Original Article

Prevalence of Femoral Shaft Fracture and Associated Injuries among Children after Road Traffic Accidents in a Saudi Arabian Trauma Center

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Abstract

Objectives: Femoral shaft fractures (FSFs) comprise approximately 1.6% of all bony injuries in children. The aim of this paper is to elaborate on the prevalence of FSFs and injuries associated with them in children after road traffic accidents (RTA). **Methods:** A retrospective review study was conducted in a trauma center in Almadinah Almunawwarah, Saudi Arabia. It evaluated FSFs in children under 16 years of age admitted under the care of orthopedics from November 2011 to October 2016. The data were analyzed using the statistical analysis system software package. **Results:** Data of 206 patients have met the inclusion criteria. The prevalence of injuries associated with FSFs after RTAs in children was 29.1%, whereas isolated FSFs were 70.9%. The average age was 6.9 ± 4.1 (1–15) years. The majority of cases were males (75.9%). The nonskeletal injuries represented 27.6% of the total cases; of these injuries, head injuries comprised 16%, chest 6.7%, abdomen 2.9%, and pelvic injuries 2%. **Conclusions:** Findings indicate the high prevalence of injuries associated with FSFs secondary to RTAs in children who were treated in this trauma center. Trauma response teams should look for the common associated injuries and manage them early.

Keywords: Associated injuries, children, femoral shaft fracture, pediatric, prevalence, road traffic accidents, Saudi Arabia, trauma

Introduction

Femoral shaft fractures (FSFs) represent the most common pediatric orthopedic injury that requires hospitalization and comprises approximately 1.6% of all bone injuries in children.[1-6] They are mostly secondary to severe trauma from road traffic accidents (RTAs) and falls from height.[1,2,7,8] Older children and adolescents most commonly sustain fractures from high-energy events, and nearly 90% of FSFs in older children result from RTAs.[1]

In most countries, trauma is a major cause of mortality and morbidity among children aged 0–15 years and bears a significant impact on healthcare expenses.[5,7] According to the World Health Organization, although the precise number of children injured or disabled each year as a result of RTAs remains unknown, it is estimated to be roughly ten million.[1] More then a fifth (21%) of children injuries resulting from RTA's that been treated in an emergency department were skeletal injuries.[1]

A systematic review of road safety and RTAs in Saudi Arabia showed that the rate of nonfatal RTAs is greatest among 10–19 year olds.[9] Moreover, the review's audit of RTAs during a 1-year period revealed that 16% of victims were <10 years old and that 47% were 11–30 years old. The audit identified Almadinah Almunawwarah region as one of the areas with high rates of RTAs in the country.[9]

Awareness of injuries associated with FSFs can help emergency physicians and orthopedic surgeons to actively identify such injuries, rapidly obtain accurate diagnoses of any additional injuries, and thereby improve patients' outcomes and reduce

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Received : 03-01-2018 **Revised :** 22-01-2018
Accepted : 13-02-2018 **Published Online :** 20-04-2018

How to cite this article: Mohmmedthani TS, Alfraidi TA, Sonbol AM, Almulla AA, Hetaimish BM, Alrashidi YA. Prevalence of femoral shaft fracture and associated injuries among children after road traffic accidents in a Saudi Arabian trauma center. J Musculoskelet Surg Res 2018;2:66-9.

Access this article online

Quick Response Code:

Website: www.journalmsr.com

DOI: 10.4103/jmsr.jmsr_2_18

medical expenses.[5] To the best of the authors' knowledge, no researchers have investigated injuries associated with FSFs in children in Saudi Arabia, though a similar study was done in adults.[10] In response, the aim of the study reported here was to elaborate on the prevalence of FSFs following RTAs and their associated injuries at a trauma center in Almadinah Almunawwarah, Saudi Arabia.

Materials and Methods

A retrospective review conducted at a trauma center in Almadinah Almunawwarah, Saudi Arabia, involved the evaluation of FSFs among young patients (0–16 years old) admitted under the care of orthopedics from November 2011 to October 2016. Ethical approval was obtained from the Institutional Review Board of the General Directorate of Health Affairs in Almadinah Almunawwarah.

The inclusion criteria for the study were the age <16 years, involvement in an RTA that caused FSF, and admission under the care of orthopedics regardless of the treatment plan (i.e., surgical vs. nonsurgical). Patients were excluded from the study if they had sustained injuries not resulting from an RTA (e.g., falls and sports injuries), had pathological fractures, or were over 16 years of age. As per protocol of this center, all pediatric patients who sustained an FSF were admitted.

Data were obtained from the electronic medical records and radiology system reports at the hospital; it also included demographic information regarding each patient, as well as his/her age at the time of injury, and information about associated injuries (i.e., skeletal or nonskeletal).

Data were analyzed using SAS software (SAS Institute Inc. Proprietary Software Release 8.2. Cary, NC, SAS Institute Inc., 1999), and characteristics of data were tabulated and presented in terms of frequency and percentage or in terms of mean ± standard deviation, if not both. A comparison of fracture sites by mean age was performed by using an independent *t*-test, whereas a comparison of fracture sites by gender was performed by Fisher's exact test. $P \leq 0.05$ was interpreted as statistically significant difference.

Results

Ultimately, 206 patients met the inclusion criteria. The sociodemographic characteristics according to gender and age are as shown in Table 1. The average age was 6.9 ± 4.1 (1–15) years, and most (72.5%) cases were <10 years of age. Most cases were males (75.9%).

Nonskeletal injuries represented 27.6% of all cases, of which 16.0% were head injuries, 6.7% were chest injuries, 2.9% were abdominal injuries, and 2.0% were pelvic injuries [Table 2]. No statistically significant differences emerged when male and female cases with nonskeletal injuries were compared. Females did not show associated pelvic injuries, and luckily neither males nor females showed any associated spinal cord injuries.

Table 1: Sociodemographic features of the studied children (*n*=206)

Items	*n* (%)
Gender	
Male	154 (74.8)
Female	52 (25.2)
Age in years; mean±SD (range)	6.9±4.1 (1-15)
Age in categories	
<10 years	149 (72.3)
10 years or more	57 (27.7)

SD: Standard deviation

An analysis of associated nonskeletal injuries in the sample by case age revealed that injuries were more significant children aged 10 years or older, a quarter of whom (24.6%) presented with head injuries [Table 2].

By contrast, associated skeletal injuries characterized only 8.7% of the sample [Table 3]. Associated skeletal injuries among male and female cases were not only comparatively uncommon in the sample but also showed no statistically significant differences. Neither male nor female cases with skeletal injuries had a hand, elbow, or ankle injuries, and female patients showed no associated vertebral or foot injuries, either.

Skeletal injuries were more common among cases aged 10 years and older than the younger age group. Results for associated forearm injuries were significantly higher in cases aged 10 years and older than below years old (5.3% vs. 0.7%). However, associated clavicle injuries were more prevalent among cases aged <10 years though not to a statistically significant level ($P = 0.75$), Table 3.

Associated lower limb fractures represented 13.5% of the total associated injuries; 8.0% of them were bilateral femoral fractures, 0.5% were fractures at the neck of the femur, 0.5% were distal femoral fractures, 4.0% were tibial fractures, and 0.5% were patellar fractures.

No statistically significant difference was detected regarding associated lower limb fractures between males and females in the sample although bilateral femoral fractures (11.5%) and tibial fractures (5.7%) were more common among females. However, no associated femoral neck, distal femoral, and patellar fractures emerged among females, and only one case of patellar fracture emerged among males [Table 4]. With the exception of bilateral femoral and tibial fractures, patients who were <10 years old did not show associated lower limb fractures. Bilateral femoral fractures were more prevalent, albeit not significantly, among children aged 10 years or more (12.3% vs. 6.7%), whereas tibial fractures were more common among younger children (4.0% vs. 3.5%), although not to a statistically significant level [Table 4].

Out of the study population, the isolated FSFs represented (146) 70.9%, while FSFs with associated injuries represented (60) 29.1%.

Table 2: Nonskeletal injuries among the studied children by their gender and age groups

Nonskeletal injuries	Male (*n*=154), *n* (%)	Female (*n*=52), *n* (%)	*P*	<10 years (*n*=149), *n* (%)	10 years or more (*n*=57), *n* (%)	*P*
Head	24 (15.6)	9 (17.5)	0.77	19 (12.8)	14 (24.6)	0.03*
Chest	10 (6.5)	4 (7.7)	0.76	6 (4.0)	8 (14.0)	0.01*
Abdomen	5 (3.3)	1 (2.0)	0.62	1 (0.7)	5 (8.7)	0.002*
Pelvis	4 (2.6)	0	0.57	1 (0.7)	3 (5.3)	0.03*

*Significant

Table 3: Skeletal injuries among the studied children according to their gender and age groups

Skeletal injuries	Male (*n*=154), *n* (%)	Female (*n*=52), *n* (%)	*P*	<10 years (*n*=149), *n* (%)	10 years or more (*n*=57), *n* (%)	*P*
Vertebrae	4 (2.6)	0	0.57	2 (1.3)	2 (3.5)	0.30
Forearm	3 (2.0)	1 (1.9)	0.99	1 (0.7)	3 (5.3)	0.03*
Humerus	3 (1.9)	2 (3.8)	0.60	2 (1.3)	2 (3.5)	0.30
Shoulder	1 (0.7)	0	0.56	0	1 (1.8)	0.10
Clavicle	2 (1.3)	1 (1.9)	0.75	2 (1.3)	1 (1.9)	0.75
Foot	1 (0.7)	0	0.56	0	1 (1.8)	0.10

*Significant

Table 4: Associated lower limb fracture among the studied children by gender and age groups

Adjacent bone fracture	Male (*n*=154), *n* (%)	Female (*n*=52), *n* (%)	*P*	<10 years (*n*=149), *n* (%)	10 years or more (*n*=57), *n* (%)	*P*
Bilateral femur	11 (7.1)	6 (11.5)	0.38	10 (6.7)	7 (12.3)	0.25
Neck of femur	1 (0.7)	0	0.56	0	1 (1.8)	0.27
Distal femur	1 (0.7)	0	0.56	0	1 (1.8)	0.27
Tabia	5 (3.3)	3 (5.7)	0.42	6 (4.0)	2 (3.5)	0.86
Patella	1 (0.7)	0	0.56	0	1 (1.8)	0.27

Discussion

The prevalence of isolated FSFs resulting from RTAs in the pediatric population in our trauma center was significantly higher than the prevalence of FSFs with associated injuries. Such finding correlates well with the results of Hunter JB, who reported that unlike adult FSFs, which are commonly associated with other injuries, children suffer more from isolated femoral shaft injuries.[11] Another study found that most children have presented with isolated FSFs (74.0%–77.1%), with only 22 out of 96 (22.9%) of their patients had one or more injuries associated with the fractures.[3] In other studies, the prevalence of injuries associated with FSF in children was 20% and 28%.[5,11] Although several injuries associated with FSF's were noticed in our study, not all were common. There were no spinal cord, hand, elbow, or ankle injuries that surfaced in the study sample.

The results indicate that most injuries associated with FSFs among children occurred in males (74.8%) with a male:female ratio of 3:1. The predominance of such injuries among males correlates with the findings of several reported studies.[5,7,9,11,12] Most FSFs in the current study occurred among children younger than 10 years (72.3%), which correlates with the findings from Qatar, in which children aged 5–9 years old comprised the largest group (44.5%) of children with FSFs, followed by 10–16 year olds (36.7%) and 1–4 year olds (18.8%).[7]

In the study sample, skeletal and nonskeletal injuries associated with FSFs were significantly more common in children aged 10 years or older. Results were significant for associated forearm fractures in that group (5.3% vs. 0.7%). Such results align with the findings of Rewers *et al*. that older children face a nearly 3-fold more risk for injuries associated with FSFs than children aged 2–5 years.[5] That bimodal age distribution for such injuries among children is consistent with the results of other studies as well.[5,13] The age distribution could be secondary to the effect of the progressive increase in bone strength during development. In early childhood, the femur is relatively weak and breaks under low-energy load conditions that can result from falls from low heights. In adolescence, high-velocity trauma is required to overcome bone stress resistance before fracture.[14]

Head trauma was the most common injury (16.0%) associated with FSFs in our sample, followed by bilateral femoral fractures (8.0%), chest injuries (6.7%), tibial fractures (4%), and abdominal injuries (2.9%). These results align to some extent with the findings of a survey conducted by the World Health Organization on 13–15 year olds in 26 countries who

had sustained injuries due to RTAs, which showed that 10% of them had sustained a minor head injury and 37% had sustained a fractured limb.[1]

Caldwell *et al*. found that out of 267 patients, only two (0.7%) had an associated femoral neck fracture.[15] Their results were nearly similar to the finding of the current study, namely that out of 206 cases, only one (0.5%) showed an associated neck of the femur fracture. Such finding highlights the lower rate of femoral neck fractures in association with FSFs among younger patients, which could be related to their skeletal immaturity.[15]

These findings suggest a peculiar pattern of injuries associated with FSFs in children, as corroborated by a recent study showing that most injuries occurred in the head and neck (29.7%), followed by the lower limb (15.3%), chest (12.6%), and abdomen (11.7%).[12] This correlates with another study findings that identified the prevalence of Waddell's triad femoral fracture, intraabdominal or intrathoracic injury, and head injury to be 25.5%, which the authors linked to a higher mortality rate among children who had suffered from these type of injuries.[5] This finding emphasizes the importance of the early recognition of such associated injuries and the value of tertiary survey to avoid missing these injuries.

Among the study's limitations, are it's retrospective nature of collecting patient's data from previously documented clinical and radiological reports, which could have exposed the results to selection or recall bias.

Furthermore, because the causes of such injuries are preventable, our data regarding the prevalence of FSFs and its associated injuries can help starting preventive measures for accidents and thus decrease their financial and social impacts.

Based on the findings, the tertiary survey and frequent assessment of children who have suffered FSFs due to RTAs are recommended. Future studies should pay close attention to the duration of follow-up and identify clinical guidelines or protocols for additional clinical and radiological evaluations of possible injuries associated with FSFs, for such evidence of concomitant injuries is relevant yet could be overlooked or detected too late for preventing further substantial complications.

Conclusions

Our findings indicate the high prevalence of injuries associated with FSFs secondary to RTAs in the pediatric population of Almadinah Almunawwarah, Saudi Arabia that were treated in this trauma center, mainly in head, chest, abdomen, and other limbs. Trauma response teams should look for such associated injuries early on and manage them to prevent undesired consequences, while orthopedic teams should be vigilance and prepared to treat children with FSFs due to RTAs as a polytraumatized patient with multiple injuries.

Acknowledgment

We would like to express our gratitude for Prof Khalid Khoshhal Pediatric Orthopaedic consultant, Taibah University, for his expert advice revision and support throughout the writing of this article.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Authors contributions

TSM, TAA, AMS, and AAA have conceived and designed the study, conducted research, provided research materials, collected and organized data, and analyzed and interpreted data. All authors wrote initial and final draft of the article and provided logistic support. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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