Pattern of Infecting Organisms and Antibiotic Sensitivity in Compound Fractures: The value of pre-debridement culture

Khanal KR,[1] Pradhan RL,[1] Pandey BK,[1] Manandhar RR,[1] Regmi A,[2] Khanal H[1]

[1]Department of Orthopaedics,

Kathmandu Medical College,

Sinamangal, Kathmandu, Nepal.

[2]Department of Orthopaedics,

Gan Regional Hospital,

LamuGan, Maldives.

Corresponding Author

Krishna Raj Khanal

Department of Orthopaedics,

Kathmandu Medical College,

Sinamangal, Kathmandu, Nepal.

E-mail: khanalkrishnaraj@gmail.com

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ABSTRACT

Background

Antibiotics along with wound care is the mainstay of treatment for compound fractures to prevent infection. Despite recommended guidelines the surgeons continue to modify the antibiotics considering recommendations inadequate. Knowledge of the flora of a region can guide the antibiotic therapy. Evidence is divided regarding the role of pre debridement culture in predicting the final infection. This study is intended to find the role of initial culture and document the bacteriology of these compound fracture wounds.

Method

Ninety seven patients with compound fractures presenting to a Kathmandu Medical College Teaching Hospital between June 2020 and March 2021 were included in the study. Wound swab cultures were sent at initial presentation. Standard treatment with antibiotics and wound care was instituted. At 48 hours of debridement, a repeat culture was sent. Predictiveness of pre-debridement culture for post debridement culture was analyzed.

Result

Twenty-six patients had initial contamination out of which 5 patients developed subsequent infection. 12 cultures yielded organism in repeat culture. The initial culture predicted the outcome of repeat culture (McNemar, p=0.013). The most common organism in predebridement and postdebridement cultures was *Staphylococcus aureus* (42.3%) and *Acinetobacter baumanii* (41.67%) respectively.Aminoglycosides (93.3%) and cephalosporins (90.9%) had the highest overall sensitivity. For Gram negative organisms, maximum sensitivity was noted with Aminoglycosides (90%). No antibiotic resistance was noted for Gram positive organisms.

Conclusion

Pre debridement culture can predict the occurrence of later infection in compound fracture though organisms tend to change over time. Commonly used antibiotics have good sensitivity.

KEY WORDS

Antibiotics, Bacteria, Compound fracture, Culture, Open fracture, Organisms

INTRODUCTION

Compound fracture communicates to the external environment through the breach in the skin and soft tissue and leads to contamination of the wound.[1] Since they are open, they are prone to infection which is one of the main complications of these fractures. Infection can lead to sepsis immediately or hinder union in the long run. The prevention and treatment of infection in these fractures is a challenge to the treating orthopedic surgeons and the infection control physicians.[2]

The institution of antibiotics as early as possible and thorough debridement is the mainstay of prevention of infection in these fractures.[3-5]

The choice of antibiotics is crucial and ideally should be based on the wound swab or tissue culture reports. The yield of organism in the culture from compound fracture wound is variable, with the literatures revealing rates as high as 83%.[6-9] Bacterial culture takes at least 24 hours but the administration of antibiotics cannot be delayed. The best way and common practice has been to start empirical antibiotics based on the common microbial flora of that region and change it to sensitive antibiotics as the culture reports are available. Hence the knowledge of common infecting organisms and antibiotic sensitivity pattern of these fractures has utmost importance.

The classical practice was to obtain culture reports and identify the organisms prior to and after debridement and change the antibiotics accordingly, as the initial positive culture was thought to identify the development of subsequent infection.[10,11] Few studies have questioned the role of predebridement culture as they were not universally found to be predictive of infection in subsequent culture and neither did they show similarity in the organisms isolated in pre and post debridement culture.[1,2]

Many changes have been noticed in the incidence and pattern of infecting organism and antibiotic sensitivity over years.[12] Surgeons have learned and modified the treatment protocol given by Gustillo and Anderson in their landmark paper, without the solid literature backup thinking that the classical antibiotic recommendations are not sufficient owing to the change in bacteriology.[13-15]

The consensus among the Orthopaedic surgeons is lacking regarding the choice of antibiotics in these fractures.[16] Furthermore, the studies that address the issue of whether positive pre debridement culture increases the risk of subsequent infection are scarce.

Therefore, this study was conducted to find out if there is any role of pre debridement culture in predicting the subsequent infection and the bacteriology of the wounds of compound fracture in our population.

METHODS

Patients presenting to the Emergency Room or Orthopaedics OPD of Kathmandu Medical College Teaching Hospital between June 2020 and March 2021 with compound fractures of the long bones were included in the study. The patients who had initial debridement at other centers, those refusing to be enrolled in the study and those who were referred to other centres were excluded from the study. Informed written consent was taken from all the participants and the clearance for the study was taken from Institutional Review Board (Ref.:2306202008).

The swab culture was obtained initially at presentation and fracture was classified according to Gustilo Anderson Classification.[13,17] The patient was then started on intravenous antibiotics. Amoxiclav or first or second generation cephalosporin was given for Grade I fractures, Gentamicin was added to Grade II and III fractures whereas Penicillin or Metronidazole was added if anaerobic organism was suspected.[18] Tetanus prophylaxis, debridement, irrigation and standard wound care were instituted. Wound swab culture was repeated at 48 hours after debridement and subsequently if the wound had persistent discharge or if the patient had fever or other signs of infection. Antibiotics were modified according to the culture reports.

All swabs were inoculated in Blood Agar and MacConkeys Agar and cultured for 72 hours. Antibiotic sensitivity was identified by disc diffusion method.

The culture reports and the antibiotic sensitivity patterns were recorded. Statistical analysis was done by Statistical Package for Social Sciences (SPSS) software version 20. Continuous data were presented as mean and categorical data as proportion. The dichotomous data about pre and post debridement culture were compared using McNemar test.

RESULTS

Total of 97 patients were included in the study. The population characteristics are presented in table 1.

Table 1. Population characteristics

No of patients	97	
Mean Age (yrs) ± SD	33.68±17.17	
Male:Female	77:20	
Median time to presentation (hrs) (inter-quartile range)	4 (2-24)	
Fracture classification (Gustilo and Anderson)	I	18 (18.56%)
	II	51(52.58%)
	IIIA	22(22.68%)
	IIIB	5 (5.15%)
	IIIC	1 (1.03%)

Mean age of the patient was 33.68 ± 17.17 years. There were 12 (12.37%) diabetic patients. Twenty six patients had initial culture positive out of which 5 patients developed subsequent infection. 12 cultures yielded organism in repeat culture. The initial culture predicted the outcome of repeat culture shown by McNemar test (Table 2).

Table 2. Association between pre and post debridement culture

Initial culture	Repeat culture		Total	McNemar test P value
	Positive	Negative		
Positive	5	21	26	0.013
Negative	7	64	71	
Total	12	85	97	

Total of 38 cultures grew organisms among which 21 were Gram negative and 17 were Gram positive. Most common Gram positive organism was found to be *Staphylococcus aureus* whereas most common gram negative organism was found to be *Klebsiella pneumonia*.

Pre debridement wound cultures showed organism in 26 cases (26.8%) most common being Staphylococcus aureus (N=11, 42.3%) (Table 3). Within the hospital stay, 12 positive results were noted on repeat culture and the most common organism isolated was Acinetobacter baumanii (N=5, 41.67%) (Table 3). Only 2 patients had growth of same organism in both pre and post debridement cultures.

Table 3. Organisms isolated in pre and post debridement culture

Organism	Predebridement	Post debridement
Staphylococcus aureus	11 (42.3%)	2 (16.7%)
Klebsiella pneumonia	6 (23.1%)	2 (16.7%)
Coagulase Negative Staphylococcus (CONS)	2 (7.7%)	2 (16.7%)
Acinetobacter baumanii	5 (19.2%)	5 (41.7%)
Psuedomonas aeruginosa	1 (3.8%)	
Escherichia coli	1 (3.8%)	1 (8.3%)
Total	26 (100%)	12 (100%)

The growth of different organisms from different grades of compound fractures is shown in table 4. All organisms isolated in Gustilo I fractures were Gram positive. Among Gustilo II fractures, mixed growth of organisms with almost equal numbers of Gram positive and Gram negative organisms were found whereas in Grade III mostly Gram negative organisms were grown. The trend of shifting from Gram positive to Gram negative organisms with increase in the Grade of compound fractures was evident (Table 4).

Among commonly tested antibiotics, Aminoglycosides and Cephalosporins had the highest overall sensitivity. Gram positive organisms were most number of times sensitive to Amoxiclav and Fluoroquinolones. For Gram negative organisms, maximum rate of sensitivity was noted with

Table 4. Organisms by grade of compound fracture

Gustilo and Anderson Grade	Staphylococcus aureus	Klebsiella pneumoniae	CONS	Acinetobacter baumanii	Pseudomonas aeruginosa	E. coli	Total
I	3	0	0	0	0	0	3
II	8	4	2	2	1	2	19
IIIa	2	0	2	8	0	0	12
IIIb	0	4	0	0	0	0	4
Total	13	8	4	10	1	2	38

Aminoglycosides (9/10, 90%). All resistant organisms were gram negative. Among the commonly used antibiotics, Aminoglycosides had the least incidence of resistance (Table 5).

Table 5. Antibiotic sensitivity of Gram positive and Gram negative organisms

Antibiotics		Gram positive	Gram negative	Total
Amoxiclav	Sensitive	9	7	16 (69.6%)
	Resistant	0	7	7 (30.4%)
Fluoroquinolones	Sensitive	9	10	19 (86.4%)
	Resistant	0	3	3 (13.6%)
Aminoglycosides	Sensitive	5	9	14 (93.3%)
	Resistant	0	1	1 (36.7%)
Cephalosporins	Sensitive	5	5	10 (90.9%)
	Resistant	0	1	1 (9.1%)
Others	Sensitive	9	30	39 (82.98%)
	Resistant	0	8	8 (17.02%)

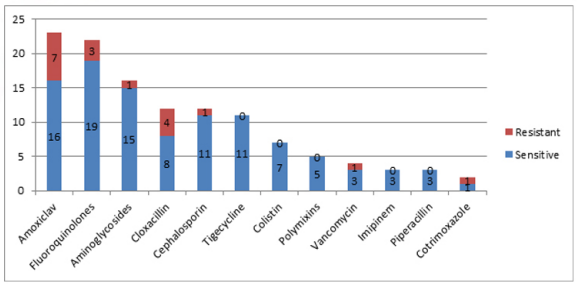

Figure 1. Pattern of antibiotic sensitivity

DISCUSSION

Infection is the most important complication of compound fracture for which antibiotics and debridement are the effective treatment options. We evaluated whether the predebridement culture predicts the occurrence of infection, the organisms involved and their sensitivity profile.

The yield of organism in compound fracture is variable. We found 26 positive cultures in initial sample out of which only 5 patients yield organism in repeat culture. Total of 33(34.02%) patients had positive culture reports in at least one occasion. Our rate of contamination and infection lies in between the values reported in the literature ranging from 20% to 84%.[1,12,14,19]

We found that initial positive culture reports to be predictive of post debridement positive culture (McNemar, p=0.013) but in only 2 occasions were the infecting organisms same in pre and post debridement culture. The predictiveness of infection by predebridement culture has been established in some studies.[10,11] However the contradictory findings were reported in studies by Lingaraj et al. and Bhatty et al. who showed pre debridement culture not to be predictive for subsequent infection.[1,2] They showed in their series no patients with same organism in pre and post debridement culture. Hao M also observed low concordance rate of 3.3% between two consecutive cultures from compound fracture wounds.[6]

Hence the patient who has initial contamination is more likely to develop infection later on although not with the same organism. This could be due to effective debridement in washing away the contaminants and later infection could be due to hospital acquired organisms. Few other studies also suggest that most of the infecting organisms in open fractures could actually be hospital acquired rather than community acquired.[2,8,20,21] This suggests that the patients having predebridement contamination should be followed up carefully with postdebridement culture to identify change in the involved flora and to adjust the antibiotics accordingly. The repeat culture in the patients not having contamination can be omitted unless clinical features of infections are evident as they are less likely to yield organism in post debridement culture. We could only isolate organisms in 38 out of 194 cultures (19.6%) which is much lower than that observed by Lingaraj et al. and Bhatty et al, which might be a reason for dissimilarity of the findings.[1,2] The studies with larger sample size and more uniform antibiotics protocol and lab techniques for culture would be suitable for better comparison.[1,2]

The commonest organism isolated from wound swab culture of compound fractures varies among different studies. Some report species of Staphylococcus either aureus or CONS to be most common ranging from 20-51%.[14,22] Few other studies report E coli to be the most common organism.[1,23] We found Staphylococcus as a single most common genus isolated in around 44.7% of the cultures including CONS and aureus. On classifying the organism as Gram positive or negative, Gram negative organism were in majority which had also been evidenced by Bhatty (71%) and Sudduth (62.2%).[2,12] Some showed Gram positive predominance.[14,22] The variation could be due to difference in antibiotic protocol in two different studies and local prevalence of the flora. A study by Carsenti-Etesse H deduced that patients receiving antibiotics against Gram positive organism are likely to grow Gram negative organism in subsequent culture and vice versa.[22] Literature suggests an increasing trend towards Gram negative, MRSA and polymicrobial growth.[12,24] Pseudomonas and Acinetobacter were reported to be most common Gram negative organism by Bhatty et al. but we found Acinetobacter and Klebsiella to be the most commonly isolated Gram negative organism.[2] We agree with the logic given by Lee et al. that the yield of flora from the wound depends on the prevalence of that flora in that hospital and wards.[21] Also the infecting organisms tend to change over time as the patients are likely to get infected from the flora of the local environment.[2] We also observed initial infection almost equally by Gram positive and negative organisms whereas organisms infecting the wound after debridement were predominantly Gram negative suggesting the final infection being acquired from hospital itself and influenced by the prescribed antibiotics. As the flora was observed to change over time the change in antibiotics might have to be considered in post operative period to cover the Gram negative organisms.

Prophylactic antibiotics are known to reduce infection rate in compound fractures and it has been observed that despite recommendations clinicians favor the use of broad spectrum antibiotics and change it based on culture reports.[14,16] Not all antibiotics are tested equal number of times in the microbiology labs. In our centre, Amoxiclav was most commonly tested antibiotics with sensitivity of 69.5%. Aminoglycosides, Floroquinolones and Cephalosporins had higher overall sensitivity although the frequency of sensitivity test was not even. No resistance was noted with newer antibiotics except one for vancomycin.

All Gram positive organisms in our study were sensitive to all tested antibiotics. All resistant organisms were Gram negative. Highest sensitivity to Gram negative organisms were observed for Aminoglycosides, Cephalosporins and Fluoroquinolones in that order. Similar sensitivity patterns of these antibiotics has been reported by Sudduth JD where he demonstrated Cephalosporins, and Beta lactams to have highest sensitivity against Gram positive whereas Aminoglycosides and newer antibiotics including Meropenem and Cefepime to be maximally sensitive against Gram negative organisms.[12] Similarly, Abraham and Wamisho also showed good sensitivity of Amoxiclav and Gentamicin towards Gram positive organisms but for Gram negatives sensitivity was better for Gentamicin and Ciprofloxacin.[25] We found that commonly used antibiotics still have good sensitivity and can be used as first line of treatment whereas newer antibiotics can be reserved for resistant organisms as the resistance to them was rare.

The yield and type of organisms in cultures from compound fracture wounds depend on many factors. Grade of compounding, surgical technique, culture methods, use of antibiotics all play an important role and influence the

outcome. These factors were not analysed individually in our study. We didnot have a set protocol for antibiotics sensitivity testing which resulted in different frequency of sensitivity test for different antibiotics and this could have led to suboptimal interpretation of the data. Late infection has been reported in compound fractures. We have assessed the infection in patients only till the patient was admitted at the hospital which might have underestimated the infection rates. Studies with more power, stringent protocol for antibiotics use and sensitivity testing and longer follow up can add up to the observations made in this study.

CONCLUSION

Pre debridement culture can predict the occurrence of later infection in compound fracture though rarely with same organism. So the patients with initial contamination should be followed up with repeat culture to identify the change in organism and subsequently antibiotic readjustment. The organisms involved in infection of compound fracture wounds are predominantly Gram negative. Gram positive organisms are rarely resistant to commonly used antibiotics. Newer antibiotics can be reserved for resistant cases as their resistance is rarely seen.

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