Frequency of Common Pathogens Isolated from Open Fractures of the Extremities and their Antimicrobial Sensitivity Pattern.

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ABSTRACT

Objective: To determine the frequency of micro organisms in open fractures of the extremities and their sensitivity pattern to the commonly used antibiotics.

Methods: This descriptive study was conducted in the Department of Orthopaedic Surgery Nishtar Medical University Hospital Multan. The duration of our study extended from 29th June 2019 to 5th July 2020. Patients of either gender and age 18 to 60 years with open fractures meeting the inclusion criteria were enrolled in our study. Wound swabs were taken with Levine technique before surgical debridement and sent to laboratory for Gram staining and culture and sensitivity of the microbial agents. Post stratification comparison of important variables were done and *P* value was calculated with the help of Chi-square test. (*P*<0.05 was considered statistically significant)

Results: The total number of patients in our study were 195.Male patients were 161(82.6%) and female 34(17.4%). The mean age was 38.86±8.05 years. The most common fractured bone was tibia (20.5%, n=40) followed by humerus (19%, n=37%) and metacarpals/phalanges (16.9%, n=33). Gustilo Anderson type IIIA was the predominant type of fracture present in 71(36.4%) patients followed by type II (27.2%, n=53).Majority (62.6%, n=122) of the patients were presented to the hospital in time period extending from 6-12 hours of sustaining the injury. The culture report was positive in 187(95.8%) patients while no growth was noted in 8(4.1%) patients. Staphylococcus Aureus was reported in 112(57.4%) patients, Streptococcus in 34(17.4%) and E. Coli in 22(11.3%). Gram positive cultures were most sensitive to first generation Cephalosporin (60.5%, n=118) while Gram negative cultures to Quinolones (69.4%, n=25).

Conclusion: Majority of open fractures of the extremities had positive culture of bacteria. Gram positive organisms were the most common isolated pathogens. First generation Cephalosporin was the most sensitive group of drugs against gram positive bacteria.

Keywords: Antibiotics, Culture, Infection, Open fracture, Pathogens, Sensitivity.

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INTRODUCTION

Open fracture is defined as a fracture in which there is discontinuity of the overlying skin and soft tissue and the bone lies in direct contact with the external environment.[1] A high morbidity and mortality rates have been reported due to complications of open fractures.[2,3] An increasing frequency of infection rate have been reported with increasing size of the wounds and contamination associated with open fractures of the extremity.[4] The incidence of infection depends on the time of exposure and the extent of injury. Wound

is considered to be less contaminated if the time of exposure has been less than six hours, after which the process of multiplication of bacteria starts at the wound site and the process of infection starts in the wound.[5] Due to lack of optimum health care services and public awareness in peripheral areas delay of open fracture management results in prolongation of the exposure time and ultimately increase in infection rate.[6] The early use of broad spectrum antibiotics is considered to delay the proliferation of bacteria at contaminated site and hence increase golden period of management of open fractures by few hours but still the data is contradictory.[7,8]

Many factors determine the choice of antibiotics and include the mechanism of the injury, the site of injury, severity of injury and bacterial culture and the sensitivity pattern.[9-14] Most commonly recommended antibiotics for the management of open fractures include penicillin, cephalosporin and aminoglycosides alone or in combination but ideally antibiotic therapy should be based on culture and sensitivity report.[15,16] Staphylococcus, Enterobacter, Pseudomonas, Klebsiella and Actinobacter are the commonest pathogens isolated in open fractures and sensitive to Cephalosporin and Quinolones.[1,9]

Department of Orthopaedics Surgery Nishtar Medical University Hospital Multan had no antibiogram yet and the choice of empiric antibiotics in open fractures depends upon individual surgeon choice and experience and patient affordability. This study will help in generating local antibiogram for open extremity fractures which will help in making guidelines for empiric antibiotic therapy. The objective of our study was to determine the frequency of micro organisms in open fractures of the extremities and their sensitivity pattern to the commonly used antibiotics.

METHODS

This descriptive study was conducted in the Department of Orthopedic Surgery Nishtar Medical University Hospital Multan from 29th June 2019 to 5th July 2020.

All patients of either gender with open fractures of the extremities and age 18 to 60 years presented to emergency department within 24 hours of injury were included in our study. Patients with pathological fracture and polytrauma patients requiring surgical intervention for head injury, abdominal and thoracic injuries were excluded. The study was performed after approval of the proposal by the Institutional Ethical Review Board (IERB). Informed written consent was taken from each patient before being enrolled in the study after explaining to them the objectives of this study and ensuring them confidentiality of their information provided. All patients were resuscitated and stabilized according to ATLS protocol. Demographic data like age (in years), cause of injury and the time since injury was noted. Relevant radiographs and blood investigations were ordered. Pre debridement three wound swabs were taken with Levine technique.[17] The result was considered positive when at least two out of three swabs were positive. These samples were then sent to laboratory for Gram staining and culture and sensitivity of the microbial agents. Laboratory reports were followed for culture and sensitivity of the microbial agents and the results were documented. All investigations were performed by the Central Laboratory of Nishtar Hospital Multan. Testing for antibiotic sensitivity was done by the Kirby-Bauer method.[18]

All the collected data was entered in SPSS version 23 for analysis. The quantitative data such as age and time since injury was presented as mean and standard deviation. The qualitative data such as gender, type of fracture, site of fracture, type of organisms and sensitivity was presented as frequency and percentage. Stratification of important data variables like age, time since injury, site of fracture and the type of fractures were done. Post stratification chi square test was applied and *P* value calculated ($P < 0.05$ was considered statistically significant)

RESULTS

The total number of patients in our study were 195. Majority (82.6%, n=161) of our patients were male while female were 34(17.4%).The mean age was 38.86±8.05 years. Most (82.6%, n=161) of our patients were in the age range of 31 to 60 years (*P* value 0.038) as shown in table I. The aetiology of fractures were road traffic accidents in 148(75.8%) patients, gunshot in 35(17.9%), fall in 8(4.1%) and assault in 4(2%) patients. The mean duration between injury and presentation to the hospital was 8.88±4.06 hours. The most common fractured bone was tibia (20.5%, n=40) followed by humerus (19%, n=37%) and metacarpals/phalanges (16.9%, n=33). Gustilo Anderson type IIIA was the predominant type of fracture present in 71(36.4%) patients followed by type II (27.2%, n=53). Majority (62.6%, n=122) of the patients were presented to the hospital in time period extending from 6-12 hours of sustaining the injury.(*P* value 0.187) The culture report was positive in 187(95.8%) patients while no growth was noted in 8(4.1%) patients as shown in table II. Staphylococcus Aureus was reported in 112(57.4%) patients,

Streptococcus in 34(17.4%), E. Coli in 22(11.3%) and Methicillin Resistant Staphylococcus (MRSA) was noted in 5 (2.5%). Gram positive cultures were most sensitive to first generation Cephalosporin (60.5%, n=118) and Gram negative cultures were most sensitive to Quinolones (69.4%, n=25).Single bacteria was noted in 144(73.8%) patients while more than one in 51(26.1%).

Table I: Demographic details and fracture patterns of our study participants.

Parameter		Demography		Organism grown on culture							*P* value
		Frequency	%age	S. Aureus	Streptococcus	E. Coli	Pseudomonas	MRSA	No growth	Total	
Age	**18-30 years**	34	17.4	24	1	2	4	0	3	34	0.038
	31-60 years	161	82.6	88	33	20	10	5	5	161	
Total				112	34	22	14	5	8	195	
Time Duration	<6hrs	39	20.0	21	8	6	2	0	2	39	0.187
	6-12 hrs	122	62.6	72	15	13	11	5	6	122	
	12-24 hrs	34	17.4	19	11	3	1	0	0	34	
Total				112	34	22	14	5	8	195	
Site of fracture	Tibia	40	20.5	19	6	9	4	0	2	40	0.001
	Ankle	33	16.9	14	2	1	7	5	4	33	
	Femur	23	11.8	20	2	0	0	0	1	23	
	Metacarpals /phalanges	33	16.9	17	11	5	0	0	0	33	
	Radius/ulna	29	14.9	19	7	3	0	0	0	29	
	Humerus	37	19.0	23	6	4	4	0	1	37	
Total				112	34	22	14	5	8	195	
Type of fracture (Gustilo)	Type I	21	10.8	14	1	2	3	0	1	21	0.001
	Type II	53	27.2	23	5	7	8	5	5	53	
	Type IIIa	71	36.4	37	21	9	2	0	2	71	
	Type IIIb	31	15.9	19	7	4	1	0	0	31	
	Type IIIc	19	9.7	19	0	0	0	0	0	19	
Total				**112**	**34**	**22**	**14**	**5**	**8**	**195**	

Table II. Frequency of isolated pathogens and their sensitivity pattern.

Organism	Staining	Frequency	Percentage	Susceptibility pattern							
					1st Gen Cephalosporin	2nd Gen Cepphalosporin	3rd Gen Cephalosporin	Coamiclav	Aminoglycoside	Quinolones	Vancomycin
S. aureus	**Gram +ve**	112	57.4%	S	n=85 (75.9%)	n=77 (68.8%)	n=56 (50%)	n=75 (67%)	n=49 (43.8%)	n=60 (53.6%)	NT
				R	n=27 (24.1%)	n=35 (31.3%)	n=56 (50%)	n=37 (33%)	n=63 (56.3%)	n=52 (46.4%)	
Streptococcus		34	17.4%	S	n=25 (73.5%)	n=24 (70.6%)	n=14 (41.2%)	n=21 (61.8%)	n=13 (38.2%)	n=13 (38.2%)	NT
				R	n=9 (26.5%)	n=10 (29.4%)	n=20 (58.8%)	n=13 (38.2%)	n=21 (61.8%)	n=21 (61.8%)	
MRSA		5	2.6%	S	n=0 (0%)	n=0 (0%)	n=0 (0%)	n=0 (0%)	n=0 (0%)	n=0 (0%)	n=5 (100%)
				R	n=5 (100%)	n=5 (100%)	n=5 (100%)	n=5 (100%)	n=5 (100%)	n=5 (100%)	
E. Coli	**Gram –ve**	22	11.3%	S	n=4 (18.2%)	n=8 (36.4%)	n=13 (59.1%)	n=6 (27.3%)	n=15 (68.2%)	n=16 (72.7%)	NA
				R	n=18 (81.8%)	n=14 (63.6%)	n=9 (40.9%)	n=16 (72.7%)	n=7 (31.8%)	n=6 (27.3%)	
Pseudomonas		14	7.2%	S	n=4 (28.6%)	n=6 (42.9%)	n=8 (57.1%)	n=2 (14.3%)	n=8 (57.1%)	n=9 (64.3%)	
				R	n=10 (71.4%)	n=8 (57.1%)	n=6 (42.9%)	n=12 (85.7%)	n=6 (42.9%)	n=5 (35.7%)	
No growth		8	4.1%								

DISCUSSION

In our study bacteria were isolated in 187(95.8%) patients while no growth was noted in 8(4.1%) patients. Staphylococcus Aureus was the predominant bacteria isolated in 112(57.4%) patients. Faisham[19] took culture from 33 open tibial fractures and positive culture was noted in 13(39.3%) and no growth in 20(60.6%) patients. Staphylococcus aureus was isolated in 5(38.4%),staphylococcus epidermidis in 4(30.7%) Bacillus Subtilis in 2(15.3%), E.coli in 1(7.6%) and Pseudomonas in 1(7.6%) patient. Sitati[20] reported positive culture in 51(52.2%) out of 98 open fractures. Gram negative culture was noted in 55.5% and gram positive in 44.1%.Staphylococcus aureus was isolated in 22%, Coagulase negative Staphylococcus aureus in 19.5%, Pseudomonas in 11,7% and Klebsiella in 10.4% fractures. Agarwal[21] reported positive growth in 36/70 patients and no growth in 34/70 in pre-debridement culture report of open fractures. He documented gram positive growth in 24/36 fractures and gram negative in 12/36 fractures. Seekamp and colleagues[22] took culture test of 269 open fractures and noted positive culture in 78.7% and negative culture in 21.3%. Staphylococcus aureus was noted in 52.8%, E.Coli in 32.5%, Streptococcui in 26%, Pesudomonas in 17.1% and Proteus in 1.6%. Bhatty[23] cultured 107 open fractures and reported gram negative pathogens in 76% fractures with Pseudomonas noted in 36% and Actinobacter in 20.7%. This study however concluded that pathogens obtained on admission or pre-debridement did not caused subsequent wound infection rather 28% of open fractures with negative culture were found infected at 2nd week.

In our study Methicillin Resistant Staphylococcus (MRSA) was yielded in 5(2.5%) patients. Naemullah and colleagues1 reported that 2% (n=1) of patients had positive MRSA culture while Shah[24] reported a very high percentage (23.5%,n=47) of MRSA positive culture in open tibial fractures.

We had documented that Gram positive cultures were most sensitive to first generation Cephalosporin (60.5%, n=118) while Gram negative cultures to Quinolones (69.4%, n=25). Ojo and colleagues[25] reported positive culture in 41(68.3%) out of 60 open fractures and Staphylococcus aureus was the most common bacteria isolated. They reported that majority of the isolated pathogens were resistant to Augmentin, Oxicillin, Cloxacillin, Cefuroxime and Ceftriaxone. Ofloxacin and Gentamicin were however noted to be effective against most of the isolated pathogens. Alongae[26] noted that most isolated bacteria were sensitive to Ciprofloxacin, Pefloxacin and Ceftriaxone while resistant was noted for Cefuroxime and Amoxycillin.

Our study had few limitations. The design of our study was descriptive. We were unable to document patients with positive culture for development of subsequent wound infection and isolation of the same or different bacteria in the next culture.

CONCLUSION

Majority of open fractures of the extremities had positive culture of bacteria. Gram positive organisms were the most common isolated pathogens. First generation Cephalosporin was the most sensitive group of drugs against gram positive bacteria. We recommend early debridement, skeletal stabilization and administration of first generation Cephalosporin to all patients of open extremity fractures.

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