Original Article

Open Femoral Shaft Fractures in a Developing Country: Pattern of Presentation and Outcome of Treatment

Henry Chinedum Ekwedigwe, Amechi Uchenna Katchy[1], Richard Chukwunonye Ezeh[2], John Kene Anieze

Department of Accident and Emergency, Enugu State University of Technology Teaching Hospital, Park Lane, [1]Department of Anatomy, University of Nigeria, Enugu Campus, [2]Department of Orthopaedics, National Orthopaedic Hospital, Enugu, Nigeria

Abstract

Background: The femur is one of the principal load-bearing bones of the lower extremity. Femur fractures are among the most common fractures encountered in orthopaedic practice. Open femur fractures are always as a result of high-velocity injury and almost invariably associated except for isolated gunshot injuries with multiple traumas. The aim of the study is to determine the pattern of presentation of open femur shaft fractures, associated injuries and outcome of treatment. **Patients and Methodology:** A 10-year retrospective study done at National Orthopaedic Hospital, Enugu, from 2007 to 2016. Patients' folders were retrieved from the Medical Records Department; patients' biodata, cause of the injury and other relevant information were collated from the folders and their management followed up for 1 year. Data analysis was done with Statistical Product and Services Solution Version 22. **Results:** A total of 62 cases were reviewed. Treatment outcome of 50 patients that completed their management was analysed. The age range with the highest frequency was 21–30 years. Associated injuries were recorded in 77.4% of the patients. Thoresen's combined excellent and good outcome was observed in 63.3% of the patients at a minimum of 1-year follow-up. **Conclusion:** Open femoral shaft fractures are more common in the younger age groups and usually associated with high frequency of associated injuries. The outcome of treatment of these fractures in our environment is good despite the limited resources usually encountered in a developing nation like ours.

Keywords: Open fractures, pattern, treatment outcome developing country

Introduction

The femur is the longest and largest bone of the human body.[1] It is one of the principal load-bearing bones in the lower extremity.[1] Fractures of the femur are among the most common fractures encountered in orthopaedic practice. Femur fractures are always as a result of high energy injury in the young; however, mild-to-moderate energy can cause the injury in the elderly.[2] Open fractures of the femur are always the result of high-velocity injury and almost invariably associated except for isolated gunshot injuries with multiple traumas.[3] Hence, the management of these serious injuries should follow the guidelines of the advanced trauma life support system and the principles of damage control orthopaedics.[3]

Open fractures of long bones are common in developing countries and are mostly due to the ever-increasing number of vehicular road traffic crashes, communal clashes and civilian gunshot injuries.[4] In this country, functional emergency medical services are often non-existent and patients with open fractures usually present late to the hospitals, some of who would have had some intervention by traditional bonesetters.

The most widely used classification system for open fractures is that of Gustilo and Anderson[5] which was modified by Gustilo *et al*.[6] in 1984. This classification system describes three groups of increasing severity based on the size of the open wound, degree of contamination and extent of soft-tissue injury.[5] The basis of treatment includes immediate, meticulous and repeated wound debridement with copious irrigation using normal saline, stabilisation of the fracture, closure of the wound, early parenteral administration of broad-spectrum

Address for correspondence: Dr. Amechi Uchenna Katchy, Department of Anatomy, University of Nigeria, Enugu Campus, Enugu, Nigeria.
E-mail: uchekatchy@yahoo.com

Access this article online

Quick Response Code:

Website: www.njotonline.org

DOI: 10.4103/njot.njot_14_19

How to cite this article: Ekwedigwe HC, Katchy AU, Ezeh RC, Anieze JK. Open femoral shaft fractures in a developing country: Pattern of presentation and outcome of treatment. Niger J Orthop Trauma 2019;18:54-9.

Submission: 29.07.2019 **Revision:** 26.08.2019
Acceptance: 28.09.2019 **Web Publication:** 13.01.2020

antibiotics and early bone grafting when indicated.[7] The early outcome of various modalities of treatment can be measured with respect to the functional status of the knee, total hospitalisation time, bone union and presence or absence of complications.[8]

Thoresen's criteria is a clinical, radiological and functional evaluation classification system for assessing the outcome of femur fractures, it considers the malalignment of the femur in degrees, shortening of the femur in centimetres, range of motion of the knee in degrees and presence or absence or pain or swelling in the limb. It is used to categorise the treated patients into four groups, namely, excellent outcome, good outcome, fair outcome and poor outcome.[9] The Thoresen's criteria are as shown in Table 1. Apart from being in the canter of controversy, especially regarding the optimal timing for their treatment over the past few years, open femur shaft fractures have also served as a benchmark for quality control in trauma centres.[10,11] There are differences between trauma centres as regards to the timing and type of intervention and the surgical staff involved.[12] To our knowledge, there has been no published evaluation of open femoral fractures in our trauma centre.

The objectives of this study are to determine the pattern of presentation of open femur fractures and evaluate the treatment given and the early outcome of treatment.

Patients and Methodology

The study was a 10-year retrospective study starting from 1 January 2007 to 31 December 2016, and it was carried out in a major trauma centre in the Southeastern part of Nigeria. Ethical clearance was obtained from the hospital ethical committee. Case notes of all the patients that had open femur fracture and presented through the accident and emergency department within the stipulated period were retrieved from the medical records department. Inclusion criteria were patients that presented with open femur fractures through the accident and emergency department. Patients who presented through the outpatient department with malunion, non-union or chronic osteomyelitis were excluded from the study. Patients' records in their case notes were followed up for 1 year. A total of 62 case notes of patients that had open femur shaft fractures were retrieved for the study. Data obtained from their folders were patients' demographics, the cause of the open femur fractures, the side of the injury, site of the fracture on the femur shaft, the associated injuries and the Gustilo *et al*. class of the open fracture. The number of debridement the patients had was documented. The option of bone stabilisation and plastic surgery procedures were also documented. Time and rate of fracture union were noted. The ranges of motion of the knees and the hip at 1 year after the injury were noted. The presence of any complications such as non-union, malunion, infection and shortening were extracted from their case notes. The offending organism and treatment given in cases of infection were also noted from records in the case notes. Fifty case notes had the required complete records of patients, and these were the ones used for analysis of the outcome in the study; however, demographics of the 62 patients were presented in the results. Thoresen's criteria were used to assess the functional outcome of the treated patients at the end of 1 year.

The data were analysed using IBM SPSS package (IBM Corp., IBM SPSS Statistics for Windows, Version 25.0, Armonk, NY, USA) developed by International Business Machines Corporation (IBM) and results were presented in tables and figures.

Results

A total of 62 case notes were reviewed, 62 patients with 63 open femur shaft fractures were found. Fifty patients who completed their management plan and were followed up in the outpatient department for 1 year. Eight patients discharged against medical advice without completion of their management, three patients were referred to other centres because of the seriousness of the associated injuries and one patient died in the trauma unit of complications from the multiple injuries. There were 51 male (82.2%) and 11 female (17.8%). The male:female ratio was 4.6:1. The age of patients ranged from 1 to 80 years with average age of 31.97 years. The age range with the highest frequency was 21–30 years. Table 2 shows the distribution of the age ranges of the patients. There was almost equal distribution of the injury between the right and left sides. The mid-shaft was the most common part of the bone affected by these injuries. The most common cause of open femur fracture from this study was road traffic accident, other aetiologic factors were outlined in Table 3. Gustilo *et al*.

Table 1: Thoresen's criteria

	Excellent	Good	Fair	Poor
Malalignment of femur (°)				
Varus or valgus	5	5	10	>10
Antecurvatum or recurvatum	5	10	15	>15
Internal rotation	5	10	15	>15
External rotation	10	15	20	>20
Shortening of the femur (cm)	1	2	3	>3
Range of motion of the knee (°)				
Flexion	>120	120	90	<90
Extension deficit	5	10	15	>15
Pain or swelling	None	Minimal	Significant	Severe

Table 2: Distribution of age range

Age range	Frequency (%)
1-10	3 (4.8)
11-20	11 (17.7)
21-30	17 (27.4)
31-40	16 (25.8)
41-50	7 (11.3)
>50	8 (12.9)

class III was the most common class of injury, followed by Class 2, and this is shown in Table 4. Majority (77.4%) of the patients had associated injuries that involved other systems or limbs as shown in Table 5.

After the initial debridement of their wounds on presentation, 37.5% of the patients had second-look debridement and one patient had a third-look debridement. Eleven patients (17.7%) who had type 1 open fractures were managed as closed fractures. The other patients had delayed wound closure. Two patients had split skin grafting, one patient had flap cover and two patients had vacuum-assisted wound closure. One patient had nerve graft for sciatic nerve injury.

Different treatment options were used for the definitive treatment of the fractures. These include open reduction and internal fixation, external fixation, traction, and cast immobilisation [Table 6]. The mean union time for the fractures was 24.9 ± 7.8 weeks. The average post-operative knee range of motion attained by the patients at the last post-operative follow-up visit was 97.2° ±38.3°. About 66% of the patients had post-operative knee range of motion of 90°–120°, 14% had knee range of motion of >120°, only 20% of the participants had flexion of <50°. About 96% of the participants had hip flexion of >90°. Six patients had malunited fracture. The union rate in this series was 94.7%. Infection occurred in 9 (15.7%) of the patients. Four patients had superficial infection which eventually resolved with wound dressing. Five patients had deep infection which discharged from within the deeper tissues; wound culture yielded coliforms in two patients, *Staphylococcus aureus* in two patients and *Pseudomonas* spp. in one patient. These infections eventually resolved with administration of appropriate antibiotics. Two patients had shortening of 3 cm and 6 cm each.

The treatment outcome based on the Thoresen's criteria is shown in Table 7. Combined excellent and good outcome was observed in 63.3% of the patients at 1 year follow-up.

Discussion

The higher number of males that was reported in this study was also documented in previous studies on fractures of long bones. Anyaehie *et al*.[13] in their work on femur fractures reported male:female ratio of 1.8:1, Ikem *et al*.[7] reported male:female ratio of 2.2:1 in a study on open fractures of the lower limbs, The preponderance of males suggests that they may be more active and more engaged in activities that predispose them to trauma. Clasper and Rowley[14] in their study on ballistic femoral fractures reported male:female ratio of 5.6:1, the very high male:female ratio in his work and in this work may be because males are always solely the culprit of gun violence. The age group with highest frequency of these fractures in this study was similar to what was reported by previous authors.[7,12] The peak age groups were between 20 and 40 years, these are the productive years which are lost to morbidity and mortality from open femur fractures and its complications. These cause great economic loss to these patients and to the country at large.

Table 3: Mechanism of injury

Injury cause	Frequency (%)	Percentage of associated injury
Motor vehicle accident	35 (56.4)	62.5
Gunshot	13 (20.9)	6.3
Motorcycle accident	12 (19.4)	29.2
Falls/sports	2 (3.2)	2.1

Table 4: Gustilo *et al*. class of the open fractures

Gustilo *et al*. class	Frequency (%)
I	11 (17.7)
II	24 (38.7)
IIIA	14 (22.5)
IIIB	11 (17.7)
IIIC	2 (3.2)

Table 5: Associated injuries

Associated injuries	Frequency (%)
Head injury	6 (12.5)
Blunt chest injury	4 (8.3)
Forearm fractures	11 (22.9)
Ankle fracture	3 (6.3)
Contralateral tibia fracture	3 (6.3)
Crush injury to the leg	2 (4.2)
Ipsilateral tibia fracture	9 (18.7)
Patella fracture	4 (8.3)
Humeral fracture	4 (8.3)
Sciatic nerve injury	1 (2.1)
Bowel rupture	1 (2.1)

Table 6: Treatment option

Definitive treatment	No	Percentage
Cast	9	17.6
Traction and cast	8	15.7
ORIF with nail	14	27.5
ORIF with plate and screw	15	29.4
Ext fix + cast	1	2.0
ORIF with screw	2	3.9
Amputation	1	2.0
ORIF with cross k-wire	1	2.0

ORIF: Open reduction and internal fixation

Table 7: Treatment outcome using Thoresen's criteria

Thoresen's grade	Frequency (%)
Excellent	7 (14.3)
Good	24 (49.0)
Fair	7 (14.3)
Poor	11 (22.4)

Majority of open femur fractures in this study were as a result of road traffic accident, motor vehicle accident and motorcycle

accident had combined frequency of 74.0%. This was not surprising because automobile accidents produce significant energy that will cause severe bone and soft-tissue damage in open fractures. A study done by Ifesanya and Alonge[4] on open long bone fractures reported automobile accident as the cause of injuries in more than 80% of cases. Other studies on femur fractures also documented results similar to what was found from this study on the cause of these injuries.[4,7,8,11,13,15,16] The high frequency of road traffic accident may be because of poorly maintained roads, ignorance of road safety rules and overspeeding. Gunshot injury was another major cause of open femur fractures from this study, and this might be justified by finding in a study by Yinusa and Ogirima[17] that in extremity gunshot injuries, the femur is the most common site of fracture. Gunshot injuries are more common these days because of incessant communal clashes and attacks on villagers by armed bandits. The almost equal affectation of the right and left sides in unilateral femur fracture seen in this study is similar to what was reported by Magerl *et al*.[18] The more affectation of the midshaft of the femur seen in this study is similar to findings from previous studies.[7,12,19] The reason the midshaft is the most common part of the bone to be fractured is because it is the extensive part of the bone that receives impact when there is trauma.

Adili *et al*.[20] in their work on organ injuries associated with femoral fractures reported that patients with femoral fractures had a higher incidence of organ damage, upper and lower limbs injuries. High frequency of associated injuries found from this study is similar to what was reported from previous studies.[7,21,22] These associated injuries were as a result of high-energy trauma involved in femur fracture. Furthermore, result from this study shows that 81.7% of the associated injuries occurred when road traffic accident was the aetiologic factor of the open femur fracture, and this was so because the high-velocity impact involved in road traffic accidents normally results in multiple injuries, gunshot injuries tend to produce isolated open femur fracture.[3] Anyaehie *et al*.[13] reported 68.3% of associated injuries in their study on femoral fractures, these very high-energy trauma results in significant incidence of associated injuries; therefore, the attending surgeon should always examine these patients thoroughly in other not to miss any of the associated injuries.

Wound debridement is important to make sure that all the contaminants are removed from the wound. Wound debridement was done for all the fractures in this study within the first 24 h. Wound debridement is the most important surgical procedure for open lower limb fractures.[6,19] Seligson and Henry[23] in their study advocated that debridement should be done within 6 h of presentation. However, studies had recently brought the 6 h window into question and found no association between rate of infection and timing of debridement.[24,25] Naique *et al*.[25] compared debridement for open fractures up to 6 h and then between 6 and 24 h and illustrated no difference in infection rates. The new British guidelines had shown that debridement should be performed by senior orthopaedic or plastic surgeons and should be on routine trauma emergency list within 24 h of injury;[26] however, very early intervention should be done if there is gross contamination, devascularisation or compartment syndrome. Griffin *et al*.[27] believed that after the initial debridement that a secondary wound debridement should only be carried out if the soft-tissue damage was unable to be assessed during the first debridement. They also documented that multiple debridements were shown to be associated with poor outcomes. The only patient that had third-look debridement in this study was because the wound was severely contaminated; also some of the devitalised segments of the wound had not separated during the second-look debridement. As open fractures are often high-energy injuries with severe tissue damage, the operation should be performed by someone skilled in dealing with both skeletal and soft tissues; ideally, this will be a joint effort by orthopaedic and plastic surgeons.[28] Our centre has both orthopaedic and plastic surgeons working in the hospital, as a result plastic surgeons input is always easy to access. Most of the patients in this study were comanaged with the plastic team and as a result lots of plastic procedures such as split skin grafting, flap cover and sciatic nerve grafting were done. Two patients had vacuum-assisted closure of their wounds. Early soft-tissue reconstruction had been shown by several authors to result in low infection rates.[29] The soft-tissue reconstruction done in this series were done not <1 week after the injury, the delay may be due to combination of extensive contamination of the wounds and lack of a specific protocol for the management of these fractures. The terminology of "fix and flap" is being recommended for specialist hospitals where the expertise is available but likely to be suited to the local flaps.[23]

Early stabilisation of femur fractures has been shown to improve patients' outcome. Primary reamed intramedullary nailing had been advised to be used for open femur fractures regardless of soft-tissue injury, including Gustilo and Anderson III wounds.[29] Zlowodzki *et al*.[30] in their study show that definitive external fixation of femoral shaft fractures yields reasonable result with non-union rate of 8.5%. They advocated that external fixation of femoral fractures can be used in some countries, because it is cheap. However, it has a common complication of knee stiffness. In this series, majority of the patients had open reduction and internal fixation of their fractures. This shows that most surgeons in this study centre had embraced international standard of internal fixation for open femur fractures. About 33.3% of the patients were managed with traction and cast immobilisation, conservative management of these fractures is common in developing nations, because it is cheap.[4] It takes about 16–24 weeks for closed femur fractures to consolidate; however, complex fractures take slightly longer time, conservative management will lead to complications of prolonged immobilisation like deep vein thrombosis. The mean union time obtained in this study was 24.98 ± 7.83 weeks with union rate of 94.7%, and this is similar to findings by Zlowodzki *et al*. in their series

who reported union time of 26 weeks with union rate of 92.5%. Ikem *et al*.[7] in his study on 12 open femur fractures reported union rate of 17.5 weeks; however, more patients may be required to further validate their result.

The most common complication encountered in this study was wound infection with frequency of 15.7%. Ikem *et al*.[7] in their study recorded infection in 3 out of 12 fractures, but 10 out of the 12 fractures had other complications. Even though the infection rate in this study is high, the fracture union rate is quite high and the overall complication rate was low. Ifesanya *et al*.[4] reported complication rate of 40.3% in their study on open long-bone fractures.

Zlowodzki *et al*.[30] in their study on complex femur fractures recorded average knee range of motion of 72°. This was <97.22° ± 38.30° obtained from this series, and it may be because they used only external fixators for their fractures which predisposes to knee stiffness. Outcome criteria using the Thoresen's criteria showed a combined excellent and good score of 63.3% from our series, poor results were 22.4%. This result most likely was as a result of the complex nature of the fractures, also many of the fractures were managed with conservative methods which predispose to different complications. Ferracini *et al*.[21] had combined excellent and good result of 75.7% from their study on open femur fractures stabilised with plate-screw and interlocking nails. Their combined excellent and good result is higher than what was obtained from this study, and it might be explained by the fact that they used only open reduction and internal fixation method for their fixation which had been shown to give better result with open fractures.

Conclusion

Open femur shaft fracture is fairly common in our environment and occurs more in younger age groups. Open femoral shaft fractures present with high frequency of associated injuries, patients' assessment should be carefully done to find out all these injuries and treat them with the open fractures. The outcome of treatment of open femur fractures in our environment is good despite the limited resources usually encountered in a developing nation like ours.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Rudloff MI. Fractures of the lower extremity. In: Canale ST, Beaty JH, editors. Campbell Operative Orthopaedics. 12th ed., Vol. 3. St. Louis: Mosby; 2013. p. 2702.
2. Nork SE. Fractures of the shaft of femur. In: Rockwood CA, Green DP, Bucholz RW, editors. Rockwood and Green's Fractures in Adults. 6th ed. Philadelphia: Lippincott Williams and Wilkins; 2006. p. 1846-914.
3. Giannoudis PV, Papakostidis C, Roberts C. A review of the management of open fractures of the tibia and femur. J Bone Joint Surg Br 2006;88:281-9.
4. Ifesanya AO, Alonge TO. Operative stabilization of open long bone fractures: A tropical tertiary hospital experience. Niger Med J 2012;53:16-20.
5. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: Retrospective and prospective analyses. J Bone Joint Surg Am 1976;58:453-8.
6. Gustilo RB, Mendoza RM, Williams DN. Problems in the management of type III (severe) open fractures: A new classification of type III open fractures. J Trauma 1984;24:742-6.
7. Ikem IC, Oginni LM, Bamgboye EA. Open fractures of the lower limb in Nigeria. Int Orthop 2001;25:386-8.
8. Dim EM, Ugwuegbulem OA, Ugbeye ME. Adult traumatic femoral shaft fractures: A review of the literature. Ibom Med J 2012;5:26-38.
9. Thoresen BO, Alho A, Ekeland A, Strømsøe K, Follerås G, Haukebø A, *et al.* Interlocking intramedullary nailing in femoral shaft fractures. A report of forty-eight cases. J Bone Joint Surg Am 1985;67:1313-20.
10. Nahm NJ, Vallier HA. Timing of definitive treatment of femoral shaft fractures in patients with multiple injuries: A systematic review of randomized and nonrandomized trials. J Trauma Acute Care Surg 2012;73:1046-63.
11. Smith JS Jr., Martin LF, Young WW, Macioce DP. Do trauma centers improve outcome over non-trauma centers: The evaluation of regional trauma care using discharge abstract data and patient management categories. J Trauma 1990;30:1533-8.
12. Khoury A, Weil Y, Liebergall M, Mosheiff R, Israeli Orthopedic Trauma Group. Outcome of femoral fractures care as a measure of trauma care between level I and level II trauma systems in Israel. Trauma Surg Acute Care Open 2016;1:e000041.
13. Anyaehie UE, Ejimofor OC, Akpuaka FC, Nwadinigwe CU. Pattern of femoral fractures and associated injuries in a Nigerian tertiary trauma centre. Niger J Clin Pract 2015;18:462-6.
14. Clasper JC, Rowley DI. Outcome, following significant delays in initial surgery, of ballistic femoral fractures managed without internal or external fixation. J Bone Joint Surg Br 2009;91:97-101.
15. Katchy AU, Agu TC, Nwankwo OE. Femoral shaft fractures in a regional setting. Niger J Med 2000;9:138-40.
16. Hollis AC, Ebbs SR, Mandari FN. The epidemiology and treatment of femur fractures at a Northern Tanzanian referral centre. Pan Afr Med J 2015;22:338.
17. Yinusa W, Ogirima MO. Extremity gunshot injuries in civilian practice: The national orthopaedic hospital Igbobi experience. West Afr J Med 2000;19:312-6.
18. Magerl F, Wyss A, Brunner CH, Binder W. Plate osteosynthesis of femoral shaft fractures in adults. Clin Orthop Rel Res 1979;138:62-73.
19. Salminen ST, Pihlajamäki HK, Avikainen VJ, Böstman OM. Population based epidemiologic and morphologic study of femoral shaft fractures. Clin Orthop Relat Res 2000;(372):241-9.
20. Adili A, Bhandari M, Lachowski RJ, Kwok DC, Dunlop RB. Organ injuries associated with femoral fractures: Implications for severity of injury in motor vehicle collisions. J Trauma 1999;46:386-91.
21. Ferracini AM, Faloppa F, Daltro G, Crisostomo D Jr., Baldy dos Reis F, Belotti JC. Prospective and randomized study of patients with open fractures of the femoral shaft, treated with plate or open intramedullary locked nail. Acta Orthop Bras 2008;16:102-6.
22. Gustilo RB, Merkow RL, Templeman D. The management of open fractures. J Bone Joint Surg Am 1990;72:299-304.
23. Seligson D, Henry SL. Treatment of compound fractures. Am J Surg 1991;161:693-701.
24. Harley BJ, Beaupre LA, Jones CA, Dulai SK, Weber DW. The effect of time to definitive treatment on the rate of nonunion and infection in open fractures. J Orthop Trauma 2002;16:484-90.
25. Naique SB, Pearse M, Nanchahal J. Management of severe open tibial fractures: The need for combined orthopaedic and plastic surgical treatment in specialist centres. J Bone Joint Surg Br 2006;88:351-7.
26. British Association of Reconstructive and Aesthetic Surgeons. Standards for Treatment of Open Fractures of the Lower Leg. British Association of Reconstructive and Aesthetic Surgeons; 2009.
27. Griffin M, Malahias M, Khan W, Hindocha S. Update on the management of open lower limb fractures. Open Orthop J 2012;6:571-7.

28. Louis S, David W, Selvadurai N. Apley's System of Orthopaedics and Fracture. 9th ed. London: Hodder Arnold, An Hachette UK Company; 2010. p. 706-10.
29. Williams MM, Askins V, Hinkes EW, Zych GA. Primary reamed intramedullary nailing of open femoral shaft fractures. Clin Orthop Relat Res 1995;(318):182-90.
30. Zlowodzki M, Prakash JS, Aggarwal NK. External fixation of complex femoral shaft fractures. Int Orthop 2007;31:409-13.