Section: Orthopaedics

Original Research Article

POST-OPERATIVE INFECTION IN OPEN FRACTURES AT A TERTIARY CARE HOSPITAL IN NORTH-EAST INDIA: A PROSPECTIVE STUDY

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Abstract

Background: In an era where there is availability of new and potent antibiotics, open fractures always carry the risk of infection due to breach of protective layers of the bone, destruction of the soft tissue covering, microbial contamination and antibiotic resistance. With this study we have tried to provide a comprehensive data about post-operative infection in open fracture. The incidence of post-operative infection has been collected, categorized and analyzed. **Materials and Methods:** A prospective study was carried out at Jawaharlal Institute of Medical Sciences from September 2022 to August 2023 among patients who satisfy the inclusion criteria. Gustilo Anderson classification of open fracture was used and patients were grouped accordingly. Approval of the ethical committee of the institution was taken and declaration of Helsinski was strictly followed. **Result:** Out of 57 patients included in the study, female and male patients constitute 26.3 % and 73.7% respectively. 87.6 % of the patients were under 60 years and remaining above 60 years. Maximum patients belong to open fracture type-2 (55.7%) and minimum patients belongs to Type 3B (5.3%). Signs of infection were found in 22.8% in the first 30 days post-operatively and the figure dwindled down to 7 % from post-operative day 31st to 90. By the end of 1 year all the patients did not show any signs of infection. **Conclusion:** 22.8 % and 7% rate of infection seen in the first 30 and 90 days respectively is relatively high. Even though it depends on the severity of open fracture and its contamination, prolongation of infection necessitates the importance of better infection control policy and judicious use of antibiotics among the general population.

INTRODUCTION

Studies showed that open fractures carries high risk of infection.[1-3] Infection can lead to longer duration of hospital stay, increased non-union, functional impairment sometimes death.[4,5] Contamination of the fracture hematoma and surgical site infection can leads to potentially complicated soft tissue requiring reconstruction and surgical revisions.[5,6] Infections following open fractures are as high as 52 % in some studies.[7] Primary goal of managing open fracture is to prevent infection.[4] The early debridement within 6 hours laid down by the classic work of Friedrich (1898) is commonly followed to decreased the rate of infection.[8] A wound indicates contamination, not necessarily infection. Quantity of the inoculum and susceptibility of the host are risk factor to infection.[9] Presence of shock, local hematoma, dead space, fracture instability, non-viable tissues and severe co-morbidities like diabetes, impaired immunity are some factors which helps the progression of infection. Infections are evident to be nosocomial for advance society and limited along with shortage of advance medical treatment in developing countries.[6] Smoking, male gender and additional risk factors like malnutrition, renal or liver diseases etc. have been associated with impaired wound healing and increased rates of infection.[10-12] Infection rates were seen with the increase in the severity of fractures with Gustilo Anderson's classification type-I, type-II and type-III showing infection rates of 4%, 52% and 44% respectively. Comparatively, type-I and Type-II showed lower rates of 0-2% and 2.4% respectively.[13,14] In pre-antibiotic era "Lose a limb to save a life" was the dictum of management of infection in pre-antibiotic era for infection in open fracture.[15] The timely use of antibiotics with the prompt and thorough debridement will reduce bacterial load preventing.[16] The importance of antibiotic in the treatment of infection has been reduced due to the development of its resistance.[17] Adherence to the judicious use of antibiotic and infection control is lacking. The World Health Organization have issued a warning about the significant threat of antibiotic resistance, which could potentially lead to a post-antibiotic era where common illness and mild accident once again pose a serious risk to life.[18] The effective management of infection following open fractures depends on a latest data about the range of organisms which can cause infection and antibiotic resistance.[19] In addition, collection of the tissue sample at the time of operation for culture and sensitivity testing, screening of patients for high risk infection and targeting the patients with suitable therapies proves to be economically efficient.[1] Currently, there is scarcity on the epidemiological characteristics of open fractures, with the majority of studies concentrated on specific region of the body.[5,20,21] Our study was undertaken to identify the total incidence of infection associated with open fractures to provide a comprehensive analysis in our institute.

MATERIALS AND METHODS

This is a prospective study carried out from September 2022 to August 2023 at Jawaharlal Nehru Institute of Medical Sciences which is a tertiary referral hospital situated in Imphal of North-Eastern India. A total of 57 patients aged above 18 years of both genders who had open fractures admitted at JNIMS during the mentioned period with fracture duration <1 week after hemodynamic stabilization were included in the study. Patients fit to undergo surgery were also set as an inclusion criterion. Open fractures which required amputations were not included in the study. Data were collected in pre-designed proforma. Fractures were categorized using Gustilo and Anderson's classification original classification. Associated co-morbidities were also addressed. Cultures were done from the debrided tissues and isolation of the organisms was carried out. Detailed history, clinical examinations, radiological and laboratory evaluations were also done. Various types of surgical procedures were performed for all the 57 patients included in the study and they were also included in the analysis.

All the cases were followed up for 30 days and on the 90th day post-operatively and assessment were done using clinical examinations, blood investigations including blood parameters like total leucocyte count and inflammatory markers like C-reactive proteins and procalcitonin etc. Assessment of the wounds were done using Asepsis wound score and Southampton grading system. Ethical approval for the study was obtained from the IEC, JNIMS. Written informed consent was obtained from the study participants. Confidentiality and privacy of data were maintained. and All data obtained were subjected to statistical analysis using SPSS software. Descriptive statistics like mean, standard deviation and proportion were used.

RESULTS

Out of the 57 patients who participated in the study, majority of them belonged to the age group of 31-40 years (22.8 %) and minimum in age group > 60 years [Table 1]. One-fourth (26.3%) of the patients were females and the remaining 73.7 % were males [Figure 1]. Majority of the patients (55.7%) had Type-2 open fractures. The number reduced as severity of the fracture increased with Type-3B open fracture comprising only 5.3% of all the open fractures. Most of the patients had no associated co-morbidities except eight patients (14%) had both type-2 diabetes and hypertension. Only one patient (1.8%) with isolated diabetes and 3 patients (5.3%) of isolated hypertension were also found among the patients under the study. Staphylococcus aureus was isolated most commonly during debridement in 12.3 % of the patients but maximum number of patients yielded no organisms. Majority of the patients were treated with combined external fixation and plating (28.2%) [Table 2]. They were followed up at 30 days, 90 days and 12 months. For the first 30 days of follow-up, signs of infection in the form of erythema with swelling and pus discharge with swelling were seen in 7.2% and 15.8% respectively. Remaining 44 patients (77.2 %) had no signs of infection. By 90 days of post-operative follow-up, only 4 patients (7%) showed signs of infection. Mean TLC showed increase from during pre-operative period to 18.25 on the 90th day. Mean CRP and Procalcitonin showed fluctuating result with increase in the value in first 30 days followed by reduction by the first 90 days [Table 3]. No signs of infection were seen among all the 57 patients who took part in the study.

At 30 days' of follow-up the commonest DLC finding was N65,L25 (14; 24.6%). This was followed by N60,L24 (5; 8.8%). At the end of 90 days of follow-up, 57 participants did not show any sign of infection. [Tables 4 & 5 and Figure 2 and 3]

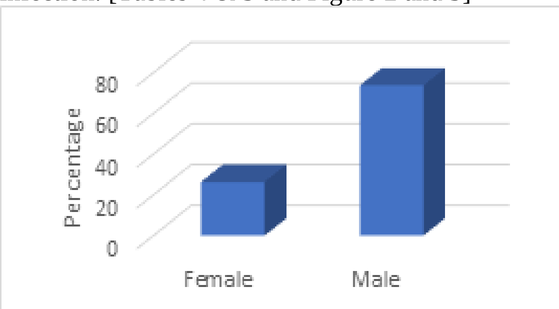

Figure 1: Sex-distribution of patients

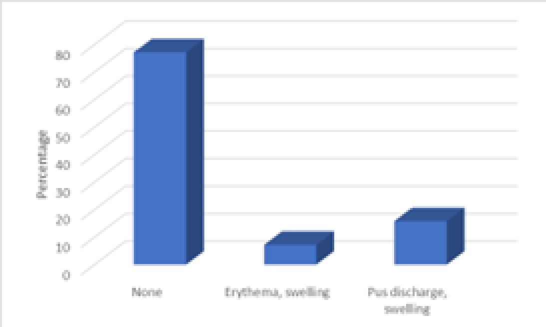

Figure 2: Distribution of signs of infection in the first 30 days follow up and the distribution of the patients with signs of infection in the first 90 days respectively

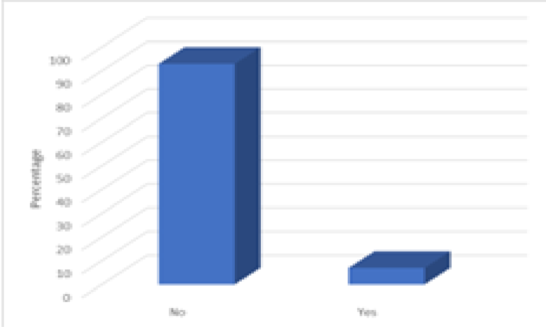

Figure 3: Distribution of signs of infection in the first 30 days follow up and the distribution of the patients with signs of infection in the first 90 days respectively

Table 1: Age- distribution of study participants.

Years	Frequency	Percent
<20	8	14.0
21-30	9	15.8
31-40	13	22.8
41-50	10	17.5
51-60	10	17.5
>60	7	12.3
Total	57	100.0

Table 2: Distribution of stabilization methods used for the patients under study

Method of Stabilization	Frequency	Percent
External Fixation followed by Plating	16	28.2
Circlage Wire	1	1.8
External Fixation Followed by Interlocking IM Nailing	2	3.5
External fixation only	1	1.8
External Fixation With K Wiring	1	1.8
External Fixation Followed by IM Nailing	2	3.5
Interlocking IM Nailing	5	8.8
K –Wiring	5	8.8
K Wire Fixation with Ligamentotaxis	1	1.8
Limb Reconstruction System	4	7.0
Proximal Femoral Nailing-A2	1	1.8
PLATING	17	29.8
Plating With K-Wiring	1	1.8

Table 3: Mean CRP, Procalcitonin and TLC level at different time interval among the patients under study

Time intervals	Mean CRP (SD)	Mean Procalcitonin level (SD)	Mean TLC level (SD)
Pre-op	1.41 (1.90)	1.05 (3.11)	9.63 (2.30)
First 90 days	28.81 (33.99)	12.45 (8.06)	-
90 days to 1 year	7.20 (2.77)	12.00 (5.03)	15.25 (5.03)

Table 4: Differential Leucocyte Count finding on first 30 days

Neutrophil and Leucocyte count	Frequency (%)
N46,L30	1 (1.8)
N50,L20	1 (1.8)
N50,L30	1 (1.8)
N54,L30	4 (7.0)
N55,L25	3 (5.3)
N56,L25	3 (5.3)
N58,L23	1 (1.8)
N59,L30	3 (5.3)
N60,L24	5 (8.8)
N61,L25	1 (1.8)
N62,L23	1 (1.8)
N64,L23	1 (1.8)
N65,L25	14 (24.6)
N66,L23	1 (1.8)
N67,L23	2 (3.5)
N67,L24	1 (1.8)
N67,L25	1 (1.8)
N67,L30	1 (1.8)
N68,L26	2 (3.5)
N70,L25	4 (7.0)

N76,L20	3 (5.3)
N78,L16	2 (3.5)
N80,L16	1 (1.8)

Table 5: Differential Leucocyte finding from first 90 days of follow-up

Neutrophil and Leucocyte count	Frequency (%)
None	53 (93.0)
N55,L35	1 (1.8)
N56,L30	1 (1.8)
N67,L24	1 (1.8)
N67,L25	1 (1.8)

DISCUSSION

Exposure of fracture hematoma with extensive soft tissue injury are challenges to the traumatologist and Surgical site infection leads to revision surgery with risk of non-union and poor surgical outcome.[5,6] At the time of trauma, from 0% to 70% of open fractures are infected.[2] Comprehensive data. of the characteristics of SSI and the identification of the associated risk are required for assessing the patients under risk of infection and initiation of cost-effective targeted treatment. A total of 57 patients with open fractures were enrolled for our study. There was male preponderance and maximum number of patients belongs to the age group 31-40 years. The fracture was categorized using Gustilo and Anderson's original categorization, which is based on the level of soft-tissue injury in open fracture sites.[22] For type I fractures, the incidence ranges from 0% to 2% for type II fractures, the incidence ranges from 2% to 10% and for type III fractures, the incidence ranges from 10% to 50%.[3,23] In the present study, the majority 55.7% of cases of open fracture were type 2, followed by 28.1% of type 1, 21.1% of type 3A and least 5.3% were type 3B. Kortram K et al reported male gender and Gustilo-Anderson grade III open fracture (RR 3.01), contaminated fracture (RR 7.85) and polytrauma patients (RR 1.49) were identified as statistically significant risk factors for the development of infectious complications.[24] There is higher rate of infection as the severity of the fracture increases with type-II and type-III open fracture showing comparatively higher rate of infection.[24,25] Management of fractures also differ as more complex surgeries are required as the severity of injury increases. These procedures are typically necessary when the fracture is accompanied by contaminated or infected wounds.[25] Tornetta P et al,[26] reported that factors associated with deep infections included Gustilo Type III injuries, fracture of lower extremity especially tibia, delayed wound closure and fractures managed with flap. In our study, patients of open fracture were treated with plating (29.8%) followed by Ex Fix followed by plating (28.2%), IMIL Nailing and K -Wiring (8.8% each), LRS (7%), Ex -Fix followed by Nailing and Ex-fix followed by IMIL Nailing (3.5% each) followed by Circlage Wire, Ex-Fix, Ex-Fix with K Wiring, K Wire Fixation with Ligamentotaxis, PFN-A2, Plating With K-Wiring.

In the present study, we have examined and described the occurrence of surgical site infection after surgical treatment in cases with open fracture. The sign of infection was found in 22.8% patients in 1st 30 days follow up period with the most common sign being pus discharge and swelling among 15.8% and erythema and swelling among 7.2% patients. On follow-up at day 31st to 90 days, the sign of infection was reduced to 7% among patients with all the patients showing pus discharge and swelling. Later at follow up 90 days – 1 year, all patients do not show any signs of infection. A similar study carried by Hu Q et al,[27] reported the occurrence rate of surgical site infections (SSI) following open fracture surgery was 18.6%. In his study seven risk variables namely kind of fracture, duration of surgery, duration under anaesthesia, body temperature during operation, blood glucose level, platelet count and leucocyte count were found to be linked to surgical site infection.[27] CRP is well acknowledged in the literature as a reliable early marker for postoperative infection. Understanding the typical progression of CRP levels in cases of tissue injury and straightforward surgery is crucial in order to recognize any abnormal changes that may indicate an infection.[28-32] In our study, the mean CRP level increased from pre-op (1.41±1.90) to first 90 days (28.81±33.99) which later decreased from 90 days to one year (7.20±2.77). Surgery elicits an immune response that is controlled by cytokines. An elevated CRP level is a widely recognized indicator of unfavorable outcomes in older patients undergoing surgery. The typical trajectory of CRP elevation ceases after the third day following surgery, meaning it increases until the third day and subsequently returns to the normal range.[33] Ayo HO et al found mean CRP levels for both groups of patients peaked on the third postoperative day with a higher value of 52.2 mg/l for patients with postoperative SSI compared with 47.7 mg/l for those without postoperative SSI, and the difference was significant ($p = 0.015$).[29] Shetty S et al also showed that patients who had postoperative wound infections had significantly higher average CRP levels on the third and seventh days after surgery compared to those who did not experience any postoperative infections.[29]

The mean procalcitonin level increased from pre-op (1.05±3.11) to first 90 days (12.45±8.06) which later decreased from 90 days to 1 year (12.00±5.03). It is possible that individuals with elevated procalcitonin levels were more susceptible to experiencing a greater number of post-operative infectious diseases.[30]

The white blood cell is a highly sensitive marker in the human body. Consequently, an elevated leukocyte count in the blood is frequently considered one of the diagnostic criteria for surgical site infections (SSI). In our study, we found preoperative white blood cell count 9.63±2.30. Our results are in concordance with the study of Hu Q et al,[27] in which the pre-operative white blood cell count was greater than 9.4 x 103. Severity of the injury with associated contamination may trigger immune and stress response leading to the peri-operative elevation of leucocyte count. It is also an indication of suspected infection in open fractures. Gradual increased in the mean TLC was seen in our study from 9.63±2.30 in the pre-operative period to 18.25±6.02 in the first post-operative 90 days. Mean TLC count was normalized thereafter. Differential leucocyte count findings in first 30 days follow-up showed the highest value of N65,L25 (N=neutrophils, L=lymphocytes) among 24.6% patients followed by N70,L25 among 7.0% subjects, N54,L30 among 7%. The values later reduced on follow-up at 90 days with 93% reporting no findings and 3.5% each reported N55,L35; N56,L30; N67,L24 and N67,L25. Further no findings were reported at follow up at 90 days to one year. Majority of the participants (93%) reported no findings neutrophils and lymphocytes whereas, 3.5% showed N54,L34, 1.8% showed N56,L35 and 1.8% showed N64,L25. Unclean wound, current smoking, high-energy trauma and lower hematocrit were independent risk factors for DSSI.[31] Timely modification of smoking and hematocrit, and limiting operation within a rational time frame for an optimized soft tissue condition, might provide potential clinical benefits for SSI prevention.

Pre-operative biochemical markers play a crucial role in assessing the physical status of patients with severe injuries. Several investigations have shown that rapid blood glucose and other specific laboratory indicators are independent risk factors for surgical site infections (SSI).[32-37] Diabetes mellitus hamper the wound healing process, hence dramatically increased the incidence of surgical site infections (SSI) in patients undergoing surgery.[38,39] In our study, the co-morbidities present were 14% patients had diabetes mellitus and hypertension, 5.3% had hypertension and 1.8% had diabetes mellitus and 78.9% had none comorbidities. Rascoe AS et al[40] reported the presence of diabetes in open type fractures was associated with deep SSI requiring revision surgery. Several studies showed Diabetes mellitus and impaired blood sugar with FBS >110 mg/dl are independent and statistically significant risk factors associated with SSI which necessitates pre-operative optimization.[24,27,32] Open fractures can lead to polymicrobial infections, which require higher amounts of antibiotics and are more likely to result in amputations.[27] Open fracture include a higher fracture grade (III), employment in agriculture, the requirement for a blood transfusion, or the need for extra surgical debridement are risk associated with polymicrobial infection.

In the present study, the most common organism found during debridement was Staph Aureus among 12.3% followed by E. Coli (5.3%) and both S. Aureus and E, coli (5.3% and the least was pseudomonas (1.8%). In some studies the commonest organism isolated even in polymicrobial causation of SSI is staphylococcus aureus and MRSA infection is in the rise.[21,38] In the study by Henkelmann R et al,[24] analysis of microbial sensitivity tests revealed that 55.1% of the pathogens were resistant to perioperative antibiotic prophylaxis and their study suggested that the choice of peri-operative antibiotic prophylaxis might influence the rate of SSI. The species causing the infection are mostly nosocomial and seems to evade the selected antibiotic prophylaxis. When compared to previous groups of people, there seems to be a rise in the occurrence of infections caused by MRSA, gram-negative bacteria, and many types of bacteria. This suggests that it may be necessary to reassess the present antibiotic treatments being used.[39]

CONCLUSION

The rate of infection of 22.8 % and 7% seen in the first 30 and 90 days respectively is relatively high. Apart from the risk factors which can lead to post-operative infection which were optimized during the study, we concluded the presence of antibiotic resistant organisms as shown by the persistence of the infection in the post-operative period. We strongly suggest further studies on the organisms causing the infection with their culture and sensitivity to antibiotics so that the negative impact on the overall surgical outcome and quality of life of patients can be prevented.

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