The etiology and pattern distribution of closed long bone diaphyseal fractures: A prospective survey in a regional trauma center Enugu, Nigeria

Emmanuel Chino Iyidobi,[1] Patrick Livinus Anijunsi,[2] Ugochukwu Enweani,[3] Remigus Tochukwu Ekwunife,[1] Emmanuel Onyekachi Agbo,[1] Uche Sebastine Ozioko[1]

[1]National Orthopaedic Hospital Enugu; [2]Esut Teaching Hospital Parklane Enugu; [3]City Hospital Enugu, Nigeria

Abstract

Extremity injuries have attained a significant position in musculoskeletal trauma. This study aims to describe the pattern of closed long bone diaphyseal fractures in acute trauma setting. A prospective study of patients who presented at the trauma unit of National Orthopaedic Hospital Enugu over a 6months period was undertaken. Sixty two patients with closed long bone diaphyseal fractures of femur, tibia and humerus who consented and met the study inclusion criteria were prospectively included and evaluated. Data was analyzed using the Statistical Package for the Social Sciences version 20. A total of 2880 patients presented during the period of study out of which, 62 (37 males and 25 females) presented with closed long bone diaphyseal fractures giving an incidence of 21.5/1000 trauma unit attendance (and occurring mostly in males 32.1/1000). The 21-30years age group distribution were the mostly affected (35.5%) with closed long bone diaphyseal fracture at presentation. Motor vehicular accident was the leading cause of closed long bone diaphyseal fractures (66.7%) followed by tricycle accident (19.4%) and assault (1.9%), the least. Transverse fractures (40.3%) were the most common fracture pattern followed by the comminuted fracture (27.4%), The anatomic location of fractures in diaphyseal long bones of the humerus, femur and tibia did not show any significant difference ($p<0.05$). With transverse and comminuted fracture being the commonest fracture patterns distribution and motor vehicular accidents the leading cause, these could be of a guide for orthopaedic surgeons to decide on the best interventional approach and to improve functional outcome.

Correspondence: Emmanuel Chino Iyidobi, Head of Clinical Services, National Orthopaedic Hospital Enugu, Nigeria.
E-mail: dreciyidobi@yahoo.com

Key words: Acute trauma; fracture patterns; long bones.

Conflict of interest: The authors declare no conflict of interest.

Availability of data and materials: All data generated or analyzed during this study are included in this published article.

Ethics approval and consent to participate: Ethical Clearance was obtained from Research Training and Education Committee of (RETC) National Orthopaedic Hospital Enugu (S/313/III). The study is conformed with the Helsinki Declaration of 1964, as revised in 2013, concerning human and animal rights. All patients participating in this study signed a written informed consent form for participating in this study.

Informed consent: Written informed consent was obtained from a legally authorized representative(s) for anonymized patient information to be published in this article.

Received for publication: 14 November 2021.
Revision received:14 January 2022.
Accepted for publication: 11 February 2022.

Annals of Clinical and Biomedical Research 2022; 3:175
doi:10.4081/acbr.2022.175

Introduction

Bone fractures constitute major components of musculoskeletal trauma that is of huge public health concern as most of the victims are of the working age group that contributes significantly to the nation's gross domestic product. The global burden of extremity fractures varies with incidence ranging from 3.21 to 22.8/1000 per annum in general population.[1]

There are regional distribution of causes of fractures within countries depending on the demographic profile, socioeconomic factors, and environmental conditions. In countries with little or no traffic regulations, motor vehicular collision remains major external cause of fracture.[2-4]

The type and pattern distribution of diaphyseal long bone fractures is entirely dependent on age, degree of the severity of the injury and involvement of the surrounding tissue.[5,6] It is of note that proper fracture evaluation may assist in identifying the location and number of impact sites, establishing the sequence of blows, determining the nature of the object that inflicted the injuries.[7,8]

The fracture patterns are basically classified into simple fracture, wedge fracture, and complex fracture. These comprise five subtypes, which include transverse, oblique or butterfly, spiral, segmental and comminuted. The inherent features of classifications were based on determination of the stability of the injury, extent of soft tissue involvement, and prognosis for recovery.[9] The diagnosis of long bone fracture involves proper patient assessment armed with the required imaging investigations. This would invariably guide the surgeon on the selection of the appropriate treatment option.[10-12]

The fracture patterns, etiology, and mechanism of injury and demographic characteristics in a defined population could have impact on preventive and treatment outcomes of closed long bone diaphyseal fractures. There is paucity of data in this region, hence this study aims to evaluate the most common causes of closed long bone diaphyseal fractures, the fracture patterns, and the vulnerable age groups of patients presenting at Trauma unit of National Orthopaedic Hospital Enugu South East, Nigeria.

Materials and Methods

Ethical Clearance was obtained from Research Training and Education Committee of (RETC) National Orthopaedic Hospital Enugu

Our work was structured as a prospective study involving 62 patients who presented at Trauma unit of National Orthopaedic Hospital Enugu over a period of six months from January 2021 to June 2021 and met the inclusion criteria.The inclusion criteria were all the closed long bone diaphyseal fractures presenting at Trauma unit within 2weeks of the injury. This included the fracture of the bones of the humerus, tibia, femur while exclusion criteria were open long bone diaphyseal fracture, close long bone diaphyseal fractures presenting at outpatient department with nonunion, delayed union, malunion, pathological fractures and patient with incomplete data. A well-structured data proforma were opened for each patient after obtaining consent. Information collected included patient's demographic (age, gender, occupation), the causes of injury, the involved long bone. Each of the patients underwent clinical evaluationand radiographs of the fractured limb evaluated in two views Anterior-Posterior (AP) and Lateral view (L) and definitive diagnosis of close long bone diaphyseal fracture was made

The fracture patterns which was based on fracture geometry included three broad categories simple fracture (spiral, oblique, transverse), wedge fracture (spiral wedge, bending wedge, fragmented wedge) and complex fracture (spiral, segmental, irregular) were determined. This was based on Muller[13] classification of fractures. Also obtained from the radiograph were anatomic location of the fracture (proximal third, middle third and distal third).

Data were analyzed using the Statistical Package for the Social Sciences version 20 (SPSS Chicago, IL, USA). The level of statistical significance was set at p<0.05.

Results

Within the 6 months period 2880 patients (1152 males and 1728 females) were seen in the trauma unit of the hospital and those that presented with diaphyseal long bone fracture were 62 (25 females and 37 males) giving an incidence of 21.5/1000 trauma unit attendance (32.1/1000 males and 14.5/1000 females trauma unit attendance).

The age range of the patients that were recruited into the study was between 11 to 70 years as shown in Figure 1 The age group 21-30 constitute the highest percentage (35.5%) that presented with closed diaphyseal long bone fractures followed by the age group of 31-40 years (24.2%) while the least were those of the age group 61-70 years (3.2%).

The leading cause of closed long bone diaphyseal fractures in this study was motor vehicular accident 66.7% followed by tricycle accident at 19.4%. However no difference exist between fall and sporting activities which makes up 3.2% respectively while assault constitute the least 1.9% of diaphyseal long bone fractures as shown in Figure 2. The fracture pattern distribution as shown in Figure 3 in this study. Transverse fracture (40.3%), was the most

Table 1. Anatomic location of fractures.

	Femur n	Tibia n	Humerus n
Proximal 3rd	5	0	0
Middle 3rd	20	4	6
Distal 3rd	15	10	2
Total	40	14	8

$\chi^2 = 8.546$, $P = 0.074$.

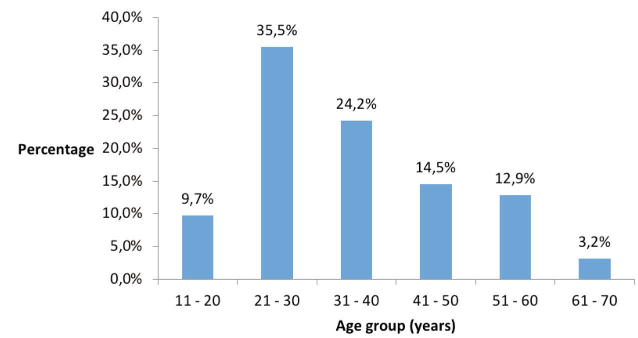

Figure 1. The age group of patients presenting with closed long bone diaphyseal fractures.

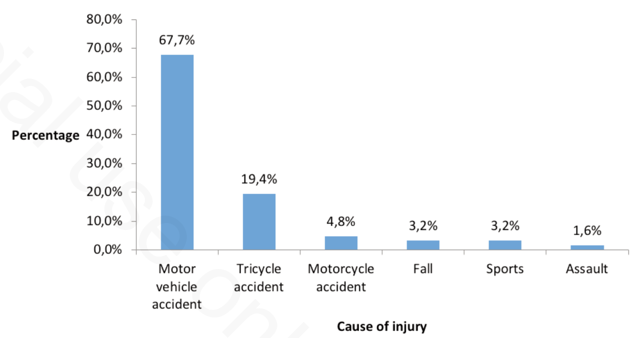

Figure 2. Cause of injury.

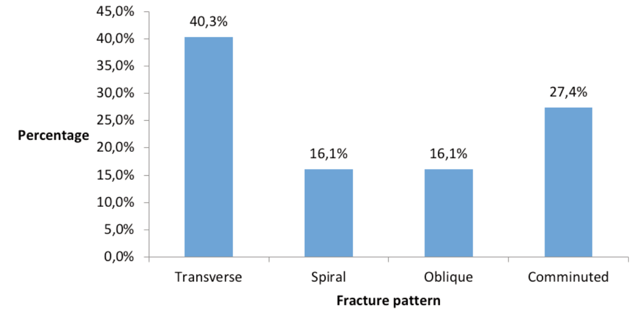

Figure 3. Pattern of fractures.

common representative fracture pattern in diaphyseal long bone fractures followed by the comminuted fracture (27.4%) while the oblique and spiral fracture were at 16.1% respectively.

The anatomical location of closed long bone diaphyseal fracture as shown in Table 1 revealed no significant difference.

There was no statistical difference between the long bones and anatomic locations of the fractures (p=0.074).

Discussion

Trauma surgeons in this region are inundated with the increasing incidence of extremity fractures as revealed in this study with incidence of 21.5/1000. This was in upward trend when compared with 15.98/1000 person-per year in developed countries as reported by Garraway *et al.*[14] This could be attributed to socio-demographic features, Drivers licensing policies, infrastructural outfit in place.

The age and sex distribution of diaphyseal long bone fractures as reported in this study revealed a male preponderance with younger people (21-30 and 31-40 years) being the more vulnerable age group as shown in Figure 1. This is in tandem with the earlier report of Kica and Rosenman[15] that males are more likely to have jobs with higher risk of fracture and occupational hazard at middle age than females. These could explain our findings since males are more likely to be involved in motor vehicular accidents, engage in hazardous sports and are more likely to engage in violent activities. Thus the preponderance of young active segment of the population adds to overall burden of fractures and its socioeconomic implications.

Road traffic injuries contribute significantly to the overall burden of trauma cost. In the present study as shown in Figure 2 motor vehicular, tricycle and motorcycle accident were the leading cause of diaphyseal long bone fractures. This constitutes 91.9% of the cause of closed diaphyseal long bone fractures as shown in this study. There are factors that could influence the amount of force transmitted to the specific anatomical structures which include velocity at impact, timing of impact, configuration of occupants and safety devices.[16,17] Sadly road traffic accidents is an abandoned epidemic in developing countries. The findings in this study also concurs with earlier report Mahdian *et al.*[18] in evaluating the epidemiological profile of extremities fractures do to road traffic accidents in Iran. Thus there is need for purposeful policy driven program aim to curb the menace of the road traffic accidents in this region ranging from providing good road networks with pedestrian pathway, continuous education program for road users, elimination of teenage drivers and driver's license issued after completion of drivers training school certified by the relevant authority.

The fracture patterns revealed in the present study as shown in Figure 3 transverse fractures (40.3%) and comminuted fractures (27.4%) were the most common representative pattern of closed long bone diaphyseal fractures. The magnitude, type and direction of forces dictates fracture pattern to a certain degree. Injury severity is determined by peak forces and moments resulting from the impact and the tissue resistance to injury.[19] This was similar to findings by Ali A *et al.*,[20] Deepak *et al.*,[21] and Yograj *et al.*,[22] in their series reported similar result. This may be probably due to the fact that transverse fractures commonly result from direct force to the bone as it is mostly seen in motor vehicular crashes. Rich *et al.*[23] demonstrated that in bones exposed to moderate to high-velocity impact, the fracture pattern becomes significantly more transverse and comminuted. Thus the fracture pattern distribution influences surgeons therapeutic interventions and treatment outcome. The middle third shaft fractures were most commonly involved in both femur (50%) and humerus (75%) respectively, while distal third shaft fractures were most commonly seen in tibia shaft fractures in the study. In Table 1, as shown in this study, no statistical difference existed in fracture distribution across the proximal, midshaft and distal part of the long bones of humerus, femur and tibia. This was in contrast to the work done by Ikpeme *et al.,*[24] where he recorded maximum numbers of fracture in middle third. Yograj *et al.*[22] reported similar results in their series. The reason why the middle third was the commonest part of the bone to be fractured could be because it is the most exposed part of the bone that receives impact when there is trauma.[12,25]

Conclusions

Closed long bone diaphyseal fractures are frequently encountered in acute trauma setting with the regional demographic characteristics, etiological component and mechanism of injury predicting the fracture patterns. This should guide orthopaedic surgeons on the best interventional approach to improve functional outcome.

References

1. Donaldson LJ, Cook A, Thomson RG. Incidence of fractures in a geographically defined population. J Epidemiol Community Health 1990;44:241-5.
2. Janmohammadi N, Montazeri M, Akbarnezhad E. The epidemiology of extremity fracture in trauma patients of shahidBeheshti hospital Babol 2001-2006. Iran J Emerg Med 2014;1:34-9
3. Awashthi B, Raina SK, Kumar N, et al. Pattern of extremity fractures among patients with musculoskeletal injuries. A hospital based study from North India J Med Soc 2016;30:37-7.
4. Sadat-Ali M, Alomran AS, Al-Sayed HN, et al. Epidemiology of fractures and dislocation among urban communities of Eastern Saudi Arabia. Saudi J Med Med Soc 2015;3:54-7.
5. Chen W, Lv H, Liu S, et al. National incidence of traumatic fractures in China. A retrospective survey of 512187 individuals. Lancet Glob Health 2017;5:e807-17.
6. Sahlin Y. Occurrence of fractures in a defined population: A 1 year study. Injury 1990;21:158-60.
7. Berryman HE, Symes SA. Recognizing gunshot and blunt cranial through fracture interpretation. In: Reichs KJ, Bass WM (Eds). Forensic osteology: Advances in the identification of Human Remains, Charles C. Thomas, Springfield, II. 1998; p. 335.
8. Reichs JK, Forensic Osteology: Advances in the identification of Human Remains, 2nd ed. Charles C. Thomas, Springfield, II. 1998.
9. Wedel VL, Galloway A. Broken Bones: Anthroplogical Analysis of Blunt Force Trauma. Charles C. Thomas Publisher Ltd. 1999.
10. Louis S, David W, Selvadurai N. Apley's System of Orthopaedic and fracture, 9th edition Hodder Arnold, an Hachette UK Company, 2010, p. 687-750.
11. Bucholz RW, Heckman JD, Court-Brown CM. Rockwood and Green's fracture in Adults Volume 1, 6th edition 2006, Lippincott William and Wilkins. 2006, pp. 1846-1914.
12. 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.
13. Müller ME, Nazarian S, Koch P, et al. The Comprehensive Classification of Fractures of Long Bones. New York: Springer-Verlag; 1990.
14. Garraway WM, Stauffer RN, Kurland LT, O' Fallon WM. Limb fractures in a defined population I. Frequency and distribution. Mayo Clinproc 1979;54:701-7.
15. Kica J, Rosenman KD. Surveillance for work-related skull fractures in Michigan. J Safety Res 2014;51;49-56.
16. Siegel JH, Loo G, Dischinger PC, et al. Factors influencing the patterns of injuries and outcomes in car versus car crashes compared to sport utility, van or pick-up truck versus car crashes: crash injury research engineering network study. J Trauma 2001;51975990
17. Chong M, Sochor M, Ipaktchi K, et al. The interaction of 'occupant factors' on the lower extremity fractures in frontal collision of motor vehicle crashes based on a level I trauma center. J Trauma 2001;51:975-990.
18. Mahdian M, Fazel MR, Schat M, et al. Epidemiological profile of extremity fractures and dislocations in road traffic accidents in Kashan, Iran. A glance at the related disabilities. Arch Bone J Surg 2017;5:186-92.
19. Degoede KM, Ashton-Miller JA, Schultz AB. Fall-related upper body injuries in the older adult: a review of the biomechanical issues. J Biomech 2003;36:1043-53.
20. Ali A, Ali S, Ghulam RW, Muhammad SG. Management of Diaphyseal Tibia Fractures with Interlocking SIGN Nail after Open Reduction without using Image Intensifier. Ann Pak Inst Med Sci 2013;9:17-21.
21. Deepak MK, Jain Rajamanya KA, Gandhi PR, et al. Functional Outcome of Diaphyseal Fractures of Femur managed by closed Intramedullary Interlocking nailing in Adults. Ann Afr Med 2012;11:52-7.
22. Yograj MR, Tarun VD, Nirakumar PM, et al. A Study of Management of Tibia Diaphyseal Fractures with intramedullary interlocking nail. A Study of 50 Cases. Int J Orthopaedics Sci 2017;3:297-302.
23. Rich J, Dean DA, Powers RH (eds.). Forensic Medicine of the Lower Extremity: Human identification and trauma analysis of the thigh, leg, and foot. The Humana Press Inc., Totowa, NJ. 2005, p. 1-422.
24. Ikpeme I, Ngin N, Udosen A, et al. External Jig – aided Intramedullary Interlocking Nailing of Diaphyseal Fractures: experience from a tropical developing centre. Int Orthop 2011;35:107-11.
25. Katchy AU, Agu TC, Nwankwo OE. Femoral Shaft Fractures in a Regional Setting. Niger J Med 2000;9:138-140.