

Original Research Article

Infection risk in Gustilo and Anderson type III tibia and fibular fractures treated with external fixation in a tertiary hospital of a developing country

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ABSTRACT

Background: Open fractures of the tibia and fibula present with multiple management challenges of wound care, bone stabilization, potential risk of infection and its control. Attempt to resolve this problem, stabilization of the fracture with external fixators was introduced. However, this procedure predisposes infection too. This was an overview of the disposition of infection in the course of managing type III fractures in our center.

Methods: This was a retrospective study of disposition of infection in Gustilo and Anderson type III open fractures of the tibia and fibula treated with external fixation device over ten years in Jos university teaching hospital. Data extracted from patients records and operation notes included age, sex, nature of open fracture with respect to Gustilo and Anderson classification in theater. Wound culture reports extracted early and weeks after commencement of treatment. The findings were analyzed using Epi info statistical software version 3.5.3.

Results: A total of 74 patients, 63 (85.1%) males and 11 (14.9%) females (M:F=5.7:1) with mean age of 37.97 ± 13.57 years. The mean duration of injury-presentation time was 13.48 ± 38.73 days, 41 (55.4%). Patients that present with clinical infection were 40 (54.1%) among which staphylococcus aureus was isolated in 21 (28.3%). While treatment was on, the flora became altered. Motor cycles were responsible for 25 (33.7%), gunshots 20 (27%), motor vehicle injuries 19 (25.6%) while pedestrians accounted for 9 (12.2%).

Conclusions: Type III fractures sustained from high energy risk of infections due to late presentation in our setting. Bacterial isolates tend to alter in course of hospitalization.

Keywords: Infection, Type III fractures, Open fractures

INTRODUCTION

Infection is the most common and obvious complication in open fracture world over.^{1,2} It is a major burden in extensive open fractures of the extremities.¹ This is because grade III fractures are considered potentially contaminated wounds.^{2,3} While delay in debridement is a predisposing factor, infection constitute a devastating complication of open fractures with a reported incidence of 3 to 40% while the tibia is most frequently involved in

49.4% to 63.2%.^{4,5} Despite improved management strategies open fractures continue to be complicated by high late infection rates of over 25%.⁶ In general greater damage to surrounding tissues such as skin, muscles, arteries and veins from high energy insults tend to increase this infection risk.¹ Independent risk of infection was increased in patients with grade IIIB and IIIC fractures, internal or external fixation, lower leg fracture, blood transfusion, injuries from motorcycle and motor vehicle-pedestrian accidents.⁷ Other factors like timing of

administration of antibiotics and the duration of antibiotic therapy may also be contributory. High prevalence of infection is also noticed among combat inflicted wounds of up to 77% among type III fractures despite early intervention.⁸ Even in civilian inflicted injuries higher Gustilo wound grade predispose to high prevalence of infection.⁹ It is important therefore, that open fractures be treated with the utmost respect in the initial and subsequent stages of treatment.

It was also paramount that open fracture management be regarded as orthopedic emergency.¹⁰ To ameliorate this, debridement should be done within six hours as standard practice.^{11,12} However, other care givers were often visited before presenting to us. This was noted by Nwadiaro et al that bone setters are the resounding first port of call for patients with fractures and dislocation in both rural and urban areas.¹³ In spite of their limited knowledge of prevention and control of infection, their patronage in critical stage of surgical care is always alarming. As a result of this delay, much time is spent on eradication of infection, its control and sequelae. This further increases the risk of infection during multiple serial surgical interventions, multi stage dressings and prolonged hospitalization. This prolong hospitalization exposes the wounds to nosocomial pathogen.¹ Presence of hardware such as Tchanz screw predispose to pin tract infection, ring sequestrum and chronic infected ulcers and sometimes chronic osteomyelitis. Treatment protocols must consider eradication of infection as a means of enhancing union and improving the functionality. The morbidity associated with open fractures present with multiple management challenges in various forms ranging from bone and soft tissue care, devascularization and control of the varying degree of contamination. These category of wounds sustained from high energy transfer have extensive periosteal stripping, contamination, extensive damage to skin appendages by the extent of the size and possible vascular compromise requiring repair. Special types of type III wounds that demand special care are those sustained in farms and gunshots.¹⁰

In the event of delayed presentation and prolonged hospitalization, growth and proliferation of multiple organisms ensues. Sometimes organisms that initially colonized the wound are altered during hospitalization. Although multiple organisms can be isolated *Staphylococcus aureus* has been found to be the most common organism in type III fractures of extremity on external fixators in life.¹⁴

The protective nature of early initial care in the form of resuscitation at the point of admission is protective and lowers burden of infection. Although thorough debridement and skeletal stabilization is the mainstay of initial surgical treatment, the role of early, meticulous painstaking evaluation, resuscitation and administration of appropriate broad spectrum antibiotics and tetanus prophylaxis is necessary.¹⁵

We set out to observe the nature of the flora affecting patients with extensive lesion at various stages of exposure. This was because the open wound and the hardware provide a special environment that influences the course of managing the patient.

The aim of the study was to demonstrate the nature of disposition of infection and nature of the microbial flora in the course of managing type III fractures in our setting. This also highlighted the need to be vigilant after stabilizing the fracture as the as the initial organism changes in the course of treatment.

METHODS

This was a retrospective study of patients presenting with Gustilo and Anderson type III open injuries to tibia and fibula from January 2004 to December 2013. The study was carried out in the department of orthopedics and trauma of Jos university teaching hospital, Plateau state in North Central Nigeria. All patients that had Gustilo and Anderson type III open fractures and presented consecutively to the accident and emergency department were recruited and resuscitated. Thorough debridement were carried out in theater with copious irrigation and the fractures of tibia and fibula stabilized with external fixation devices. Anti-tetanus prophylaxis and peri-operative antibiotics were administered while staging was carried during debridement. We achieved rigid fixation with one bar four clamps and four pins with the AO type frames. Further dressings were carried out on the ward. Patients with gangrene, those with severe co-morbid states warranting ICU care, those who left against medical advice were excluded. Bio-data, descriptive nature of the injuries, duration of hospital stay, injury-presentation time and radiographic assessment reviewed at presentation, immediately after fixation, six and twelve weeks thereafter were extracted from folders and operation records. Wound swabs were taken for microscopy, culture and sensitivity on those who presented with frank infection and at least twice during hospitalization and at clinical suspicion of infection. Ethical approval was obtained from the ethical committee of Jos university teaching hospital. Data was analyzed using Epi info version 3.5.3.

RESULTS

During the ten years under study, 74 patients in which 63 (85.1%) were males and 11 (14.9%) were females. With male and female ratio 5.7:1. Age range from 15 to 70 years with a mean age of 37.97 ± 13.57 years. All the patients were admitted with Gustillo and Anderson grade III fractures of tibia and fibula. The mean duration of injury-presentation time was 13.48 ± 38.73 days. The range of period of injury-presenting time range from one day to 180 days while the duration of hospitalization ranged from three weeks to twenty-three weeks. Twenty-five patients (33.5%) presented on the day of injury 20% were victims of gunshots and 5 (0.7%) were victims of

pedestrian crash. From the second day to the seventh day 34 (45.9%) patients were admitted out of which 70% had sought traditional bone setter's intervention. Twelve (16%) patients presented between the first week and six months while 3 (4%) presented at six months. All those that presented after one week consulted traditional bone setters. Motorcycles were responsible for 25 (33.7%), gunshots 20 (27%), motor vehicle crash 19 (25.6%) while traumatic injuries among pedestrians accounted for 9 (12.2%).

Those admitted with established infections were 40 (54.1%) had *S. aureus* as predominant organism. Twelve (16.2%) contracted infection while on admission. The spectrum of the infections included cellulitis 11 (14.6%), 29 (39.1%) chronic osteomyelitis. The duration of use of external fixation devices ranged from six weeks to eighteen weeks with a mean of 9.35 ± 6.41 weeks.

Table 1: Age range of patients.

Age range (in years)	Frequency	Percentage
1-10	0	0
11-20	6	8.1
21-30	20	27.0
31-40	22	29.7
41-50	12	16.2
51-60	9	12.1
61-70	5	6.7
Total	74	100

Table 2: Mechanism of injuries.

Aetiology	Frequency	Percentage
Fall	1	1.4
Gunshot	20	27.0
MCA	25	33.8
MVA	19	25.7
PED AC	9	12.2
Total	74	100.0

Table 3: Organisms isolated after 3 weeks of admission.

Organisms	Frequency	Percentage
<i>Pseudomonas species</i>	29	39.9
<i>Klebsiella species</i>	29	39.9
<i>Proteus species</i>	23	31
<i>S. aureus</i>	21	25.6

Table 4: Co-morbid status of the patients.

Co-morbid status	Frequency	Percentage
CLD	1	1.4
Diabetes	4	5.4
Hypertension	10	13.5
No co-morbidity	58	78.4
SCA	1	1.4
Total	74	100.0

There was gradual diminishing *Staphylococcus* and appearance of coliforms.

Pseudomonas was dominant organism among the mixed infections and individual isolates. Among the 52 (70.2%) now infected, organisms isolated after three weeks of

hospitalization were mixed infection in 23, *Pseudomonas* in 9, *Proteus* in 6, *Klebsiella* in 4. *S. aureus* was still found in among 21 patients.

Their sensitivity pattern detected were gentamycin in 47 (63.5%), streptomycin in 23 (31.1%), ciprofloxacin in 6

(8.1%). Others were ofloxacin in 6 (8.1%), levofloxacin in 8 (10.8%), cotrimoxazole in 15 (20.3%), erythromycin in 25 (33.8%) and ceftriaxon in 3 (4.1%).

DISCUSSION

Open traumatic fractures of tibia and fibula are at risk of infection.¹⁴ This cut across all age groups that engage in active lifestyle 15 to 70 years (Table 1). In this age 21 to 40 years (56.7%) in range are found, the adventurous and individuals actively fending for living, hence expose to accidental traumatic events (Table 1). In our setting these injuries are worsen by late presentation. Prolonged injury-presenting time contributes immensely to the increased risk of infection. However infection risk is not increased by timing of antibiotic care nor duration of its administration.¹⁵ In spite of this, open fractures of lower extremities must be considered for operative intervention.¹⁶ Only ten percent of the one-third of the patients that present on the same day of injury presented within six hours of injury. This further add to other morbidity associated with these fractures. Although the 6 hour golden rule that was of import in the pre-antibiotic era may not strictly determine infectious outcome but serves as an index of prognostication¹⁷. Guidelines recommended early debridement within 6-8 hours, however, newer studies have shown that delaying surgical debridement up to 24 hours can be done safely without an increased risk in surgical site infection, nonunion or sepsis.¹⁷ It is also useful in determining the level of care in low energy wounds.¹⁸ Despite subjecting our patients to a modest protocol of evaluation, serial debridement, copious irrigation and therapeutic antimicrobials, infection could not be eradicated completely.

Patronage of traditional bone setters is almost always the rule until proven otherwise.¹⁸ This often results in further exposing the wound to ischemia and infection. In spite of the fact that our wounds were inflicted in civilian setting, our infection rate is comparable to those found in combat wounds, where despite early intervention, a significant number still develop infection.¹⁹

In order to control infection while bone union is enhanced, stabilization of the fracture that permits access to the wound with external fixation device is necessary. Its limited contact with the tissues through Tschanz pins allows less periosteal stripping and early tissue recovery.

Type III fractures are known to be associated with high risk of infection 10-50% which is comparable to the over two-thirds seen in our patients.² The extent of infection as depicted by sequestrum, signifies late presentation hence established chronic osteomyelitis.¹⁴ One-third of our patients fall in this category.

Among those with clinical infection at presentation, *S. aureus* was isolated in 21% while 19 (25.7%) had no isolates as they were on various antibiotics. *S. aureus* is

known to be the most prevalent species in osteomyelitis and a known cause of various community and hospital-acquired infections such as abscess, pneumonias and septic arthritis.²⁰⁻²³

However, in patients that were on admission longer than three weeks, gram-negative organisms were isolated in 81 instances suggesting the presence of mixed microbes among the forty patients involved (Table 3). Coliforms were responsible for the 12 (16%) that contracted the infection while on admission. This correlates with the findings in Ife where multiple organisms were also isolated from open fractures wounds.¹⁴ Pin tract infection were detected in eleven patients in form of hyperemia, serous discharge at pin sites.

The relevance of co-morbid conditions such as diabetic mellitus, hypertension and chronic liver diseases in 16 (21.6%) of the patients contributed to increased risk of infection hence serial debridement, aggressive multidisciplinary care, instituted enhance early wound cover although after secondary procedures (Table 4). The duration of hospitalization, wound healing, the need for changing antibiotics and the overall cost of treatment were prolonged. Other adjuncts to treatment were serial debridement, microscopy culture and sensitivity done at suspicion of local infection. The uniqueness of this is that harbored risks of infection in open fractures is far beyond those encountered with similar but closed fractures that might have occurred with the same amount of impact.¹⁶ In view of the anatomically rigid nature of the bone with guarded vascularity and perfusion, spread of infection in the medullary canal is of grave consequence. Its limited tissue perfusion has a direct relationship with consequent difficulty in eradication of infection. The altered local immune status caused by trauma and transgression of the skin and its appendages which hitherto constitute the first line of defense also contributes to low perfusion.

The propensity of our patients to seek medication from traditional bone setters before orthodox remedy leads to establishment of infection with *S. aureus*.²⁴ The risk of infection is not only high but poses a great threat to the fracture union. Two-third presented after the first day of injury sought treatment elsewhere before presentation. The 3 (4%) that presented after six months had established chronic osteomyelitis with non-union and sequestrectomy was part of the early treatment. The correlation between infection and injury-presentation time, non-union, fracture healing and development of chronic osteomyelitis was emphasized.²⁵ This infection was however modified by early administration of broad spectrum antibiotics as seen among 19 (25.7%) of our patients.

Despite the protocols instituted aimed at prevention of infections in those that presented early 12 (16.2%) developed further infection. These were the ones with co-morbid conditions. However, no infection was recorded

among those who presented on the first day when time of surgery was within two hours.

It is herculean preventing the incidence of infection in contaminated cases while eradicating infection in already established ones. Experience in our setting requires a special attention because patients present late and the wounds often tampered with by the untrained. The incidence of infection and non-union has decreased with our treatment approaches but infection continues to be a source of significant morbidity.

Evidence have shown no difference between the time of debridement and clinical or functional outcome in type III fractures specifically, whilst a delay from injury to presentation such as in more remote regions has been shown to have acceptable outcomes as long as the main principles of satisfactory debridement, fracture stabilization and soft tissue management are offered.^{7,26} Ironically most of their patients presented after a week while some were actually type II injuries.

The risk of infection must be seen beyond the timing of presentation as nature of the inflicting injury could be a source of infection too (Table 2). Gunshot injuries are mostly type III B injuries that require prolong regular dressings while diabetics with poorly controlled sugar and the long duration of externally placed hardware in the extremity contribute to infection risk and in our case required other means of surgical prophylaxis. Delay administration of antibiotics six to twenty four hours had profound detrimental effect on the infection rate regardless of the timing of surgery.²⁷

Our challenge at this stage of established infection was active methods to eradicate infection and enforcing procedures that effectively enhance wound healing and fracture union. The early surgical intervention protocol, early immobilization and rest encourage this.

Infection rate have been found elsewhere to be 13.7 % in the overall in grade III fractures while in the sub groups IIIA, IIIB and IIIC injuries were found to be 2.5%,5.6% and 25% respectively.²⁸ Gustilo and Anderson reported 50.7% positive wound culture on initial evaluation.²⁴ In our setting more needed to be done to create similar selection criteria that replicate acceptable outcome that was comparable. Perhaps only those that present within the 24 hour injury-presenting time may be included. As only a third of patients presented within the first 24 hour were mainly gunshot injuries possibly due to potential legal implications. In other climes 5 hour 40 minutes was the average injury-presenting time compared to 13.73 days±38.73 in this study.²⁹

An average of 36 days hospital stay was achieved by Rittman et al after evaluating 214 patients with open fractures from automobile accidents.²⁸ One third of our patients sustained gunshot wounds which by definition is high energy injuries. This contributes in no small way to

our prolonged hospitalization. This prolonged stay often contributes to alteration of the microbial flora in the wounds. The implication of this is the development of multiple resistant organisms. In our study, *S. aureus* was seen in wounds that presented late while coliforms were isolated in patients that remained for long period of time on the ward.

Our primary goal was eradication of infection, while the secondary goal was ensuring osteosynthesis (bone union) and wound cover. Early intervention with debridement, antibiotic therapy, immobilization of fracture, rest, optimization of the hemodynamic status must be ensured early in the treatment. This was necessary because infection of an open fracture can be devastating, potentially leading to osteomyelitis, systemic infection, amputation, or even death.²⁹ Although the duration of antibiotic therapy in open fractures has been suggested to be 1 to 3 days without a definite consensus we continued antibiotics few a week after wound closure was achieved.³ The prolonged antibiotic usage may be justified by the gross soft tissue defect, potential organ site infection and varying degree of contamination and in instances where infection is already established as in 40 (54.1%) of our patients.

Complications such as compartment syndrome, vascular, nerve injuries and nonunion are common but none of our patients developed such.³⁰

Limitations

Limitations of this study lied with it being a retrospective study and the fact that the patients presented at no fixed injury-presenting time. There was a large time intervals between injury and presentation as result wounds were at different phases of healing and recovery. The presence of hardware might have contributed to delay healing and increased risk of infection. The problem of retrieval of data from hospital based information could be cumbersome with some information poorly kept.

CONCLUSION

While most of the delays in presentation provide fertile nourishment for the gram-positive organisms prolonged hospitalization results in colonization by coliforms. In most of these patients who presented late, chronic osteomyelitis had established but 100% union was achieved with this modest protocol. In view of the extensive soft tissue injury and underlying infection, limited use of hardware becomes necessary. Open wounds are formidable challenge in themselves while the underlying infection presents a herculean task to contend in order to achieve an acceptable outcome.

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