



Epidemiology and Associated Injuries in Pediatric Femoral Shaft Fracture Treated at a Limited Resource Zonal Referral Hospital in Northern Tanzania

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Abstract

Background: Femoral shaft fractures contribute up to 40% of pediatric orthopedic admissions with the World Health Organization data showing youth are particularly vulnerable and road traffic injuries are the leading cause of death for children and young adults. The mechanism of injury varies with age and geographical location of the patient and involves a variety of mechanisms from falls to road traffic injuries. Understanding the incidence, mechanism and pattern of these injuries allows planning for preventive measures and treatment to meet modern day patient demands, generation of appropriate and timely protocols with minimum social and economic burden to the patient and family.

Objectives and Methods: A hospital based cross sectional study was conducted using the orthopedic department patient registry among children aged less than 18 years admitted from 2014 to 2018. Our research question was to determine the epidemiology of femoral shaft fractures and coexisting associated injuries among admitted pediatric orthopedic patients. Patient files were reviewed from the medical records department and a data collecting sheet was used to record demographics and injury data. Odds ratios with 95% confidence intervals for associated injuries in pediatric femoral shaft fractures were estimated using multivariable logistic regression model.

Results: We found the prevalence of femoral shaft fracture among pediatric orthopedic admissions was 18% with the majority 111 (68.5%) being males. The most common injury mechanism was a fall (57.4%) followed by road traffic injuries with 35.8% of which 48.3% resulted from pedestrian vs. motorcycle accidents. Traumatic Brain Injury (TBI) was the most common associated injuries accounting for 69% of these injuries with the majority 79% occurring in patients aged 6 years and older. When comparing 6 to 12 years and 13 to 18 years age groups to those younger ≤ 2 years, they had 8 and 11 times higher odds for associated injuries (OR=8.25, 95% CI, 1.04 to 65.31) $p=0.046$ and (OR=10.54, 95% CI, 1.26 to 88.31) $p=0.031$ respectively with road traffic related injuries having 17 times higher odds of associated injuries when compared to fall (OR=16.73, 95% CI, 6.28 to 44.57) $p<0.001$. 112 (69.1%) were treated by non-operative method out of this 90 (55.6%) by traction with delayed Spica application. The overall mean duration of hospital stay was 18.5 ± 11 days, ranging from 3 to 68 days.

Conclusion: Pedestrian vs. motorcycle injuries was the leading specific cause of pediatric femoral shaft fractures with TBI being the common associated injury. Non-operative management was the most utilized treatment plan and contributed to ten times higher odds for a longer duration of hospital stay. Initiatives to insure children safety on roads should be strengthened in order to reduce/eliminate this burden. Application and practice of current evidence based clinical guidelines and a recommendation is paramount for timely and appropriate treatment of these injuries.

Keywords: Orthopedic injuries; Childhood; Fracture; Femur

Introduction

The World Health Organization (WHO) endorses injury as the leading cause of morbidity and mortality in children after their first year of life [1]. Femoral shaft fractures account for up to 40% of pediatric orthopedic admissions in low and middle income countries [2]. The mechanism of injury for these fractures vary with patient age; falls from standing height or playground equipment are more in younger children while high energy injuries are more commonly seen in adolescents and older children [2,3]. Recent studies report the significant rise in Road Traffic Injuries (RTI) as the

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major cause of these fractures [3-5].

Associated bodily injuries are common in children that sustain a femoral shaft fracture. High energy injury mechanisms increase the risk of associated injuries; and the presence of an associated injury portends a two-fold increase in the hospital Length of Stay (LOS) irrespective of the treatment modality employed [6-8]. Understanding the mechanism of injury and the resulting pattern of pediatric femoral fractures is essential to determine the risk of associated injuries among children. Currently, limited information is available regarding the magnitude and trends of this clinical scenario in sub-Saharan Africa.

We conducted a retrospective audit of over five years to determine the mechanism of injury of pediatric femoral shaft fractures and associated injuries at a zonal referral-teaching hospital in northern Tanzania. Our research question was to determine the prevalence of femoral shaft fractures and coexisting associated injuries among admitted pediatric orthopedic patients. Defining the magnitude of this problem will be a platform for initiating preventive measures, planning interventions and allocating resources to deliver the best evidence-based patient care [9-11].

Material and Methods

The institutional review Ethical and Research Committee approved the study with certificate number 2333. We performed a retrospective, cross-sectional study of all pediatric orthopedic patients with femoral shaft fractures from January 2014 to December 2018 admitted to the Orthopedic ward at a zonal referral teaching hospital in northern Tanzania. Located in Moshi district-Tanzania, it is the third largest hospital in the country with 700 official inpatient beds often stretched to accommodate about 100 to 150 more patients on canvas beds as it serves the country's northern corridor with an estimated catchment population of 15 million people per the national census data [12]. The Orthopedic ward admission registry was reviewed for all patients admitted during the study review period. All patients aged 18 years and younger were identified by their diagnosis and further classified by name and file identification number if diagnosed with a femur fracture. Files for patients with a femur fracture were retrieved from the medical records department and were sub-categorized based on fracture location and type of fracture (pathological versus traumatic). All patients with incomplete data were excluded from the study.

A standardized data extraction form was designed to record all demographic and pertinent injury data including age and gender of the patient, admission date, injury mechanisms, site of the fracture, type of associated injury, fracture type, fracture location, treatment type and duration of hospital stay. Collected data were processed and analyzed using SPSS (Statistical Package for Social Sciences) software version 22 (IBM Corp., Armonk, NY, USA). Frequencies, percentages, mean and median were calculated and summarized by narration, frequency tables, histograms and pie charts. Multivariate analysis and Fisher exact tests were computed to determine the risk factors for associated injuries and their corresponding 95% confidence intervals were also calculated. A P-value less than 0.05 were considered statistically significant.

Results

Over the study period, a total of 1,092 pediatric patients were admitted to the orthopedic ward of which 192 (17.6%) were diagnosed with a femoral shaft fracture. Of this group, 162 (84.4%) femoral shaft

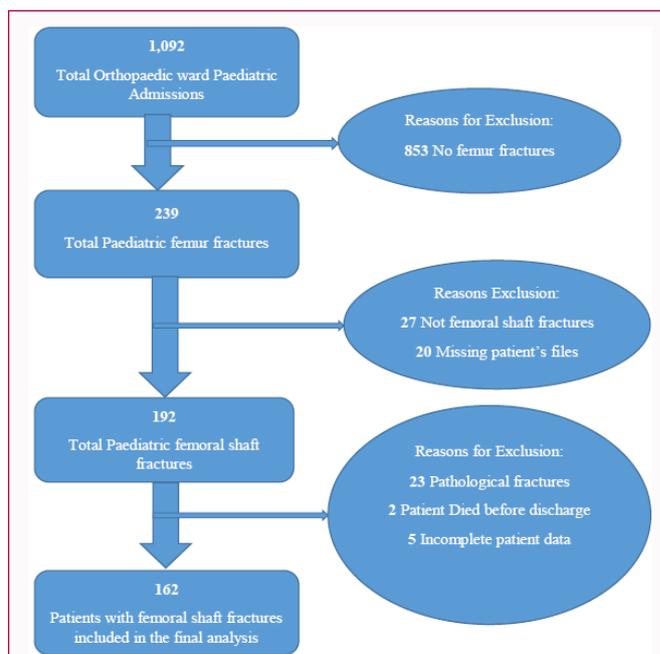


Figure 1: Femoral shaft fractures recruitment flowchart.

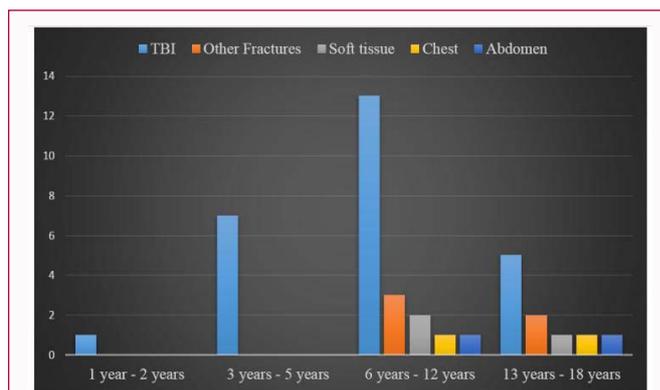


Figure 2: Distribution of associated injuries across different age categories (n=38).

fractures met the inclusion criteria to be in the final patient cohort for analysis, resulting in a femoral shaft fracture prevalence of 18% (Figure 1).

Of this cohort, the median age was eight years and 72 patients (44.4%) were aged between 6 to 12 years. Most fractures were seen in males 111 (68.5%) with more than half of the patients being primary school children. In addition, one-hundred forty-four (88.9%) patients had no health insurance, and 64 patients (39.5%) had fractures that occurred while along the road-side (Table 1).

Most femur fractures were closed 156 (96.3%). Eighty fractures (49.4%) were mid-shaft femur fractures with a transverse fracture being the most common pattern. Skeletal traction was the most frequent inpatient fracture immobilization method observed. 69.1% of patients were treated Non-operatively with 104 (65.4%) having longer than two weeks length of hospital stay (Table 2).

All children under one-year of age sustained a femoral shaft fracture from a fall at heights less than 2 meters. Toddlers (1 to 2 years) had most of their fractures result from falls of less than 2 meters followed by falling objects as the second most common mechanism

Table 1: Patient Demographics (n=162).

Characteristics	N	%
Median Age in years (IQR)	8 (4-12)	
Age category in years		
<1	3	1.9
1-2	21	13
3-5	31	19
6-12	72	44
13-18	35	22
Sex		
Male	111	69
Female	51	32
Level of Education		
Preschool	36	22
Kindergarten	22	14
Primary	86	53
Secondary	18	11
Insurance status		
Insured	18	11
Not insured	144	89
Location at time of injury		
Home	54	33
School	13	8
Road	64	40
Public playground	18	11
Other	13	8

Table 2: Patient Injury Characteristics (n= 162).

Characteristics	N	%
Fracture type		
Closed	156	96
Open	6	3.7
Fracture location		
Proximal	50	31
Middle	80	49
Distal	32	20
Side of femur fracture		
Right	85	53
Left	72	44
Both	5	3.1
Fracture pattern		
Transverse	79	49
Oblique	36	22
Spiral	33	20
Comminuted	14	8.6
Type of traction		
Skin	53	33
Skeletal	109	67
Treatment Type		

Non Operative	112	69
Operative	50	31
Length Of Hospital Stay		
≤ 7 Days	22	14
8 Days to 14 Days	34	21
14>	106	65

Table 3: Mechanism of Injury of Paediatric Femoral Shaft Fractures by Age (n=162).

Mechanism of Injury	Age Categories in Years					N	%	
	<1	1-2	3-5	6-12	13 - 18			
Fall								
≤ 2 m	Running	0	6	5	4	3	18	11.1
	Playground	0	2	2	8	8	20	12.3
	Furniture	3	6	3	4	0	16	9.9
	Other	0	1	5	7	3	16	9.9
>2 m	Tree	0	0	0	16	7	23	14.2
RTI								
Pedestrian MCA	0	2	10	12	4	28	17.3	
Pedestrian MVA	0	0	0	11	1	12	7.4	
Pillion* MCA	0	0	3	3	4	10	6.2	
Passenger MVA	0	0	1	2	5	8	4.9	
Falling Objects								
Gate/Doors/walls	0	1	1	2	0	4	2.5	
Other objects	0	3	1	3	0	7	4.3	

(*) - Pillion refers to a patient was carried on a motorcycle at the time of injury
MCA: Motorcycle Accident; MVA: Motor Vehicle Accident

of injury. Fractures resulting from RTIs were predominantly seen in older children, the 6 to 12 years and 13 to 18 years of age categories, respectively. There were a significant number of children aged within 3 to 5 years age group whom sustained femoral shaft fractures as a pedestrian vs. a Motorcycle Accident (MCA). Pedestrian RTIs was the leading mechanism of injury for this cohort of pediatric femoral shaft fractures (Table 3).

A total of 38 (23.5%) femoral shaft fracture patients presented with associated injuries, with traumatic brain injury (TBI) seen in 26 (69%) patients in this group; and was the most common associated injury across all age groups. Most associated injuries were seen in the 6 to 12 year-old group. Combined TBI, abdominal injury and femur fracture (Waddell’s triad) was present in three (8%) patients with associated injuries (Figure 2). Children in the older age categories were more at risk of an associated injury compared to younger children. When comparing the age categories, the 6 to 12 year-old and the 13 to 18 year-old groups had 8 and 11 times higher odds for associated injuries, respectively. Females were 18% more likely to sustain associated injuries, although this was not statistically significant (p=0.679). Patients with an open fracture had statistically significant more associated injuries (p<0.001), while having a spiral fracture was protective against an associated injury. Children with fractures because of a RTI exhibited 17 times higher odds of associated injuries compared to a fall (Table 4).

Discussion

Prevalence

The prevalence of femoral shaft fractures among pediatric

Table 4: Risk Factors for Femoral Shaft Fracture Associated Injuries (n=162).

Risk Factor	Associated injuries		OR (95% CI)	p-value
	Yes n (%)	Total n (%)		
Age (years)				
≤ 2	1 (2.6)	24 (14.8)	1	
3 to 5	7 (18.4)	31 (19.1)	6.71 (0.76 - 58.87)	0.086
6 to 12	19 (50.0)	72 (44.4)	8.25 (1.04 - 65.31)	0.046
13 to 18	11 (28.9)	35 (21.6)	10.54 (1.26 - 88.31)	0.031
Sex				
Male	25 (65.8)	111 (68.5)	1	
Female	13 (34.2)	51 (31.5)	1.18 (0.54 - 2.55)	0.679
Fracture type*				
Closed	32 (84.2)	156 (96.3)	-	
Open	6 (15.8)	6 (3.7)	-	<0.001
Fracture pattern				
Transverse	23 (60.5)	79 (48.8)	1	
Oblique	8 (21.1)	36 (22.2)	0.69 (0.27 - 1.75)	0.441
Spiral	2 (5.3)	33 (20.4)	0.16 (0.03 - 0.71)	0.016
Comminuted	5 (13.2)	14 (8.6)	1.35 (0.41 - 4.47)	0.621
Injury Mechanism				
Falling	6 (15.8)	93 (57.4)	1	
RTI	30 (78.9)	58 (35.8)	16.73 (6.28 - 44.57)	<0.001
Falling objects	2 (5.3)	11 (6.8)	2.64 (0.47 - 14.71)	0.269

* Fisher's exact test

CI: Confidence Interval; OR: Odds Ratio; RTI: Road Traffic Injuries

orthopedic admissions in this study was 18%. This prevalence conforms to the reported Sub-Saharan prevalence observed in hospital-based studies conducted in Nigeria, Cameroon and Uganda which reported 10%, 16% and 22%, respectively [13-15].

Studies showing a lower prevalence of pediatric femoral shaft fractures in the literature [4,16,17], were population based retrospective studies in Europe and America and had a prevalence of 1.7% to 5%. The large difference in patient cohort size when comparing hospital-based and population-based studies could explain this discrepancy. Our hospital-based study might underestimate the true pediatric femoral shaft fracture prevalence for the region as some patients are missed due to treatment at other facilities or have sought treatment with a traditional bone setter.

We also found that males were more likely to sustain a femoral shaft fracture, as they represented 111 (68.5%) patients in the cohort with a M:F ratio of 2.2:1. Our findings are similar to previous studies that showed male patients accounting for 62% to 73% of femur fracture patients [2,5,18]. This result reflects the typical high risk behavior exhibited by boys in Tanzanian society and requires an aggressive preventive strategy for this subset of the population.

Mechanism of injury

In our study, the most common injury mechanism was a fall accounting for 57.4% (93) of all fractures and nearly half of these falls were in children in their home environment. Earlier studies also demonstrated falls as a common mechanism of injury [6,14,15,19]. We found that most falls were from trees (25%, 23), while other studies have documented that most occurred during playground activities

[18,19]. Regional variation in childhood recreational activities in addition to the habit of harvesting fruits and firewood from trees which is observed in our society might explain this difference.

Akinyoola et al. [8], from Nigeria and Mughal et al. [2], in South Africa reported RTI as the most common mechanism of injury throughout Sub-Saharan Africa [2,8]. We found that RTIs resulting from a pedestrian vs. MCA was the most common mechanism for sustaining a femoral shaft fracture accounting for 17.3% of overall childhood femoral shaft fractures. The absence of adequate infrastructure, poor traffic regulations and a lack of adult supervision most likely results in a higher risk of sustaining these injuries in the pediatric population. Child education on road safety and implementation of road safety rules is paramount to prevent a continued rise in the prevalence of fractures.

Our data did not demonstrate the expected variation in the mechanism of injury across age groups. Other studies have shown a transition from falls to RTI as the major mechanism when shifting from younger to older children. Socio-economic activities in our region that involve tree climbing attribute the overrepresentation of falls from a height [18,19]. In addition, 54 (33%) of the femur fractures in our study occurred at home which poses a challenge as children are considered safe while at home due to theoretical adult supervision. This necessitates a need for public health interventions to further understand the risk, design appropriate family level education and prevent these injuries in the future.

Associated injuries

We found a 23.5% prevalence of femur fracture associated injuries that agree with other published studies, demonstrating a prevalence ranging from 28.6% in the USA to 36% in New Zealand [6,7]. Being older than 6 years and being female increased the odds of sustaining an associated injury that is similar to findings reported in the literature [6,7]. Older children are more likely to sustain a high energy injury mechanism, either a RTI or a fall from a height above 2 meters, which explains the predisposition to these associated injuries.

TBI was the most common associated injury in our patient cohort. Other studies have reported that other long-bone fractures are the most common associated injury followed by TBI. The use of helmets and protective equipment during contact or motorized sports which is mandated and paid attention to it in Western countries partly contribute to this. Sports related falls were the most common mechanism of sustaining a femur fracture in these other studies, while our study saw a higher incidence of RTI with pedestrian vs. MCA (17.3%) [16,20].

Fractures resulting from RTIs had an increased risk of having an associated injury that is similar to other studies in the literature [2,17]. RTI also increased the risk of Waddell's triad, which was 3 (8%) of those with associated injuries in this study, similar to that seen in Nigeria (8.7%) but significantly lower than seen in the USA (25.5%) [6,8]. Understanding this association is critical in determining patient care requirements from the injury scene all the way until definitive hospital treatment as some associated injuries are life threatening if missed.

Limitations and Strength

This study being retrospective could not control for the quality of the information found in the patient files and this resulted in 25 (13%) of femoral shaft fractures being excluded from the study. The

study established baseline data in pediatric femoral shaft fractures at our centre, which will help improve the management of these injuries.

Recommendations

Childhood femoral shaft fractures address a crucial component in children health and safety as these injuries often times are a result of high energy trauma as in this study pedestrian MCA and falling from trees were the top two leading specific mechanisms of injury, respectively. The need for a population-based study exists to obtain a better understanding of this phenomenon, as other children continue to be treated at different facilities or traditional bone setters. More emphasis on road safety measures for drivers and pedestrians is critical as RTI attributed to most those with associated injuries and was the second leading cause of pediatric femoral shaft fractures.

Conclusion

Falls contributed to most femoral shaft fractures sustained in our cohort of pediatric patients, but pedestrian versus MCA was the leading mechanism of injury followed by falling from trees. The 18% femoral shaft fractures prevalence in our settings correlates with injury burden observed in other hospital-based studies within the region. TBI was the most common associated injury with RTI injuries contributing to the majority of them. It was established that being over the age of 6 years and being female increased the odds of having an associated injury.

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