

Research Article

Radiographic Evaluation of Femoral Fractures Due to Road Traffic Accidents in Benin City

Blackie, O.H^{1*}, Ogbe, O.C², Odiase, D.E³, Enoghase, R.J⁴, Blackie, F.F⁵, Olukayode, S.B⁶, Iyhobhebhe, V.D⁷

^{1, 2, 7} Department of Anatomy, Faculty of Basic Medical Sciences, College of Medicine, Ambrose Alli University, Ekpoma, Edo State, Nigeria: blackieshot0@gmail.com

^{3, 4, 6} Department of Anatomy, School of Basic Medical Sciences, College of Medical Sciences, University of Benin, Benin-City, Edo State, Nigeria.

⁵ Department of Ear, Nose and Throat, Faculty of Clinical Sciences, Ambrose Alli University, Ekpoma, Edo State, Nigeria.

Corresponding Author: Blackie, O.H

Abstract Femoral fractures resulting from road traffic accidents (RTAs) are a major cause of morbidity in developing countries, particularly among economically active young adults. Despite the increasing rate of RTAs in Nigeria, there is a lack of localized data concerning the radiographic distribution and epidemiological characteristics of femoral fractures. This study provides region-specific baseline data for clinical decision-making and public health interventions. A retrospective descriptive study was conducted using patient case notes and radiographic records of 141 individuals with femoral fractures resulting from RTAs, presented at Erichris Diagnostic Centre, Benin City, between January 2019 and December 2022. Radiographs were evaluated to determine fracture location (proximal, middle, or distal third). Data were analyzed using SPSS version 20, and results were presented using descriptive and inferential statistics. Associations between fracture type, age, and gender were examined using Chi-square tests with significance set at $p < 0.05$. The majority of patients were males (87.2%) and within the 16–30-year age group (72.3%), with a mean age of 31.6 years. The right femur was affected in 55.3% of cases. Middle third femoral shaft fractures were the most prevalent (63.8%), followed by proximal (26.3%) and distal fractures (9.9%). There was no statistically significant association between gender and fracture type ($p > 0.05$) or between age group and fracture type ($p > 0.05$). This study demonstrates a high incidence of middle shaft femoral fractures among young adult males due to RTAs in Benin City. These findings highlight the urgent need for targeted road safety policies, improved trauma care infrastructure, and preventive strategies directed at high-risk groups. The data provided serve as a critical reference for orthopedic management and public health planning.

Received: September 14, 2025

Revised: September 27, 2025

Accepted: October 28, 2025

Published: October 31, 2025

Current Ver.: October 31, 2025



Copyright: © 2025 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY SA) license (<https://creativecommons.org/licenses/by-sa/4.0/>)

Keywords: Benin City; Epidemiology; Femoral Fractures; Radiographic Patterns; Road Traffic Accidents

1. Introduction

Research Object

The femur is the largest and strongest bone in the human body, serving a critical role in locomotion, weight bearing, and stability of the hip and knee joints (Bojsen-Møller *et al.*, 2001; Bolanowski *et al.*, 2005). Its anatomical configuration—from the proximal head articulating with the acetabulum to the distal condyles forming the knee joint—renders it susceptible to severe injury during high-energy trauma such as road traffic accidents (RTAs) (Li and Cole, 2015; Carballido-Gamio and Nicolella, 2013). Femoral fractures, particularly those involving the shaft, constitute a major public health concern as they are often associated with significant morbidity, long-term disability, and increased socioeconomic burden (Reynolds, 2013; Fernandez *et al.*,

2015). Radiographic evaluation plays a pivotal role in diagnosing fracture type, determining treatment strategy, and predicting outcomes.

Previous Studies/Methods

Several studies have employed conventional radiography to assess femoral fractures resulting from trauma due to its accessibility and effectiveness in visualizing bone discontinuity and alignment (Singer *et al.*, 1998; Percival and Richtsmeier, 2013). Other imaging modalities such as magnetic resonance imaging (MRI) and computed tomography (CT) have been utilized to assess associated soft tissue damage and complex fracture configurations (Wagner *et al.*, 2012; Fernandez *et al.*, 2015). Previous research has established that RTAs account for a high proportion of femoral fractures globally, particularly in young adult males (Peden and Scurfield, 2004; Sharma, 2008). The mid-shaft region has consistently been reported as the most frequently fractured site due to the direct impact forces transmitted during vehicular collisions (Singer *et al.*, 1998; Kouris *et al.*, 2012).

Weaknesses and Strengths of Previous Methods

Despite these advancements, most existing studies were conducted in high-income countries and do not adequately reflect fracture epidemiology in low- and middle-income settings where infrastructural deficits, non-compliance with traffic laws, and limited access to emergency care contribute to increased incidence and severity of RTAs (Ciuhodaru *et al.*, 2009; Murray, 2014). Furthermore, previous studies have often focused on general trauma patterns without a specific emphasis on radiographic distribution, anatomical classification, or demographic variations of femoral fractures. While these studies provide global estimates, their applicability to the Nigerian population is limited due to differences in road safety standards, vehicle conditions, and healthcare infrastructure.

Research Problem

The major research problem addressed in this study is the paucity of region-specific data on the radiographic patterns of femoral fractures due to RTAs in Benin City, Nigeria. Limited epidemiological data impedes effective planning for trauma management, prevention strategies, and allocation of healthcare resources. Without locally derived evidence, policymakers and healthcare practitioners face challenges in developing targeted interventions to reduce the burden of RTA-related femoral fractures.

Proposed Solution / Study Aim

This study proposes a retrospective analysis of radiographs and patient case notes to determine the incidence and anatomical distribution of femoral fractures resulting from RTAs in Benin City. By focusing on demographic factors such as age, gender, and anatomical site of fracture, this research offers clinically relevant insight into the burden of femoral fractures within this population.

List of Contributions

1. It provides region-specific data on the incidence and radiographic patterns of femoral fractures due to RTAs in Benin City.
2. It identifies demographic groups at highest risk, particularly young adult males, supporting targeted public health interventions.
3. It classifies femoral fractures based on anatomical site, offering valuable information for clinical decision-making and trauma care planning.
4. It bridges a critical gap in epidemiological knowledge and serves as a foundation for future multicenter studies in Nigeria.

Rest of Paper Structure

The remainder of this paper is organized as follows: Section 2 presents the materials and methods, including research design, sampling procedures, and data analysis techniques. Section 3 outlines the results, focusing on demographic characteristics and fracture distribution. Section 4 discusses the findings in relation to previous studies, while Section 5 provides the conclusion and recommendations for policy and practice.

2. Materials and Methods

Research Design

This study employed a descriptive retrospective research design. Data were retrieved from patient case notes and radiographic reports of individuals diagnosed with femoral fractures resulting from road traffic accidents (RTAs) between January 1, 2019, and December 31, 2022, at

Erichris Diagnostic Centre, Benin City, Edo State, Nigeria. This design was chosen to evaluate existing records and identify patterns in fracture presentation based on radiological evidence.

Study Area

The research was conducted at Erichris Diagnostic Centre, a private medical imaging and diagnostic facility located in Aduwawa, Benin City. The center serves a large population from urban and peri-urban communities, making it a suitable site for epidemiological analysis of trauma-related fractures. Benin City is a major transportation hub with heavy vehicular movement, contributing to a high incidence of RTAs.

Study Population and Sampling Technique

The study population comprised all patients presenting with radiologically confirmed femoral fractures due to RTAs during the four-year study period. A convenience sampling technique was utilized, whereby all eligible cases that met the inclusion criteria were selected.

Inclusion and Exclusion Criteria

Inclusion Criteria:

1. Patients aged 16–60 years.
2. Confirmed femoral fractures resulting specifically from RTAs.
3. Complete radiographic and clinical data available for review.

Exclusion Criteria:

1. Femoral fractures resulting from other causes such as domestic falls, sports injuries, or gunshot wounds.
2. Patients with pre-existing pathological fractures or congenital deformities.
3. Incomplete case records or poor-quality radiographs.

Ethical Considerations

Ethical approval was granted by the Erichris Diagnostic Centre Ethical Committee. Confidentiality was ensured by assigning unique codes to patient records, and no personal identifiers were used. Since data were collected retrospectively, there was no direct patient contact or risk.

Data Collection Procedure

Relevant demographic and clinical information, including age, gender, side of femoral involvement, and anatomical location of the fracture, were extracted from patient records and radiographic reports. Radiographs were reviewed independently, and findings were documented using a standardized data extraction sheet.

Operational Definitions

To ensure clarity and consistency of interpretation, the following operational definitions were applied:

1. **Femoral Fracture:** A complete or partial discontinuity in the femoral bone confirmed through radiographic imaging.
2. **Proximal Femur Fracture:** Fracture involving the femoral head, neck, or intertrochanteric region.
3. **Middle (Shaft) Femur Fracture:** Fracture located in the diaphyseal region, extending between the lesser trochanter and the supracondylar region.
4. **Distal Femur Fracture:** Fracture involving the metaphyseal or condylar regions near the knee joint.
5. **Right or Left Femoral Involvement:** Side of the lower limb affected as documented in radiographic reports.
6. **Road Traffic Accident (RTA):** A collision involving one or more vehicles resulting in injury to a road user, including drivers, passengers, pedestrians, or cyclists, as recorded in the patient's medical report.
7. **Young Adult:** For the purpose of demographic classification, individuals aged 16–30 years were categorized as young adults, in accordance with prior trauma studies.

Radiographic Evaluation and Classification

Standard anteroposterior (AP) and lateral radiographs of the femur were assessed for fracture classification. Fractures were categorized anatomically into proximal, middle, and distal segments based on established radiological criteria (Singer *et al.*, 1998; Reynolds, 2013). Only radiographs with adequate visibility and proper positioning were included.

Data Analysis

Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 20. Descriptive statistics such as frequencies and percentages were used to summarize patient demographics and fracture patterns. Chi-square tests were employed to determine associations between age group, sex, and fracture location. Statistical significance was set at $p < 0.05$.

3. Results

Demographic Characteristics of Patients

A total of 141 radiographically confirmed cases of femoral fractures due to road traffic accidents were included in the analysis. The age range of patients was 16–60 years, with a mean age of 31.6 years. The majority of patients were within the 16–30 years age group (72.3%), followed by 31–45 years (22.0%), and 46–60 years (5.7%). Males accounted for most cases (87.2%), while females constituted 12.8% of the study population, indicating a male-to-female ratio of approximately 7:1. As shown in Table 1, the right femur was more frequently affected (55.3%) compared to the left (44.7%).

Table 1. Demographic Characteristics of Patients with Femoral Fractures.

Variable	n	Percentage (%)
Gender		
Male	123	87.2
Female	18	12.8
Age Group (years)		
16–30	102	72.3
31–45	31	22.0
46–60	8	5.7
Side of Fracture		
Right	78	55.3
Left	63	44.7
Fracture Site		
Proximal	37	26.3
Middle	90	63.8
Distal	14	9.9

Note: n = total number of cases (141).

Distribution of Fracture Types by Gender

As shown in Table 2, middle femoral shaft fractures were the most common in both males (64.2%) and females (61.1%). Proximal fractures accounted for 26.0% of male cases and 27.8% in females, while distal fractures were the least frequent. There was no statistically significant association between gender and fracture type ($p > 0.05$).

Table 2. Distribution of Fracture Types According to Gender.

Gender	Proximal n (%)	Middle n (%)	Distal n (%)	χ^2	p-value
Male	32 (26.0)	79 (64.2)	12 (9.8)		>0.05
Female	5 (27.8)	11 (61.1)	2 (11.1)	0.07	>0.05

Distribution of Fracture Types by Age Group

Age-based analysis revealed that middle shaft fractures were predominant across all age groups. As shown in Table 3, 64.7% of fractures in the 16–30-year group were mid-shaft, similar to 61.3% in the 31–45-year group and 62.5% among patients aged 46–60 years. The association between age group and fracture type was not statistically significant ($p > 0.05$).

Table 3. Distribution of Fracture Types According to Age Group.

Age Group (years)	Proximal n (%)	Middle n (%)	Distal n (%)	χ^2	p-value
16–30	28 (27.5)	66 (64.7)	8 (7.8)		
31–45	7 (22.6)	19 (61.3)	5 (11.1)	1.97	>0.05
46–60	2 (25.0)	5 (62.5)	1 (12.5)		

4. Discussion

Summary of Key Findings

This retrospective study investigated the incidence and radiographic distribution of femoral fractures resulting from road traffic accidents (RTAs) in Benin City. The findings revealed that young adults aged 16–30 years constituted the majority of cases, and males were significantly more affected than females. The right femur was slightly more frequently involved than the left. The most common anatomical site of fracture was the middle third (shaft) of the femur, followed by the proximal and distal regions. Statistical analysis demonstrated no significant association between age or gender and the anatomical site of the fracture. These patterns align with global trauma epidemiology and highlight RTAs as a major contributor to orthopedic injuries in developing regions.

Interpretation and Comparison with Previous Studies

The predominance of males in femoral fractures observed in this study is consistent with previous literature indicating that young adult males are more prone to high-energy trauma due to risky behavior, driving occupation, and greater exposure to road use (Peden and Scurfield, 2004; Sharma, 2008). This demographic pattern has been widely reported in trauma studies and is attributed to increased involvement in commercial driving, motorcycling, and non-adherence to protective measures such as seatbelts and helmets (Murray, 2014). Similarly, Singer *et al.* (1998) reported a higher incidence of mid-shaft femoral fractures among males, reflecting the impact of high-velocity direct trauma.

The anatomical distribution of fractures, with a predominance in the middle femoral shaft, corresponds with findings by Kouris *et al.* (2012), who documented that mid-shaft fractures are more common due to the biomechanical characteristics of the femur and its vulnerability to direct impact during collisions. The mid-shaft region bears significant mechanical stress during vehicular crashes, particularly when the dashboard or vehicle structure impacts the thigh. Prior research also indicates that shaft fractures are typically associated with severe energy transfer, leading to extensive soft tissue damage, consistent with the clinical complexity of such cases (Percival and Richtsmeier, 2013; Fernandez *et al.*, 2015).

The observed absence of significant association between age or gender and fracture site suggests that mechanical forces rather than biological differences are the primary determinants of fracture location. This finding is supported by global trauma literature indicating that the mechanism and intensity of impact are more critical than patient characteristics in determining fracture pattern (Singer *et al.*, 1998). Furthermore, although osteoporosis has been noted as a contributing factor for proximal femoral fractures in older females (Kouris *et al.*, 2012), the younger population distribution in this study may explain the lower proportion of proximal fractures.

The predominance of RTAs as the leading cause of femoral fractures is consistent with global health data identifying RTAs as a top cause of injury-related mortality and disability (Peden and Scurfield, 2004). In low- and middle-income countries such as Nigeria, inadequate road infrastructure, poor enforcement of safety regulations, and limited pre-hospital emergency services exacerbate the burden of RTAs (Sharma, 2008; Murray, 2014). These contextual factors likely contribute to the high incidence of femoral shaft fractures observed in this study.

Clinical and Public Health Implications

The findings of this study have significant clinical and public health implications. Femoral fractures, particularly those involving the shaft, often require surgical intervention, prolonged immobilization, and rehabilitation, imposing a substantial financial burden on affected individuals and healthcare systems. The increased incidence among young adults suggests potential loss of productivity and long-term disability, which may contribute to socioeconomic instability in affected households.

Radiographic data reflecting the predominance of middle shaft fractures underscore the need for trauma centers to be adequately equipped with orthopedic surgical implants, skilled personnel, and rehabilitation services. The findings also highlight the necessity for targeted public health interventions aimed at reducing RTAs through road safety campaigns, law enforcement, and driver education programs. Policymakers must prioritize road safety infrastructure, emergency response systems, and trauma care networks to mitigate the burden of femoral fractures.

Additionally, the high incidence of fractures in males suggests that interventions should particularly target commercial drivers, motorcyclists, and young male road users. Preventive strategies may include mandatory seatbelt use, enforcement of speed limits, and public awareness campaigns emphasizing road safety.

Strengths and Limitations of the Study

A major strength of this study is its focus on locally sourced radiographic data, which provides region-specific evidence relevant for clinical decision-making and public health policy in Nigeria. The four-year retrospective design allowed for the identification of fracture trends over time, enhancing the reliability of findings. The anatomical classification of fractures based on radiographic analysis further strengthens the diagnostic accuracy of the study.

However, several limitations must be acknowledged. First, the study was conducted in a single diagnostic center, which may limit the generalizability of findings to the broader population. Second, the retrospective nature of the study restricted access to additional variables such as mechanism details, vehicle type, speed at impact, and patient outcomes after treatment. Third, the exclusion of fractures from non-traffic-related causes may underestimate the overall burden of femoral fractures in the region. Lastly, the study did not assess the severity of fractures or associated injuries, which could provide further insight into treatment outcomes.

Recommendations for Future Research

Future studies should adopt multicenter designs and include larger sample sizes to improve generalizability. Longitudinal research is recommended to evaluate treatment outcomes, complications, and functional recovery in patients with femoral fractures. Additionally, studies incorporating variables such as use of protective devices, type of vehicle, and road conditions would provide a more comprehensive understanding of risk factors associated with femoral fractures. The development of a regional trauma registry is also recommended to facilitate continuous monitoring of injury patterns and outcomes.

From a policy perspective, this study underscores the urgent need for enhanced road safety regulations, improved emergency medical services, and capacity building in orthopedic trauma care. Further research exploring cost-effective preventive strategies and treatment protocols appropriate for low-resource settings will be critical in addressing the growing public health burden associated with RTAs.

5. Conclusion

This study established that femoral fractures resulting from road traffic accidents are predominantly sustained by young adult males, with the middle third (shaft) region of the femur being the most commonly affected anatomical site. These findings underscore the substantial public health burden of RTAs in Benin City and the high vulnerability of economically active age groups. The absence of a statistically significant association between demographic variables and fracture type suggests that injury mechanisms rather than biological factors are the primary determinants of fracture distribution.

The outcomes of this research contribute valuable region-specific epidemiological data that can support clinical planning, orthopedic resource allocation, and the formulation of targeted road safety interventions. Strengthening trauma care infrastructure and improving emergency response systems are essential steps in reducing the morbidity and disability associated with femoral shaft fractures.

Author Contributions: Conceptualization: Author 1 and Author 2; Methodology: Author 1; Software: Author 3; Validation: Author 1, Author 2, and Author 4; Formal analysis: Author 1; Investigation: Author 1; Resources: Author 3; Data curation: Author 1; Writing—original draft preparation: Author 1; Writing—review and editing: Author 2 and Author 4; Visualization: Author 3; Supervision: Author 5; Project administration: Author 5; Funding acquisition: Author 5.

Funding: This research received no external funding.

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request. Due to institutional privacy and ethical restrictions, the radiographic and clinical records used in this study are not publicly archived.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

- Boese, C., Dargel, J., Oppermann, J., Eysel, P., Scheyerer, M., Bredow, J., & Lechler, P. (2016). The femoral neck-shaft angle on plain radiographs: A systematic review. *Skeletal Radiology*, 45(1), 19–28. <https://doi.org/10.1007/s00256-015-2236-z>
- Bojsen-Møller, F., Simonsen, B., & Tranum-Jensen, J. (2001). *Bevægeapparatets anatomi* [Anatomy of the locomotive apparatus] (12th ed., pp. 239–241).
- Bolanowski, W., Śmiszkiewicz-Skwarska, A., Polguy, M., & Jędrzejewski, S. (2005). The occurrence of the third trochanter and its correlation to certain anthropometric parameters of the human femur. *Folia Morphologica*, 64(3), 168–175.
- Carballido-Gamio, J., & Nicolella, P. (2013). Computational anatomy in the study of bone structure. *Current Osteoporosis Reports*, 11(3), 237–245. <https://doi.org/10.1007/s11914-013-0148-1>
- Ciuhodaru, T., Romedea, S., & Arhipescu, T. (2008). Factors increasing mortality rates in suicide attempts in jail and prison. *Romanian Journal of Legal Medicine*, 17(1), 69–72. <https://doi.org/10.4323/rjlm.2009.69>
- Dobrin, I., Dobrin, N., & Poeata, I. (2011). [Statistical data on head trauma with frontal sinus involvement at the Emergency Hospital Clinic "Prof. Dr. Nicolae Oblu", Iași, Romania]. *Revista Medico-Chirurgicală a Societății de Medici și Naturaliști din Iași*, 115(4), 1131–1136.*
- Fernandez, M., Griffin, X., & Costa, L. (2015). Management of hip fracture. *British Medical Bulletin*, 115(1), 165–172. <https://doi.org/10.1093/bmb/ldv036>
- Kouris, G., Hostiuc, S., & Negoii, I. (2012). Femoral fractures in road traffic accidents. *Revista de Medicina Legală*, 20, 279–282. <https://doi.org/10.4323/rjlm.2012.279>
- Kumar, N. (2016). Pattern of fractures and dislocations in road traffic accident victims in a tertiary care institute of central India. *International Journal of Scientific Research*, 15, 21–23.*
- Li, M., & Cole, P. A. (2015). Anatomical considerations in adult femoral neck fractures: How anatomy influences the treatment issues? *Injury*, 46(3), 453–458. <https://doi.org/10.1016/j.injury.2014.11.017>
- Murray, L. (2014). Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990–2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, 385(9963), 117–171. [https://doi.org/10.1016/S0140-6736\(14\)61682-2](https://doi.org/10.1016/S0140-6736(14)61682-2)
- Peden, M., & Scurfield, R. (2004). *World report on road traffic injury prevention*. World Health Organization.
- Percival, J., & Richtsmeier, T. (2013). Angiogenesis and intramembranous osteogenesis. *Developmental Dynamics*, 242(8), 909–922. <https://doi.org/10.1002/dvdy.23992>
- Reynolds, A. (2013). The fractured femur. *Radiologic Technology*, 84(3), 273–291.*
- Sharma, B. (2008). Road traffic injuries: A major global public health crisis. *Public Health*, 122(12), 1399–1406. <https://doi.org/10.1016/j.puhe.2008.06.009>
- Singer, B., McLauchlan, G., Robinson, C., & Christie, J. (1998). Epidemiology of fractures in 15,000 adults: The influence of age and gender. *Journal of Bone and Joint Surgery (British Volume)*, 80(2), 243–248. <https://doi.org/10.1302/0301-620X.80B2.0800243>
- Sonbol, A., Almulla, A., Hetaimish, B., Taha, W., Mohammedthani, T., Alfraidi, T., & Alrashidi, Y. (2018). Prevalence of femoral shaft fractures and associated injuries among adults after road traffic accidents in a Saudi Arabian trauma center. *Journal of Musculoskeletal Surgery and Research*, 2(2), 62–65. https://doi.org/10.4103/jmsr.jmsr_42_17
- van Arkel, R., Amis, A., & Jeffers, J. (2015). The envelope of passive motion allowed by the capsular ligaments of the hip. *Journal of Biomechanics*, 48(14), 3803–3809. <https://doi.org/10.1016/j.jbiomech.2015.09.002>
- Vos, T. (2015). Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, 386(9995), 743–800.*
- Wagner, F., Negrão, R., Campos, J., Ward, S., Haghghi, P., Trudell, D., & Resnick, D. (2012). Capsular ligaments of the hip: Anatomic, histologic, and positional study in cadaveric specimens with MR arthrography. *Radiology*, 263(1), 189–198. <https://doi.org/10.1148/radiol.12111320>