Original Article

Common Pathogen Frequency And Antimicrobial Sensitivity Pattern In Open Fractures Of The Extremities

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Abstract

Background: When there is a discontinuity between soft tissue and overlying skin, and the external environment is in direct contact with the bone, such types of fractures are known as open fractures. The frequency of the rate of infection is increased with the increase in size of wounds. Several factors determine the choice of antibiotics. Those factors include the site of injury, bacterial culture and the sensitivity pattern, severity of the injury and mechanism of the injury.

Objective: This research aims to evaluate the frequency of microorganisms in severe open fractures and determine the pattern of sensitivity to commonly used antibiotics.

Study design: A cross-sectional study

Place and Duration: This study was conducted at Jinnah Postgraduate Medical Center Karachi **from November 2021 to November 2022.**

Methodology: All the participants of this research were having open fractures. According to the ATLS criteria, every patient was stabilized and resuscitated. Every participant's demographic data such as gender, age, the reason for injury, and duration of injury was recorded. Blood investigations and relevant radiographs were ordered. Levine method was used to take 3 samples of pre-debridement wound swabs. The Kirby-Bauer method was used to test antibiotic sensitivity.

Results: Overall, 180 participants enrolled in this research. These participants were aged from 18 years to 60 years. The mean age was 38.87±7.99 years. The majority of the participants were from the age group of 31-60 years. The mean duration of injury was 8.88 hours. The most common fractured bone was the tibia (n=37) followed by the humerus (n=35). Total positive cultures were noted in 172 patients while no growth in 8 patients.

Conclusion: The majority of open fractures in the extremities showed a positive bacterial culture, with gram-positive pathogens being isolated the most commonly. First-generation Cephalosporin showed the highest sensitivity against gram-positive bacteria among the various medication classes evaluated.

Keywords: First-generation Cephalosporin, gram-positive bacteria, Open Fractures of the Extremities

Introduction

When there is a discontinuity between soft tissue and overlying skin, and the external environment is in direct contact with the bone, such types of fractures are known as open fractures [1]. These types of fractures are associated with

several complications which cause the mortality and morbidity rates to be on a higher level [2, 3]. The frequency of the rate of infection is increased with the increase in size of wounds [4]. It also increases with contamination which is linked with the severity of the open fracture [5]. The prevalence of the infection depends on the extent of the injury and the duration of exposure. If the duration of exposure is less than 6 hours, the wound is considered less contaminated. After this, the bacteria start to multiply at the wound site and the infection starts to grow [6]. The infection increases and the exposure time increases due to delay in the management of open fracture. There is a lack of public awareness and healthcare services in peripheral areas [7]. The proliferation of the bacteria at contaminated sites can be delayed by using broad-spectrum antibodies earlier [8].

Several factors determine the choice of antibiotics. Those factors include the site of injury, bacterial culture and sensitivity patterns, severity of the injury and mechanism of the injury [9]. Many well-known antibiotics are used to treat open fractures. These antibiotics include aminoglycosides, penicillin, and cephalosporin individually or in combination [10]. Some common pathogens that are sensitive to Quinolones and Cephalosporin, and are isolated in open fractures include Enterobacter, Staphylococcus, Actinobacter, Klebsiella, and Pseudomonas [11].
In our research, there were no antibiogram available in our hospital. So the empiric antibiotics for open fractures were chosen based on the surgeon's choice, experience, and affordability of the patient. Through our research, we will be able to generate a local antibiogram for treating severe open fractures. This will help in making guidelines for empiric antibiotic therapy. Therefore, this research aims to evaluate the frequency of microorganisms in severe open fractures and determine the pattern of sensitivity to commonly used antibiotics.

Methodology

All the participants of this research were having open fractures and presented in the emergency department of the hospital within 1 day of injury. Those polytrauma people who required surgeries for abdominal injury, head injury, and thoracic injury were not considered for this research. Moreover, people with pathological fractures were also excluded.
The Institutional Ethical Review Board approved this research. Every patient was informed about this research and its objectives before it was conducted and written consent from every patient was obtained. It ensured that every patient's information was confidential. According to the ATLS criteria, every patient was stabilized and resuscitated. Every participant's demographic data such as gender, age, the reason for injury, and duration of injury was recorded. Blood investigations and relevant radiographs were ordered. Levine method was used to take 3 samples of pre-debridement wound swabs [12]. If 2 out of 3 swabs were positive, the result was considered positive. To determine the sensitivity and culture of the microbial agents and for gram staining, 3 samples were sent to the laboratory. All of the investigations were performed in the laboratory of our hospital. The Kirby-Bauer method was used to test antibiotic sensitivity [13].
SPSS version 23 was used to analyze the data. The mean and standard deviation were calculated for quantitative data such as duration of injury and age. All the qualitative variables like type of organisms, type of fracture, sensitivity, and site of fracture were expressed in terms of percentage and frequency. Stratification of variables including duration of injury, age, type of fracture, and site of fracture was done. After stratification, the P-value was calculated using the Chi-square test. The p-value was considered significant when it was below 0.05.

Results

Overall, there were a total of 180 participants enrolled in this research. These participants were aged from 18 years to 60 years. Most of the participants were male. There were 148 males and only 32 females in our research. The mean age was 38.87±7.99 years. The majority of the participants were from the age group of 31-60 years. The mean duration of injury was 8.88 hours. Table number 1 shows the demographics of the patients involved in this study.

Table No. 1:demographics of the study participants

Parameters	N	%
Age (years)		
• **18-30**	31	17.2
• **31-60**	149	82.8
Duration of injury (hours)		
• **<6**	36	20.0
• **6-12**	112	62.2
• **13-24**	32	17.8
Type of fracture		
• **Type I**	20	11.1
• **Type II**	49	27.2
• **Type IIIa**	65	36.1
• **Type IIIb**	28	15.5
• **Type IIIc**	18	10.1
Site of fracture		
• **Tibia**	37	20.5
• **Ankle**	30	16.7
• **Femur**	21	11.7
• **Metacarpals**	30	16.7
• **Radius**	27	15.0
• **Humerus**	35	19.4

The most common fractured bone was the tibia (n=37) followed by the humerus (n=35). Table number 2 shows fracture patterns along with organisms grown.

Table No. 2: fracture patterns along with organisms grown

Parameters	Organism grown					
	S. Aureus	**Streptococcus**	**E. Coli**	**Pseudomonas**	**MRSA**	**No growth**

Age (years)						
• **18-30**	22	1	2	3	0	3
• **31-60**	80	30	17	11	6	5
Duration of injury (hours)						
• **<6**	19	7	6	2	0	2
• **6-12**	68	13	11	8	6	6
• **13-24**	15	11	2	4	0	0
Type of fracture						
• **Type I**	12	1	2	4	0	1
• **Type II**	21	4	5	8	6	5
• **Type IIIa**	34	20	8	1	0	2
• **Type IIIb**	17	6	4	1	0	0
• **Type IIIc**	18	0	0	0	0	0
Site of fracture						
• **Tibia**	18	7	6	4	0	2
• **Ankle**	12	1	1	6	6	4
• **Femur**	19	1	0	0	0	1
• **Metacarpals**	15	10	5	0	0	0
• **Radius**	17	7	3	0	0	0
• **Humerus**	21	5	4	4	0	1

Total positive cultures were noted in 172 patients while no growth in 8 patients. Gram-positive cultures were most sensitive to first generation Cephalosporin and gram-negative cultures were most sensitive to Quinolones. Table number 3 shows isolated pathogens and their sensitivity patterns.

Table No: 3 isolated pathogens and their sensitivity patterns.

Organism	**N**		**Susceptibility pattern**						
			1st Gen	**2nd Gen**	**3rd Gen**	**Coamixicla**	**Aminoglyc**	**Quinolones**	**Vancomy**

			Cephalosporin	Cephalosporin	Cephalosporin	v	oside		cin
S. Aureus	102	S	77 (75.4%)	70 (68.6%)	51 (50%)	69 (67.6%)	44 (43.1%)	55 (53.9%)	NT
		R	25 (24.6%)	32 (31.4%)	51 (50%)	33 (32.4%)	58 (56.9%)	47 (46.1%)	
Streptococcus	31	S	23 (74.1%)	22 (70.9%)	13 (41.9%)	19 (61.2%)	12 (38.7%)	12 (38.7%)	NT
		R	8 (25.9%)	9 (29.1%)	18 (58.1%)	12 (38.8%)	19 (61.3%)	19 (61.3%)	
MRSA	6	S	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6 (100%)
		R	6 (100%)	6 (100%)	6 (100%)	6 (100%)	6 (100%)	6 (100%)	
E. Coli	19	S	3 (15.7%)	7 (36.8%)	11 (57.8%)	5 (26.3%)	13 (68.4%)	14 (73.6%)	NA
		R	16 (84.3%)	12 63.2%)	8 (42.2%)	14 (73.7%)	6 (31.6%)	5 (26.4%)	
Pseudomonas	14	S	4 (28.6%)	6 (42.9%)	8 (57.1%)	2 (14.3%)	8 (57.1%)	9 (64.3%)	
		R	10 (71.4%)	8 (57.1%)	6 (42.9%)	12 (85.7%)	6 (42.9%)	5 (35.7%)	
No growth	8								

Discussion

In our research, bacteria was isolated in 172 patients (95.5%) while there was no growth in 8 (4.5%) patients. S. Aureus was the most predominant bacteria which was isolated in 56.7% (n=102) of patients. Faisham examined the culture of 33 open tibial fractures and observed positive culture results in 39.3% of cases, while no growth was found in 60.6% [14]. Bacillus Subtilis in 15.3% of cases, S. Aureus was detected in 38.4% of cases, E.coli in 7.6% of cases, staphylococcus epidermidis in 30.7% of cases, and Pseudomonas in 7.6% cases. Out of 98 open fractures, Sitati discovered positive culture findings in 52.2% of cases [15]. Gram-positive cultures were found in 44.1% of cases, and gram-negative cultures in 55.5% of them. In 22% of the fractures, S. Aureus was identified, Coagulase-negative Staphylococcus aureus in 19.5%, Klebsiella in 10.4%, and Pseudomonas in 11.7%. In the pre-debridement culture report of open fractures, Agarwal noted positive growth in 36 out of 70 patients while 34 out of 70 exhibited no increase [16]. Gram-positive growth was seen in 24 out of the 36 fractures that showed positive growth, while gram-negative growth was seen in 12 out of the 36 fractures. A total of 269 open fractures were subjected to culture testing by Seekamp et al., who discovered positive cultures in 78.7% of the cases and negative cultures in 21.3% of the cases [17]. Overall52.8% of the fractures had S. Aureus, 17.1% had Pseudomonas, 32.5% had E. coli, 26% had Streptococcus, and 1.6% had Proteus. Bhatty performed culture tests on 107 open fractures and discovered gram-negative bacteria in 76% of the fractures; Pseudomonas was discovered in 36% of the fractures and Actinobacteria

was discovered in 20.7% [18]. The study conclude that the pathogens acquired at the time of admission or before debridement did not cause wound infection. Surprisingly, after the second week, 28% of open fractures with negative culture findings had become infected. Methicillin-resistant Staphylococcus (MRSA) was found in our investigation in 6 patients. A total of 2% (n=1) of patients had a positive MRSA culture, according to Naemullah et al [19]. Shah, on the other hand, found a substantially larger proportion, with 23.5% (n=47) of patients demonstrating positive MRSA culture in cases of open tibial fractures particularly [20].

Our research has several restrictions. First of all, our study was descriptive in design. We also had trouble recording patients who had positive cultures, figuring out if they later acquired wound infections, and figuring out whether the same or different bacteria were recovered in the follow-up culture.

Conclusion

The majority of open fractures in the extremities showed a positive bacterial culture, with gram-positive pathogens being isolated the most commonly. First-generation Cephalosporin showed the highest sensitivity against gram-positive bacteria among the various medication classes evaluated. Based on our research, we advise all patients with open extremity fractures to have early debridement, skeletal stabilization, and first-generation Cephalosporin.

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Conflict of interest

None

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