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Evaluation of Bacteriological Contamination Pattern of Open Fractures of Extremities- A Study from Tertiary Centre at Western India

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Abstract

Background and Aim: *In underdeveloped countries, open fractures are fairly prevalent. Open fractures can be caused by a variety of factors, including a car accident, a fall from a great height, a gunshot, an attack, machine injuries, and others. Infection is a typical side effect of open fractures. The goal of our study was to describe the pattern of bacterial contamination, antibiotic susceptibility, and possible antibiotic resistance in open fractures that arrived at our institute within 6 hours after injury.* ***Material and Methods:*** *A one-year prospective study was undertaken on 200 patients with open fractures of the extremities admitted to the accident and emergency department of Tertiary Care Teaching Institute of India. The first swab is obtained at the primary wound assessment, followed by the second culture swab shortly after debridement, the third culture swab on the day of the first aseptic dressing, and the fourth culture swab if the infection persists or the asepsis score is greater than 20 for a period of four days. Reports on culture and sensitivity were collected in order to analyse the pattern of bacterial isolates and their sensitivity.* ***Results:*** *The majority of the patients in this study were men (83%). We discovered 144 (72%) open fractures in the lower limb, with the tibia being the most often fractured bone, with 76 (38%) occurrences with right sided predominance (58%). Out of 200 patients, 78 (39%) had Gustilo II open fractures, followed by type IIIA (33%). Pre-debridement swabs were collected from all 200 patients with open fractures of the extremities upon admission. 26 (13%) of the patients were determined to be culture positive.* ***Conclusion****: In the therapy of patients with open fractures of the extremities, cultures acquired during the first aseptic dressing are considerably more predictive than pre- and post-debridement cultures, and are important in developing an antibiotic policy. It is thus recommended that cultures acquired during the first aseptic dressing provide direction in the selection of antimicrobial therapy, which, when paired with complete wound debridement, will allow for early wound closure and fewer problems.*

Keywords: *Antibiotic Susceptibility, Culture, Infection, Open Fractures*

1. Introduction

Traumatic open fractures are still a significant problem in orthopaedics. Handling open fractures necessitates a longer treatment period and higher costs, especially if the infection is chronic.[1] They are frequently the result of high-energy trauma.[2] Open fractures are still a prevalent occurrence. A typical consequence of open fractures is infection at the site of traumatic wounds.[3] At the time of damage, 60-70% of open fracture contamination occurs. Bacteria can be found on the skin as well as in the environment.[4,5] In certain circumstances, the organism is not present when the injury occurs, and the wound becomes infected later.[6]

The major goal of open fracture therapy is to keep the bone and soft tissue from becoming infected. Gustilo-Anderson (G-A) classifies open fractures into three basic kinds based on the mechanism of injury, the degree of soft-tissue damage, the fracture configuration, and the level of contamination (G-A). Bacterial contamination of bones and soft tissue in open fractures causes up to 50% infection.[6-10] Several extensive series from several centers have identified the most common organisms present,

leading to the approval of wide spectrum antibiotics in grade III open fractures and penicillin in farmyard injuries.

Contamination may also arise during therapy. Pathogens and their resistance to treatment medicines evolve over time and vary by place. The choice of antibiotics to treat contaminating organisms and provide infection protection is still debatable. These bacterial patterns are critical in the development of antibiotics.

The goal of our study was to describe the pattern of bacterial contamination, antibiotic susceptibility, and possible antibiotic resistance in open fractures that arrived at our institute within 6 hours after injury.

2. Materials And Methods

A one-year prospective study was undertaken on 200 patients with open fractures of the extremities admitted to the accident and emergency department of Tertiary Care Teaching Institute of India. Patients were fully informed about the trial, and each patient provided informed permission.

The study included all patients with open fractures of the extremities caused by a car accident, a household fall, a sports injury, a crush injury, a fall from a great height, an attack, or other causes with an injury time of less than 6 hours.

Patients with diabetes and peripheral vascular disease were excluded, as were patients with open fractures treated elsewhere, patients who had received oral or parenteral antibiotics prior to presentation, patients who had not received definitive treatment at our institution, and patients who were unwilling to participate in this study.

All patients who met the inclusion criteria were chosen to research bacterial flora in open fractures of the extremities, and their antibiotic susceptibility was tested after bacteria isolation. Wounds were inspected upon presentation in the emergency department; pre and post debridement wound swabs were taken for aerobic culture in types I to IIIA, and aerobic and anaerobic culture in types IIIB and IIIC.

Collection of swabs Swabs were obtained at the following times: at the time of admission on the initial inspection of the wound, after wound debridement, at the time of the first aseptic dressing, and in patients with an asepsis score greater than 20 for a period of four days.

The microbiology department received all of the swab samples. To assess the likely organism present, preliminary gramme staining was performed. The samples were inoculated on blood agar, MacConkey agar, Robertson's cooked meat, and glucose broth and incubated at 37° C for 24-48 hours. All of the isolates were identified using standard colony morphology, gramme stain, and biochemical testing. Each isolate was screened for antibiotic sensitivity testing by the Kirby-Bauer disc diffusion method including-ampicillin, ampicillin sulbactam, amoxicillin-clavulanic acid, piperacillin tazobactam, ceftazidime, cefitaxime, gentamicin, amikacin, clindamycin, erythromycin, chloramphenicol, linezolid, vancomycin, clotrimazole, cefepime, imipenem, meropenem, cefoperazone-sulbactam, tetracyclin, ciprofloxacin and aztreonam.

Statistical analysis

The collected data was assembled and input into a spreadsheet programmed (Microsoft Excel 2007) before being exported to the data editor page of SPSS version 15 (SPSS Inc., Chicago, Illinois, USA). The confidence level and level of significance for all tests were set at 95% and 5%, respectively.

3. Results and Discussion

The current study was conducted at the Department of Orthopaedic Surgery, Tertiary Care Teaching Institute of India, on a total of 200 patients with open fractures of the extremities who met the inclusion criteria and attended the accident and emergency department, and the overall outcomes were analysed. The majority of the patients in this study were men (83%). Table 1 depicts the gender distribution.

As indicated in Table 2, the majority of patients in our study were between the ages of 20 and 49. This is because this age group is middle-aged, and they are more interested in outdoor activities and road traffic accidents than young and old people.

The most common cause of open fractures of the extremities in our analysis was a traffic collision, which accounted for 130 cases (65%). We discovered 144 (72%) open fractures in the lower limb, with the tibia being the most often fractured bone, with 76 (38%) occurrences with right sided predominance (58%). Out of 200 patients, 78 (39%) had Gustilo II open fractures, followed by type IIIA (33%). Pre-debridement swabs were collected from all 200 patients with open fractures of the extremities upon admission. 26 (13%) of the patients were determined to be culture positive. The majority of the cultures grew gram-positive (58%). Staphylococcus aureus was discovered to be the most common

contamination. Post-debridement swabs revealed growth in only two (1%) individuals, with equal proportions of Staphylococcus aureus, E. coli, and Pseudomonas. In 32 cases, the first aseptic dressing cultures revealed growth. Only two patients out of 32 demonstrated growth in pre-debridement cultures, but with different species. At this point, all positive post-debridement culture patients turned negative. The majority of the positive first aseptic dressing cultures (84%) had gram-negative growth as opposed to gram-positive (16%). Pseudomonas was discovered to be the most prevalent isolate. In our study, we had 57 patients whose discharge was continued and whose asepsis score was more than 12. In 45 individuals, infection developed, and gram-negative organisms caused the majority of bacterial infections (79%). Pseudomonas (35%) was the most common infecting organism among gram-negative isolates, while Staphylococcus aureus (100%) was the most prevalent culprit among gram-positive isolates. (Table 3) We discovered that only 13% of patients had positive cultures on admission (predebridement cultures). Similarly, negative first cultures did not rule out the possibility of infection later on, as many instances that were negative for growth in early cultures grew in final cultures. While cultures taken on the first aseptic dressing day were shown to be more sensitive, 61% of the 32 instances developed infection in the final cultures, and similar types of organisms were detected in 57% of the cases. Thus, cultures collected during the first aseptic dressing had a stronger predictive value than initial cultures. The predictive significance of pre- and postdebridement cultures for infection development in the final cultures was determined to be statistically insignificant because the p value was >0.05 when compared to the p value of the first aseptic dressing cultures, which was 0.05.

All gram-positive pathogens tested positive for linezolid, vancomycin, and cefotaxime in this investigation. Other drugs were less sensitive to gram-positive isolates and demonstrated high resistance. AExcept for Citrobacter, all gram-negative isolates tested positive for amikacin and ciprofloxacin in this investigation.

Table 1: Gender wise Distribution of Study Population

Gender	Number	Percentage (%)
Male	166	83
Female	34	17
Total	200	100

Table 2: Age wise Distribution of Study Population

Age (Years)	Number	Percentage (%)
1-19	36	18
20-49	136	68
>50	28	14

Table 3: Bacterial flora at different stages of wound management

Cultures at different stages of wound management	No growth	Growth seen	Gram-positive growth (%)	Gram-negative growth (%
Pre-debridement cultures (n=200)	174	26	58	42
Post-debridement cultures (n=200)	198	2	34	66
1st aseptic dressing cultures (n=200)	68	32	16	84
Final culture (57)	12	45	20	80

Because Gram-negative rods and Gram-positive staphylococci produce the majority of open fracture infections, medicines should cover both types of organism.[11] However, in other studies, Methicillin-resistant S. aureus has been linked to open lower limb fractures. The literature does not indicate the best antibiotic regimen to combat the infection rate with open fracture.[12]

The age group of 20-49 years had the highest number of patients in the current study. The findings of Agarwal et al and Mangala et al are likewise consistent.[13,14] There were 166 males and 34 females in our study of 200 cases. Males outnumber females in the studies undertaken by Lingaraj et al and Yishak et al.[15,16] In the current investigation, RTA was revealed to be the most common cause of open fractures, accounting for 130 (65%) of cases. The similar thing was discovered in the studies conducted by Agarwal et al and Bhatty et al.[13,17] In our investigation, we discovered 144 (72%) occurrences of open

fractures in the lower limbs. Agarwal et al, Yishak et al, and Mangala et al all come to the same conclusion.[13,14,17]

The tibia and fibula were the most often broken bones in the current investigation, accounting for 38% of all occurrences. Agarwal et al and Mangala et al discovered the same thing.[13,14] In the current investigation, cultures taken before admission (pre- and post-debridement) were found to be useless in predicting and treating infections because none of the organisms produced on these cultures eventually caused infection. The positive predebridement culture grew the most Gram-positive bacteria when the predebridement, postdebridement, and third cultures were analysed. However, the majority of these patients had development of various organisms in their postdebridement culture results. Our study's findings lead us to the conclusion that predebridement cultures are unimportant. Our results corroborated the findings of Faisham et al[18] and Lee[19], who concluded that predebridement cultures have minimal prognostic value.

Because of the continually changing local wound ecology and sampling variances, various authors in the orthopaedic literature proposed various solutions. Several publications have claimed that many infections of open fracture fractures are nosocomial based on the sorts of organisms producing infection compared to those on early wound cultures.[20] Because wound contamination occurs with both Gram-positive and Gram-negative microorganisms, the antimicrobial therapy should be effective against both pathogen types.[21]

In our investigation, gram-negative organisms generated the majority of bacterial infections in open fracture wounds, with Pseudomonas and Klebsiella being the most common gramme negative isolates. Staphylococcus aureus was discovered to be the most common gram-positive isolate. Mangala and colleagues, as well as Bhatty and colleagues, noticed the same thing.[14,17] This observation is also consistent with the findings of Lee[19] and Merritt[22], who believe that infection in open fractures is of nosocomial origin because the causal bacterium of infection differs from that discovered in first smears. In the industrialized world, nosocomial organisms have emerged as the primary source of infection in open fractures. Pseudomonas and Enterobacter spp. are more commonly associated with hospital-acquired illness than with first contamination of an open fracture in the field.[23,24] Acinetobacter spp. is the most common nosocomial infection because it can persist in dry environments and is medication resistant.[25]

Linezolid and vancomycin were determined to be the most efficient antibiotics against the tested gram-positive pathogens in this investigation. However, these medications are expensive and should not be used for prophylaxis to protect their efficacy. Grampositive organisms showed high susceptibility to 3rd generation cephalosporins in our investigation, which is similar with the findings of Sitati et al.[19] Except for Citrobacter, amikacin and ciprofloxacin were determined to be the most efficient antibiotics against the tested gram-negative pathogens in this investigation. With the exception of ampicillin and penicillin, all gram-positive bacteria had poor antibiotic resistance.[26] Almost of gram-positive bacteria tested positive for multiple antibiotic resistance. Clostridium spp. was all susceptible to tetracycline, doxycycline, and kanamycin, with limited resistance to chloramphenicol, clindamycin, and penicillin.[27] All gram-negative showed low resistance to antibiotics except ampicillin and amoxicillin (60–80%). Fifty-one per cent of gram-negative bacteria were identified as multiple drug-resistant (MDR).

4. Conclusion

In the care of patients with open fractures of the extremities, cultures acquired at the first aseptic dressing are considerably more predictive than pre- and postdebridement cultures and are useful in developing an antibiotic policy. It is thus recommended that cultures acquired during the first aseptic dressing provide direction in the selection of antimicrobial therapy, which, when paired with complete wound debridement, will allow for early wound closure and fewer problems. We believe that all institutions and hospitals should identify the most common pathogens in their environment and develop an antibiotic policy accordingly.

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