ORIGINAL ARTICLE

Bacterial Cultures and Antibiotic Sensitivity in Open Fractures

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ABSTRACT

Aim: To determine the frequency of patients having positive bacterial cultures in open fractures as well as the types of bacteria in open fracture wounds and their antibiotic sensitivity patterns.
Method: This descriptive cross-sectional study was carried out at the department of Orthopedic Surgery Services Hospital, Lahore from February 2011 to August 2011. Sample size of 100 cases was calculated with 95% confidence level, 5.5% margin of error and non-probability purposive sampling technique. Swab cultures were taken from open fracture wounds and sent in the hospital laboratory to measure the frequency and types of bacteria. Antibiotic sensitivity also tested against the bacteria isolated.
Results: The mean age was (mean ± SD) (38.29 years ± 15.04). Male to female ratio was 4:1. Of the hundred patients, 32(32%) wound specimens were positive for the presence of bacteria. 44 bacteria was isolated from 32 cultures. Staphylococcus aureus was the most common pathogen found (34.1%) followed by Staphylococcus epiderdimis (20.5%). Ceftriaxone and Ciprofloxacin was the most effective antibiotic against most of the bacteria isolated from open fractures.
Conclusion: Initial contaminations in open fractures are caused by both gram positive and gram negative bacteria. Prophylactic antibiotic should be broad spectrum in order to prevent developing infection in open fractures. Ceftriaxone and Ciprofloxacin in combination can be used prophylactically in open fractures.
Keywords: Open fractures, Bacterial cultures, Antibiotic sensitivity, Gram positive, Gram negative.

INTRODUCTION

Open fractures are described as a fracture in which there is breach in the continuity of skin and underlying soft tissues and it gets across with the fracture and its hematoma.[1] These constitute about 3-4% of all fractures[2]. Road traffic accidents, gunshot injuries, fall from height or machine injuries are the major causes of open fracture . Males are affected more than females and mean age of presentation is 36.5years[3].

Infection is one of the most common and disastrous complications of an open fracture, with reported incidence of 2-25%[4]. Intact skin acts as a mechanical barrier for microbial organisms. When it is damaged in open fractures, it causes bacteria infiltration at the site . In addition, the devitalized soft tissue caters an excellent atmosphere for bacterial growth and subsequent infection[5].

The anatomical location of fracture also helps in determining the risk of infection. The commonest long bone to be involved in open fracture is tibia owing to its long subcutaneous surface, with an incidence rate ranging from 50-60% and 10-20 times higher infection rate than open fractures in other locality[5].

Gustilo and Anderson classified these open fractures into three grades based on the mechanism of injury, the extent of periosteal soft tissue damage, the morphology of fracture and the degree of contamination. Depending on the severity, the infection risk ranges from 0-2% for type I, 2-10% for type II and 10-50% for type III open fractures[7,8].
Wound infecting organisms shows regional differentiation[9]. Due to change in wound ecology and sampling variations, there are different concepts by different authors in literature. In some cases, wounds are not infected initially and later becomes inoculated.[10] Most of infections in open fracture are caused by Staphlococcus aureus and gram negative bacilli which includes Acinobacter, E.coli, Pseudomonas, Enterobacter and Klebsiella[11].
The source of pathogenic organism in open fracture may be 1) Environmental, contamination of wounds during time of injury; 2) Endogenous, from patients own flora and 3) Exogenous, from another patient or hospital staff.[12] The factors which influence the nature and frequency of infection are low resistance of patients, contaminated environmental sites, contact with infectious persons, or drug resistance of pathogenic bacteria[13].

In open fractures especially grade III, the loss of skin and devitalization of bone and soft tissue are usually the main reasons for development of infection[14]. Chronic osteomyelitis can result from deep fracture with or without discharging sinus, non-union, functional deficit or even limb amputation.[15] Complications of open fractures increase with age of patient and complexity of injury. Sufficient soft tissue coverage surrounding the traumatized bone also determines the risk of complications.

Orthopedic surgeons should be acquainted with the pathophysiology of the fractured bone as well as soft tissue, the timing, risks and benefits of the different treatment options. Proper assessment should include complete history of injury, neurovascular examination and a proper diagnosis of bone and soft tissue damage, thus taking into consideration the general condition of the patient[16].

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The primary goal in the management of open fractures is to prevent the infection of bone and soft tissue. The treatment protocol includes surgical debridement, wound irrigation, broad spectrum antibiotics, stabilization of fracture and early soft tissue coverage.[17] Several studies have been done to identify the most common bacteria involved in contaminating open fractures and have led to acceptance of usage of broad spectrum antibiotics for their eradication. The selection of antibiotics to treat these infections is still controversial[18].

The aim of this study is to observe the density of common bacterial flora contaminating open fractures and antibiotic sensitivity pattern of various bacterial isolates to implement the most effective antibiotics for open fractures in our population; as common pathogenic organisms and their sensitivity pattern may vary from population to population and not much work has been done on this locally.

SUBJECTS AND METHOD

This is descriptive cross-sectional study had ethical review and was carried from February 2011 to August 2011 in the Department of Orthopedic surgery, Services hospital, Lahore. Our inclusion criteria included patients of either gender between ages 15 to 65 years having Open fracture of any type in one or both limbs presenting within 12 hours of injury. Patients without any other site of infection (determined clinically and by investigations such as WBC count and Urine analysis) were also inducted in this study. On the other hand, patients who had been treated with any form of antibiotics before initial presentation, those who had undergone debridement or any other surgery and with known history of immunosuppressive disease such as Diabetes mellitus (diagnosed by blood sugar level) were excluded from the study.

Non-probability, purposive sampling was done after Sample size of 100 cases was calculated with 95% confidence interval, 5.5% margin of error and taking expected percentage of Klebsiella i.e., 7.4% (bacteria involved in contaminated open fracture wounds). A complete history was written that include demographic data (age, sex, and address) in the Emergency Department. After taking informed consent, these patients were carried to operation theatre room and detailed wound examination was undertaken. The end of a sterile cotton-tipped applicator (culture tube) was rotated over 1 cm^2 area in the deep tissue of open fracture wound with sufficient pressure to express fluid and bacteria to surface from within the wound tissue. In order to avoid contaminants that were usually found on the skin surface the cotton tip applicator were applied deep into the wounds. After taking culture, the applicator was kept in the culture tube. The culture was then immediately sent to the laboratory to avoid any false negative results. Sensitivity of the bacterial cultures were tested against Amoxicillin-clavulanic acid, Ciprofloxacin, Ceftriaxone, Ampicillin, and Gentacin. The culture and sensitivity reports were collected usually three days afterwards. All this information was recorded in a pre-designed Performa.

The collected data was entered and analyzed accordingly using SPSS version 11 through its statistical program. The qualitative variables were pathogenic bacteria i.e., Staphylococcus aureus, Staphylococcus epiderdimis, Acinobacter, E. coli, Pseudomonas, Enterobacter and Klebsiella; and their antibiotic sensitivity for Ampicillin, Amoxicillin-clavulanic acid, Gentacin, Ciprofloxacin and Ceftriaxone were presented in the form of frequency and percentage. The variables were analyzed using simple descriptive statistics, calculating mean and standard deviation for qualitative variables like age.

RESULTS

Sample study consisted of 100 patients. Mean age of the sample was 38.3 years with standard deviation of 15.04. The youngest patient was 15 years of age and oldest patient being 65 years of age (Figure-1). Four age groups were selected. Out of which most of the patients (39%) affected were in age group 15-30 years (Figure-1). 80 patients out of hundred were male and 20 patients were female in the result with the ratio of 4:1(Figure-1). Type-I open fractures were seen in 8 patients and Type II open fractures were seen in 32 patients. Most of the patients were Type III-A which accounted 46 patients (Figure-2). 83 open fractures were seen in the lower limb and 17 were in the upper limb. Tibia and fibula was the most common bone affected (59%) followed by 16 were in femur, 10 were in Radius /Ulna, 8 were in Patella, and 7 open fractures were seen in the Humerus (Figure-2). In 32 patients out of hundred, culture report were positive for the presence of bacteria. Staphylococcus aureus was the most common bacteria which was found to be present in 15 out of 44 bacteria isolated followed by Staphylococcus epiderdimis(9), Pseudomonas(8), E.Coli(5), Klebsiella(3), Acinobacter and Enterobacter in 2 culture reports (Figure 3). 20 bacteria out of 44 were isolated as single bacteria in culture reports while 24 bacteria were isolated in remaining 12 culture reports. Staphylococcus aureus was the most common bacteria as single bacteria. (Table-1) Ciprofloxacin shows the highest sensitivity against Staphylococcus aureus and epiderdimis while Ceftriaxone was the most sensitive antibiotic against other bacteria (Table-2).

Table 1: Frequency distribution according to pattern of bacteria

Bacteria (n)	Single in (%)	Polymicrobial(%)
Staphylococcus aureus(15)	10(66.7)	5(33.3)
Staphylococcus epiderdimis(9)	5(55.5)	4(45.5)
Pseudomonas(8)	4(50.0)	4(50.0)
E.coli(5)	1(20.0)	4(80.0)
Klebsiella(3)	0(0.0)	3(100.0)
Acinobacter(2)	0(0.0)	2(100.0)
Enterobacter(2)	0(0.0)	2(100.0)
Total(44) out of 32 cultures	20(62.5%)	24 (37.5%)

Figure-1: Frequency distribution of patients according to age and Gender

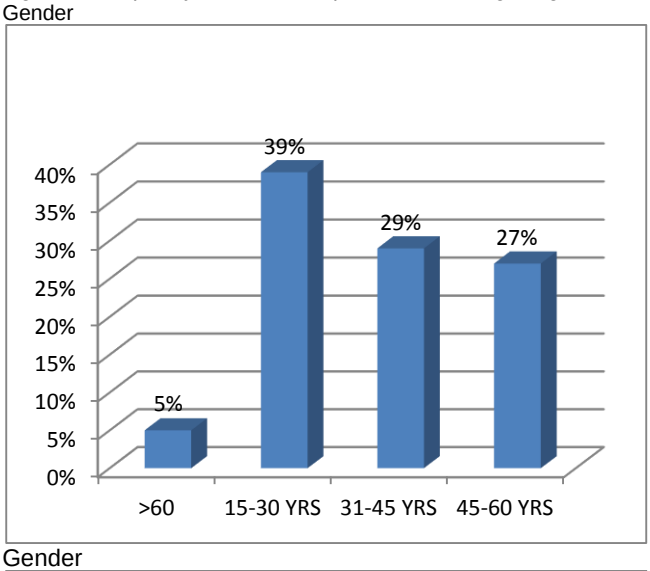
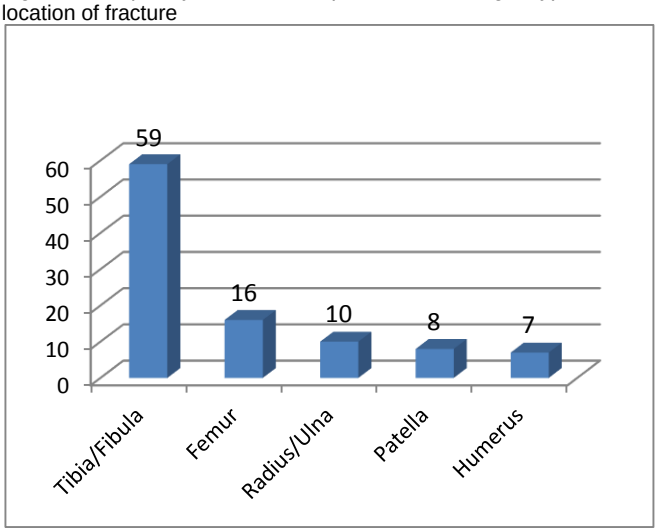
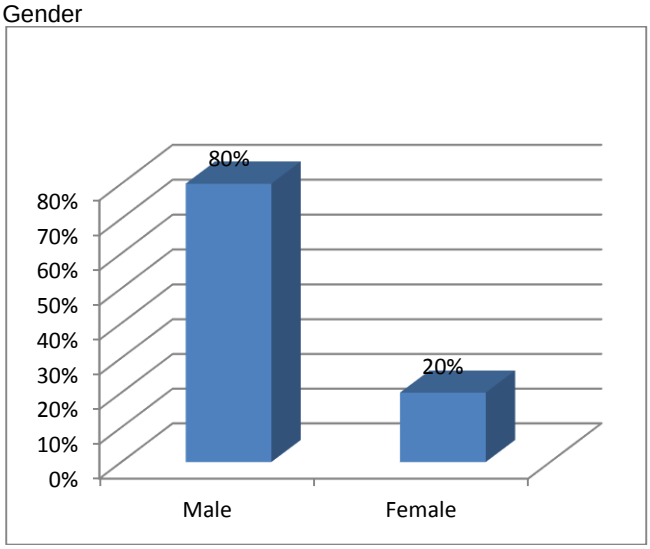


Figure 2: Frequency distribution of patients according to type and location of fracture



Gender



Location of fracture

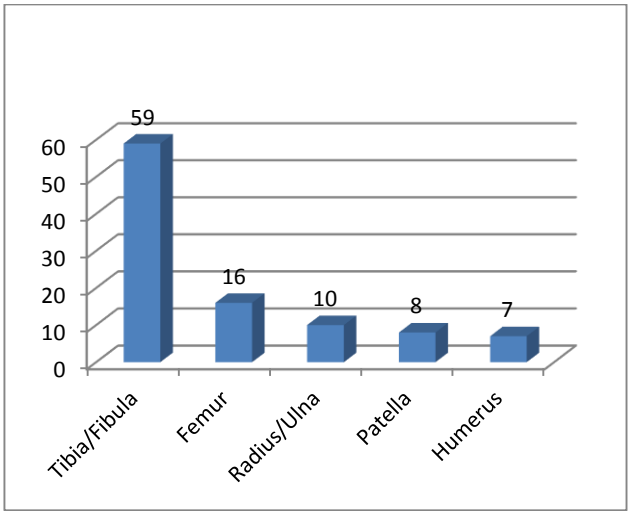
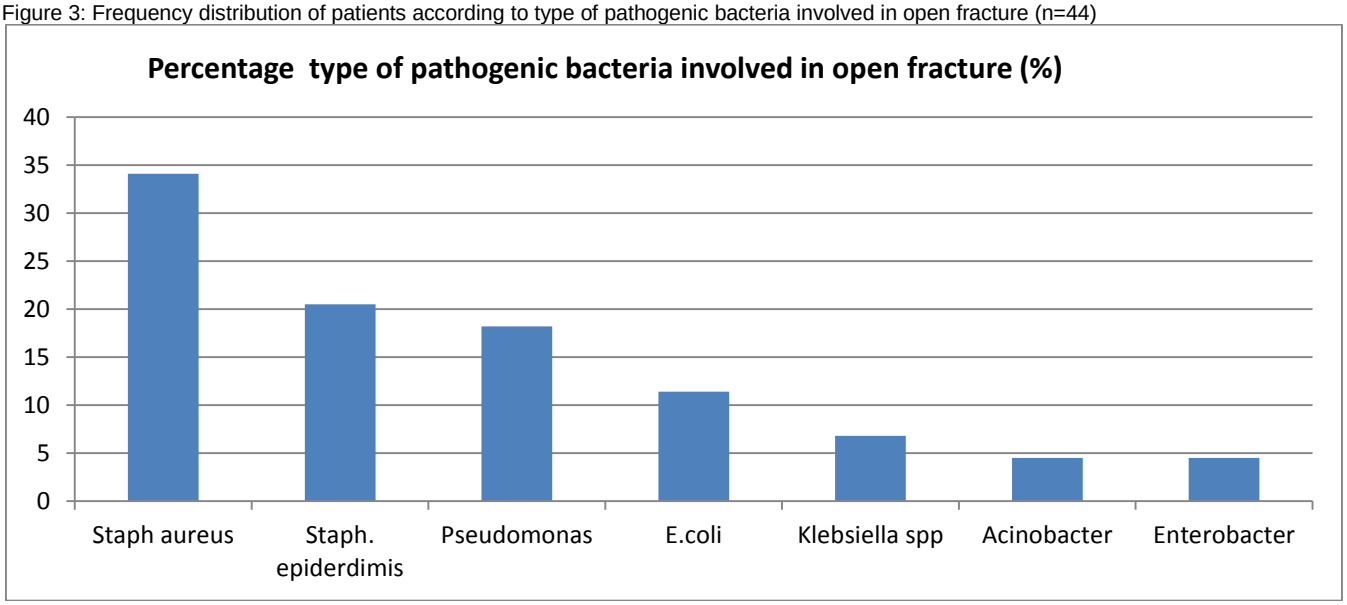


Table 2: Frequency distribution according to antibiotic sensitivity

Bacteria		AMP	AMC	GC	CPO	CRO
Staph. Aureus	S	10(66.7)	12(80.0)	4(26.7)	13(86.6)	10(66.7)
	R	5(33.3)	3(20.0)	11(73.3)	2(13.4)	5(33.3)
Staph. Epiderdimis	S	5(55.5)	7(77.8)	5(55.5)	7(77.8)	6(66.7)
	R	4(44.5)	2(22.2)	4(44.5)	2(22.2)	3(33.3)
Pseudomonas	S	0(0.0)	2(25.0)	6(80.0)	6(80.0)	7(87.5)
	R	8(100.0)	6(75.0)	2(20.0)	2(20.0)	1(12.5)
E.coli	S	2(40.0)	2(40.0)	5(100.0)	4(85.7)	5(100.0)
	R	3(60.0)	3(60.0)	0(0.0)	1(33.3)	0(0.0)
Klebsiella	S	0(0.0)	1(33.3)	2(66.7)	2(66.7)	3(100.0)
	R	3(100.0)	2(66.7)	1(33.3)	1(33.3)	0(0.0)
Acinobacter	S	0(0.0)	0(0.0)	0(0.0)	2(100.0)	2(100.0)
	R	2(100.0)	2(100.0)	2(100.0)	0(0.0)	0(0.0)
Enterobacter	S	0(0.0)	0(0.0)	2(100.0)	2(100.0)	2(100.0)
	R	2(100.0)	2(100.0)	0(0.0)	0(0.0)	0(0.0)

Figure 3: Frequency distribution of patients according to type of pathogenic bacteria involved in open fracture (n=44)



DISSCUSSION

Most of the open fractures are supposed to be infected at the time of initial trauma and are often associated with soft tissue injury. Infection is the most devastating complication of an open fracture which can lead to osteomyelitis, sepsis, tissue loss or even amputation. Despite improvement in management, late infection still occurs in 2-25% of open fractures[4].

The present study addresses the bacteriology of open fracture wounds and their antibiotic sensitivity patterns. Not much work has been done regarding this problem in Pakistan. This study identifies the etiological agents which causes early contamination of wounds associated with open fractures.

In this study, most of the open fractures occur in males in between ages 15-30 years. This is in concordance with the research done by Ahmad et al that showed the incidence of open tibial shaft fractures most common in this age group.[3] This is explained by the fact that most of the transportation and industrial works are associated with males of this age group. Males of this group are also usually involved in assault and interpersonal violence which results in open fractures. Road traffic accidents (RTA) are the main cause of open fractures with male predominance[3, 10].

In our study, 83% of the fractures involve the lower limb. Tibia was the most common bone affected (59%) followed by femur (16%). Sukhsathein et al also stated that Tibia associated with fibula as the most frequent fractured bone in open fractures. Most of the open fractures occur in tibia due to more subcutaneous location of the bone and severe soft tissue injury[6].

Most of the open fractures in our study were graded type III-A (46%) according to Gustilo and Anderson classification. This is due to fact that grade III open fractures are usually associated with high velocity injuries which are increasing day by day in our setting. This is due to over speeding, high number of vehicles and overcrowded roads[2,7,15].

This study showed that 32% of the wound specimens were positive for the presence of bacteria. This is in concordance with the studies conducted in other countries. Abraham et al concluded 30.5% of the bacterial cultures to be positive in open fractures on initial presentation[10]. Faisham et al showed in their result that 39.3% wound cultures were contaminated initially in open fractures. There are multiple factors which affects the bacterial isolation cultures such as technique of swab culture, sample collection and transportation[21].

A D'Souza et al reported that pre and post debridement cultures have a role in detecting infections in open fractures.[4] They further discussed that pre debridement cultures have better sensitivity and post debridement cultures have better specificity for identifying infections. However Carsenti-Etessi et al found that the initial contaminants in open fracture wounds were not the same that caused infection and opposed culture immediately after fracture[22].

Biruk and Webshut concluded in their study that most common pathogenic bacteria in initial contamination open fracture is Staphylococcus aureus[20]. The present study also concluded Staph. aureus to be the most common bacteria isolated (34.1%) followed by Staphylococcus epiderdimis (20.5%). The other bacteria isolated were Pseudomonas (18.2%), E.coli (11.4%), Klebsiella (6.8%), Acinobacter (4.5%) and Enterobacter (4.5%). There is an increasing trend towards gram negative organisms as the development of resistance and hospital acquired infections. Agrawal et al emphasized that most of the infections in orthopedic patients after hospital admission are caused by Pseudomonas and E.coli (gram negative bacteria)[12].

In this study, 62.5% of the culture positive wounds showed single bacteria and 37.5% delivered polymicrobial pattern. A study conducted by Abraham et al reported 48.8% polymicrobial pattern in positive wound cultures and most of the bacteria in this pattern were gram negative microorganisms.[10] Alonge et al also discussed that time factor is important in the emergence of mixed pattern

bacteria. He stated that the frequency of polymicrobial culture pattern increased after 48 hours of hospital admission[23].

Patzakis et al recommended early use of an antibiotic has a protective role in preventing infection in open fractures.[24] Zalvras et al also stated that good prophylactic antibiotic prevents subsequent infection in open fractures. Early, systemic and wide spectrum antibiotic is essential in the treatment of open fractures. But, with the excessive use of antibiotics, there is development of more resistant microorganisms[5,19].

According to this study, Ampicillin showed the highest level of resistance against all the bacteria isolated from the open fractures. Sattar et al in his study on antimicrobial susceptibility of Staphylococcus aureus also concluded that it has developed resistance against most of Penicillins[25].

Ceftriaxone and Ciprofloxacin was the most effective antibiotic which showed maximal sensitivity against all the bacteria tested. Alonge et al in a study concluded pefloxacin, ciprofloxacin and ceftriaxone to be the most effective antibiotics against the bacteria contaminating open fractures.[23] Zalvras et al recommended that wide spectrum antibiotic therapy effective against both gram positive and gram negative bacteria should be used in open fractures. He stated that combination therapy has been shown to be effective in reducing infection rates in open fractures.[19]

CONCLUSION

Early contamination in open fractures is caused by Staphyloccocus aureus, Staphylococcus epiderdimis, Pseudomonas, E. coli, Klebsiella, Acinobacter and Enterobacter. Most common pathogen which initially contaminates open fractStaphyloccocus aureus and Staphylococcus epiderdimis which constitute half of the cases. Most of the bacteria are resistant to Penicillin. Ceftriaxone and Ciprofloxacin is the most effective drug against most bacteria that are found initially in open fractures. These are good spectrum drugs which can be given prophylactically in open fractures before culture and sensitivity report. However, when antibiotic sensitivity is known, narrowest spectrum drug should be chosen that has highest efficacy and less toxicity.

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