ORIGINAL ARTICLE

Bacteriological Study and its Role in the Management of Open Tibial Fracture

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Summary

Sixty percent of open fracture wounds are contaminated at the time of injury. Despite that, the necessity for sequential multiple cultures and sensitivity studies for open fractures and their interpretation are still controversial. Predebridement, intraoperative, postoperative swabs and swabs in established infection for culture and sensitivity study were taken in 33 open tibial fractures over a 6 months period. 39.3% of predebridement swabs grew bacteria with the majority yielding gram-positive organism. None of the patients developed infection with similar organisms. 24.2% of the postoperative swabs grew bacteria, of which 75% were gram-negative. 50% of the patients with positive postoperative swabs developed infection. Thus, the role of sequential multiple cultures and sensitivity studies are not helpful in management of open fracture.

Key Words: Open tibial fracture, Sequential multiple cultures, Bacteriology, Infection

Introduction

The primary goal in management of open fracture is the prevention of the infection of bone and soft tissue. To achieve this goal, the most widely accepted treatment protocols include early surgical debridement, irrigation of open wounds, administration of broad-spectrum antibiotics and stabilisation of fracture. Sixty percent of open fracture wounds are contaminated with bacteria at the time of injury[1-6]. Several large series from multiple centres have identified the most common organisms present and have led to the acceptance of using broad spectrum antibiotics; cephalosporins augmented by aminoglycosides in grade III open fractures and penicillin in farmyard injuries[1-7]. The selection of antibiotics to treat the contaminating organisms and coverage against the infection is still controversial.

Several authors have proposed that most infections in open fracture are nosocomial. It has also been observed that most infecting organism are found to be enteric flora rather than normal skin flora[8,9]. Thus the necessity for sequential or multiple cultures of open fracture wound and their interpretation is still controversial. This is due to the lack of correlation between culture results and subsequent infections following the constantly changing local wound ecology and the use of systemic antibiotic[6,10].

Materials and Methods

We had carried out a prospective study on all open tibial fractures hospitalised in Kota Bharu Hospital from April to September 1998 with a view to analyse the local bacteriological profile, necessity for multiple cultures and antibiotic of

choice. All of the cases were classified and managed according to the protocol outlined by *Gustillo and Anderson*[1-4].

Sequential swabs and tissue cultures were taken in four phases; predebridement, intraoperative, immediate postoperative and in established infection. Upon arrival at Emergency unit, the first swab was taken from the deep part of the wound after cleansing the skin edges with normal saline. Intraoperative swabs were taken in the operation theatre before preparation of wounds with antiseptic solutions. These were taken together with two pieces of muscle at different sites measuring 1 x 1 cm and bone marrow from proximal and distal ends of the fractured bone. During the first wound inspection, swabs were also taken from the deep part of the wounds (3 to 5 days after surgery). The final swabs or tissue cultures were taken in established wound infection.

We commenced intravenous antibiotics immediately upon arrival at Emergency unit according to the guideline on antibiotics usage distributed by Malaysian Ministry of Health in 1997[11].

All open fractures of the tibia were debrided and lavaged in the operating theatre by all levels of medical officers and surgeons. These were done under regional or general anesthesia adhering strictly to the protocol established by Gustillo 1996[25]. All fractures were stabilised by certain forms of fixation depending on the types of open fracture and degree of contamination. All postoperative wounds were left open.

Post operatively, all the patients were evaluated with special attention to the detection of infection based on criteria outlined by the Centers for Disease Control (CDC) in 1992[12]. All patients were followed for at least six months or until the fracture showed clinical or radiological union.

The following criteria were excluded from this study:

1. Patient who received antibiotic treatment prior to this admission.
2. Wounds, which had antiseptic dressing procedure prior to this admission.
3. Immunosuppressed patients such as those with diabetes mellitus, on corticosteroid therapy and HIV infection.
4. Existing trauma at other contaminated areas such as gastrointestinal, genitourinary and oropharynx perforation which required additional antibiotics.
5. Grade IIIC open fractures and gun shot wounds.
6. Patients with peripheral vascular disease.

The data were analysed for significant association with T-test and Chi-square method using SPSS 9.05.

Results

We studied 33 patients with open fractures of the tibia, who fulfilled the inclusion criteria. The ages of the patients ranged from 8 to 65 years old with mean age of 25.5 years. Patients between 17 and 22 years of age represented about one third of the cases, with male to female ratio of 1.54 to 1.

Motor vehicle accidents were the cause of the injury in 87.9% of the cases. Nineteen patients (57.5%) were motorcyclists and nine (27.3%) were pedestrians. The other causes of injury were fall from a horse, industrial accidents, sports injuries and falls at home. The mean duration of injury to admission in emergency unit was 3.25 hours (0.5 - 9.3 hours). There was no statistically significant association between duration of injury to admission and presence of bacteria in primary culture.

The right side (72.7%) was more frequently involved. Middle third fractures (62.6%) were the commonest followed by upper third (21.2%), and lower third (18.2%). The majority of the cases were Grade IIIB (36.4%) followed by Grade I (33.3%), Grade IIIA (18.2%) and Grade II (12.1%).

We noted that 13 (39.3%) out of 33 predebridement swabs grew bacteria. Five swabs grew Staphylococcus aureus, 4 swabs grew

Fig. 1
Final Results of Bacterial Swabs
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SWABS	Grew Bacteria	Did not Grew Bacteria	Positive Culture & Final Infection	Negative Culture & Final Infection	Similar Organism Grew in Final Infection
Swab I Predebridement	13	20	5	2	0
Swab II Intra Operative	3	30	2	5	0
Swab III Post Operative	8	25	6	1	4

Staphylococcus epidermidis, 2 *Bacillus subtilis,* 1 *Escherichia coli and* 1 *cultured Pseudomonas aeruginosa.*

Intraoperative cultures of the tissue and marrow were only positive for 3 patients (1%). In the first case, *Pseudomonas aeruginosa* was cultured from both tissue and marrow. In the second case, predebridement swabs were positive for coagulase-negative *Staphylococcus,* which was also grown from tissue and marrow cultures. *Escherichia coli* was isolated from tissue culture in the third case. The bone marrow cultures were negative but similar organisms were grown in predebridement swabs.

Immediate postoperative swabs grew bacteria in 8 cases (24.2%) i.e. 2 *Bacillus subtilis,* 2 *Pseudomonas aeruginosa,* 1 *Escherichia coli,* 1 *Penicillium spp.,* 1 *Aeromonas spp,* and 1 MRSA. Four swabs grew similar organisms in predebridement swabs but negative in intraoperative cultures. We also observed that different types of organisms were cultured in predebridement and intraoperative swabs in the other four wounds.

Infection developed in 7 out of the 33 fractures (21.2%). Infection developed within one week of injury in five patients and two developed late infections. However, all ended up with osteomyelitis. The late infection was most probably secondary to skin and soft tissue necrosis in one patient, and the second patient had a persistent discharging sinus, which was temporarily healed with oral antibiotics before it flared up again following internal fixation for delayed union at 3 months. Both of these cases cultured MRSA. Four cases developed non-union after 6 months of follow up. Three cases grew single infecting organism and four cases had multiple infecting organisms. All infecting organisms were resistant to multiple antibiotics. All patients required changing of antibiotic regimens for the final treatment.

Fig. 2
Organisms Causing Infections in Open Tibial Fracture

Organism	Number of Patient
Pseudomonas aeruginosa	1
Aeromonas spp.	2
MRSA	1
Pseudomonas & Aeromonas spp.	2
P aeruginosa, Aeromonas spp. & MRSA	1

Six (18%) of the predebridement swabs which eventually grew bacteria, became established infection. However, none of these bacteria were isolated in the established infection. A negative predebridement swab did not preclude infection as two (6%) of these open fractures developed frank infection. There was no statistically

significant association between the culture results in the predebridement swab and the occurrence of established infection post-operatively.

Intraoperative swabs grew coagulase-negative *Staphylococcus* from tissue and marrow culture in one case. Similar organism was present in predebridement swabs. However, subsequently developed infection with MRSA. There was also no statistically significant association between the culture results in intraoperative swab and the occurrence of established infection post-operatively.

Six out of eight post debridement swabs subsequently had an established infection. Similar organism cultured in immediate postoperative period became frank infection in four patients. There were two cases, which grew *Pseudomonas aeruginosa*, one grew *Aeromonas spp*, and one grew MRSA. All of these cases subsequently grew similar organisms on established infection. Thus, it was assumed to be the causative bacteria for the infections. There was also no statistically significant association between the culture results in postoperative swabs and the occurrence of established infection post-operatively.

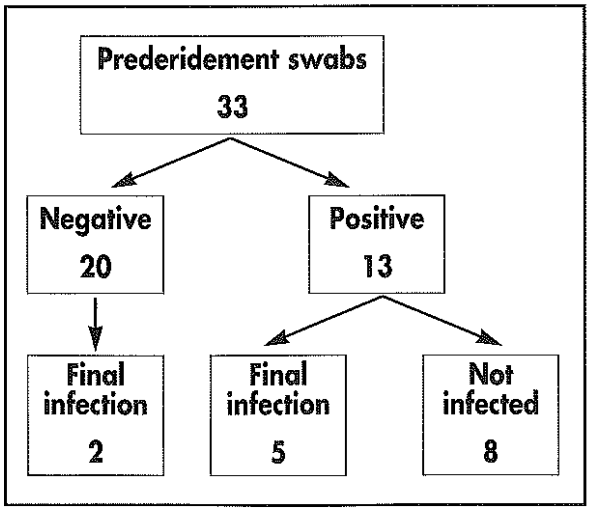

Fig. 3: Predebridement swabs and established infection.

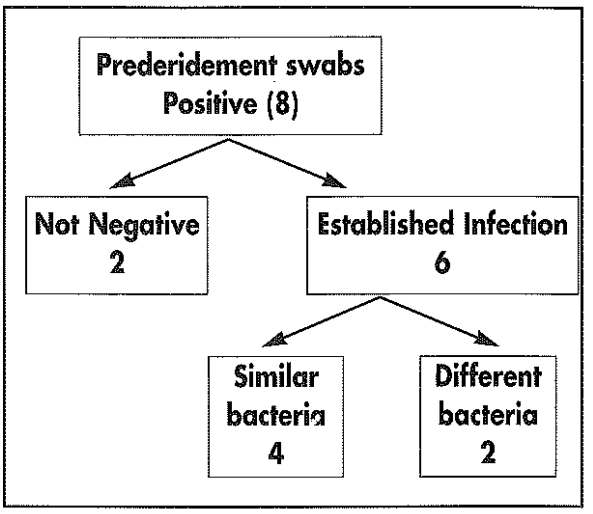

Fig. 4: Postdebridement swabs and established Infection.

Discussion

The relationship between predebridement and established infection from this study revealed that only 18% of predebridement swabs eventually became infected. However, none of the organisms, which grew in the predebridement culture, caused later infection. A negative predebridement culture did not preclude infection as 6% of these open fractures became infected. The predictive value for similar organism to grow on predebridement and established infection was zero. These results supported the observation by *Merritt* and *Lee* (1997) that predebridement culture of little predictive values[13,14]. None of the same bacteria grown on predebridement cultures, were grown on established infection. This was compared to 22% of such incidence in a study done by *Lee*[13].

Intraoperative cultures of tissues and marrow were also of no help in determining causative organism, as none of the intraoperative bacteria cultures eventually caused infection. Postoperative culture results were more representative. Seventy-five percent of cases with positive post debridement cultures eventually

developed infection and in 50% of cases, similar types of organisms were isolated. These findings were consistent with those found by *Lee*, who noticed that the infecting organisms were the same as that in the postdebridement swabs in 42% of cases[13].

Thirty-nine percent of open tibial fracture in this study was contaminated at the time of injury. Contaminant bacteria were mainly of gram-positive cocci (69.2%): namely *Staphylococcus aureus* and *Staphylococcus epididermis*. These findings contradicted those by Gustillo from 1976-1988 who noted that bacteria, which grew in open fractures had changed from a predominant gram positive organism to gram negative or mixed infection[1-4].

It was also observed in this study that all infecting organism exhibited multiple resistance to antibiotics, which occurred during period of hospitalisation. Several authors have proposed that many infection of open fracture wounds are nosocomial, as organisms found were mainly enteric flora rather than normal skin flora[9,14,15]. The cultured organisms also change from predebridement, intraoperative, postdebridement and established infection. It was also observed that new organisms appear. These new organisms may occur in combination with previous organisms in the infected cases.

There are several possible reasons to the lack of correlation between culture results and subsequent infection. The absence of infecting organisms in most of the predebridement cultures may be due to sampling errors. Such sampling errors could occur if the infection-causing organisms were initially present in very small numbers. A constantly changing local wound ecology during the pre injury period, surgical irrigation and debridement served to decrease the amount of necrotic tissues which may favour certain organisms while diluting the total number of organisms present. The use of antibiotics would also tend to select those organisms that may be less susceptible or even resistant.

Predebridement and postdebridement cultures, which have been proposed as routine procedures in the management of open fracture[5-8,16] were found to have no significant value from this study. Currently, the management of open fractures has changed. There is an aggressive trend towards early soft tissue coverage and free soft tissue transfers to convert contaminated dirty wounds into clean closed wounds for further reconstructive procedures. There is also a tendency to use 24 to 48 hour courses of antibiotics in early management of open fractures. Thus, sequential cultures are not beneficial in the management decision.

The value of antibiotics therapy in open fractures and the beneficial effects have been well documented[1-6]. The rationale for the use and selection of antibiotics in treatment of open fractures is predicated on treating the present contamination and coverage against the majority of the organisms that are most likely to cause infection. It is important to emphasize that antibiotics therapy is only an adjunct in the treatment of open fracture wounds. Liberal surgical debridement, meticulous wound care, and stabilization of fractures are very important factors in the overall management. Antibiotics are not a substitute for formal adequate surgical debridement.

Based on this study, the value of broad spectrum antibiotics for management of open fractures needs to be reevaluated as we found that the majority of contaminant organisms were gram-positive bacteria and sensitive to inexpensive antibiotics such as Cloxacillin but all late infection in open fractures were caused by multiply resistant bacteria that required changes in the antibiotic treatment.

Conclusion

Contaminant organisms in open fractures of tibia are mainly gram-positive organisms. Infecting organisms however, are mainly of gram-negative or MRSA. The role of predebridement swabs, intraoperative tissues and postoperative swabs culture and sensitivity are not helpful in the management of open fractures.

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