram-negative microorganism; therefore, the antimicrobial regimen should be effective against both the types of pathogen [15].

In our study, on analysis of the predebridement, postdebridement, and third culture, positive predebridement culture showed maximum growth of Gram-positive bacteria. However, majority of these patients were found to have growth of different organism in their postdebridement culture reports. These positive postdebridement culture patients either showed no growth or the microbial isolate was totally different from the predebridement culture. A positive predebridement culture does not conclude that the patient is infected or going to have infection later on because of in our study only 30% of patients of positive predebridement culture showed growth of bacterial isolate in the postdebridement phase. Out of which only two showed the growth of the same organism. Similarly, negative predebridement cultures does not rule out the probability of infection later on, as many cases negative for growth of organism in predebridement phase showed growth of organism in postdebridement cultures. P value of the results of predebridement and postdebridement was calculated using Chi-square test and it came out to be 0.421, which was insignificant. These findings in our study led us to conclusion that predebridement cultures are of no importance. Our findings supported the observation by Faisham et al.[16] and Lee, [11] who concluded that predebridement cultures are of little predictive value.

In our study, postdebridement cultures were more representative then predebridement. Postdebridement culture in our study showed growth of both Gram- positive and Gram-negative bacteria in equal number; clearly indicating a fact that there was increase in growth of Gram-negative bacterial isolates. Another important aspect was that 80% of the patients who showed growth of the bacterial isolates in third culture or who showed signs of continued infection were found to have bacterial growth in their postdebridement culture. This finding in our study led us to the conclusion that postdebridement culture is best to formulate a proper antibiotic regimen according to the sensitivity pattern found in our vicinity for all patients with open fractures. Our finding of postdebridement culture being important coincides with study by Faisham et al. [16].

Third culture analysis showed an increase in growth of Gram-negative bacteria, namely Acinetobacter, Pseudomonas, Enterobacter, and Escherichia coli. Ninety percent bacterial isolates were Gram-negative, probably indicating nosocomial infection because growth of organism was different from postdebridement culture. This finding coincides with finding of Lee [11] and Merritt [17] who were of the opinion that infection in open fractures are of nosocomial origin as causative microorganism of infection are different to that found in initial smears. Nosocomial organisms have emerged as the main source of infection in open fractures in the developed world [18]. Pseudomonas and Enterobacter spp. are associated with hospital-acquired infection rather than initial contamination of the open fracture in the field [19]. Acinetobacter spp. is the most important nosocomial pathogen as it survives in dry environment and is multiple drug resistant [20]. Acinetobacter spp. is ubiquitous in the environment and transmitted through hands, clothing, contaminated surgical instruments, and air conditioning or ventilation devices.

On analysis of predebridement, postdebridement, and subsequent culture pattern in our study, we found that open fractures of tibia showed more growth of pathogens as compared to growth seen in open fractures involving any other bone. The high susceptibility can be explained on the basis of severe comminution, contamination, and devitalization due to superficial location, subcutaneous characteristic, delay in providing early coverage, and most importantly delay in getting proper medical care at right time, which coincides with the finding of Ikem et al. [7].

Lee [11] concluded in his study that both pre- and post-debridement cultures have essentially no value and is an unnecessary expense to the patient and hence should not be used. Our study also shows no significant correlation between pre- and post- debridement cultures, but we found postdebridement culture to be important in formulating an antibiotic regimen to be started early in emergency and subsequent cultures to be taken as long as there is any discharge from the wound site, so as to study the bacterial isolate and its sensitivity pattern to change antibiotics if necessary.

Based on the results, we would like to reemphasize that all patients with open fractures need to be assessed individually, and the basic principles of open fracture management including wound debridement, fracture stabilization, and soft tissue cover must be carried out with culture samples taken at appropriate time.

5. Conclusion

Predebridement cultures are of no importance in treating open fractures. Postdebridement cultures are important in formulating an antibiotic policy to be started in patients of open fractures as soon as possible. Gram-negative organisms are the most probable cause of infection in cases of open fracture. Our antibiotic policy should cover both Gram- positive and Gram-negative organisms with two antibiotic drug regimen if possible. Aminoglycosides are the most sensitive group of drugs in both Gram- positive and Gram-negative bacteria. Quinolones or cephalosporins should be used in combination with aminoglycosides in all cases of open fracture in our vicinity. Absolutely, considering the results of the study, we have change the antibiotic choice and regimen in our department.

We would like to suggest that, all institutions and hospitals should find out the most common infecting pathogen in their environment and formulate an antibiotic policy accordingly.

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