



ELSEVIER

Femoral fractures in children related to motor vehicle injuries

Abdulbari Bener PhD, FFPH, FRSS (Fulltime professor, Consultant and Head of Department)^{a,b,*}, David Justham PhD (Senior Lecturer)^c, Abdulaziz Azhar MD, FRCS (Senior Consultant)^d, Martin Rysavy MD (Consultant)^e, Fatima Hamad Al-Mulla BSc (Acting Head of Physiotherapy Department)^f

^a Department of Medical Statistics and Epidemiology, Hamad General Hospital, Hamad Medical Corporation, Weill Cornell Medical College Qatar, P.O. Box 3050, Doha, Qatar

^b Department Evidence for Population Health Unit, School of Epidemiology and Health Sciences, University of Manchester, United Kingdom

^c School of Nursing, University of Nottingham, United Kingdom

^d Department of Accident Emergency, Hamad General Hospital, Qatar

^e Department of Orthopaedics, Hamad General Hospital, Qatar

^f Department of Physiotherapy and Rehabilitations, Hamad General Hospital, Qatar

KEYWORDS

Epidemiology;
Children;
Femur fractures;
Motor vehicle injuries;
Trauma;
Qatar

Summary The aim of this study is to determine the incidence of injuries in children aged from 1 to 16 years old who sustain a femoral fracture associated with a motor vehicle accident in the State of Qatar. It is a retrospective descriptive case series study conducted in the Accident Emergency Department at the Hamad General Hospital, State of Qatar, from January 1992 to December 2004. A total of 256 subjects aged 1–16 years with femoral fractures, secondary to a motor vehicle accidents were studied. All of them were seen at the Accident Emergency Department (AED), Critical Care, and Physiotherapy Departments of the Hospital. The socio-demographic information and the details of the injury of the studied subjects were collected.

Of the 256 children, 82% of them were boys and 18% were girls with a male to female ratio of 4.6:1. Most femoral fractures were secondary to automobile-pedestrian accidents (43.4%), followed by motor vehicle crashes (30.1%). Of the 256 fractured femurs, 38 were open (15%) and 218 were closed (85%). Two hundred and ninety-eight associated injuries occurred in 240 patients (93.8%). Non-femoral fractures were common (46.6%), followed by soft-tissue injuries (21.5%)

* Corresponding author. Address: Department of Medical Statistics and Epidemiology, Hamad General Hospital, Hamad Medical Corporation, Weill Cornell Medical College Qatar, P.O. Box 3050, Doha, Qatar. Tel.: +974 439 3765; fax: +974 439 3769.

E-mail address: abener@hmc.org.qa (A. Bener).

and head injuries (14.4%). The lower limbs were most commonly involved with associated fractures (38.1%), followed by upper limbs (27.4%) and soft-tissue injuries (21.4%). The incidence of intra-abdominal injury was 5.4%. Ninety children (35.2%) developed 1 or more complications. Furthermore, there was a statistically significant correlation between the duration of hospital stay and the fracture site ($r = 0.820$, $p = 0.01$), and between age ($r = 0.295$, $p = 0.01$) and type of injury ($r = 0.241$, $p = 0.01$). The study revealed that the fracture of the femur secondary to motor vehicle accidents is a common injury among children in Qatar. There was an increased incidence of lower and upper limb injuries associated with femoral fracture in children involved in motor vehicle injuries. One third of the children developed one or more complications. Complications of injuries influenced the length of stay in hospital.

© 2007 Elsevier Ltd. All rights reserved.

Editor's comments

To look at data from motor vehicle injuries is often sobering, but when children form the main focus it becomes more so. This descriptive but enlightening study demonstrates clearly the threat to life that road traffic imposes. **PD**

Introduction

Accidents and injuries are a large and growing public health problem, although our knowledge of their epidemiology is inadequate (Bener et al., 1998; Mohan and Romer, 1991). Trauma is a prominent cause of death among children aged 0–15 years in most countries. Statistics on mortality resulting from accidents or injuries by age and sex are available for most developed and developing countries. Some of this information has been presented by the World Health Organization (Mohan and Romer, 1991) and in United Arab Emirates (Bener et al., 1998; Bener et al., 1997) and in the State of Qatar (Bener, 2005). Data on morbidity resulting from accidents is far less satisfactory. A system for registration of accidents is unavailable in most countries, even in industrialized ones (Bener et al., 1998).

Over the past 2 decades, the number of musculoskeletal injuries sustained by children and adolescents has increased markedly (Bener et al., 1997; Bener et al., 1998; Jawadi and Letts, 2003; Huurman and Ginsburg, 1997). A contributing factor is undoubtedly an increasing use by children of motorized, high-speed vehicles such as snowmobiles, all-terrain vehicles, cycles and motorcycles (Jawadi and Letts, 2003).

A femoral shaft fracture in children is usually a result of severe trauma secondary to motor vehicle accidents, falls from high places, and other high-energy trauma (Jawadi and Letts, 2003; Mackenzie, 1994; Beaty, 1995; Hedlund and Lindgren, 1986). Fractures of the femur in children are associated with considerable morbidity and significant mortality, primarily from other injuries (Taylor et al.,

1994a; Newton and Mubarak, 1994). Studies concerning injuries associated with femoral fractures caused by motor vehicles injuries have been rarely reported in children (Jawadi and Letts, 2003). The aim of this study is to determine the incidence of injuries in children aged from 1 to 16 years old who sustain a femoral fracture associated with a motor vehicle accident with particular attention to the effect on morbidity and patient outcomes in the State of Qatar.

Subjects and methods

This is a retrospective case series study that includes all injuries and the frequency of femur fractures associated with motor vehicle injuries among children aged 1–16 years during the period from 1992 to 2004 in the State of Qatar. The study was based on a review of medical records, and did not require Ethical Committee approval. Local policy requires only those studies which are prospective such as drug trials, or based on case reports, or include invasive examinations or require blood samples, urine samples, MRI and radiological examinations, to obtain Ethical Committee approval.

The total medical charts of 256 patients with femoral fractures, secondary to motor vehicle injuries, were reviewed. The study was based at Hamad General Hospital where the patients visited the Accident Emergency Department (AED), Critical Care, and Physiotherapy Departments of the Hospital. Hamad General Hospital is the main tertiary care centre in the country and all trauma cases are treated in this hospital. Data were

obtained from the Medical Records Department, and from the records of the ward, intensive care unit and operating theatre. The medical records comprised the following variables and factors: date of birth (age), sex, nationality, date of admission, arrival time, type of injury, mechanism of injury, fracture site, associated injury, complications, follow-up course, date of discharge, length of hospitalization and outcome of treatment. Inclusion criteria consisted of the following: Children aged 1–16 years at the time of injury, femoral fracture due to motor vehicle injuries, and no history of underlying bone disease or conditions that predispose to femoral fracture such as bone cyst, cerebral palsy and spina bifida.

Student-*t* test was used to ascertain the significance of differences between mean values of two continuous variables. Chi-square and Fisher exact test (two-tailed) was performed to test for differences in proportions of categorical variables between two or more groups. One Way Analysis of variance (ANOVA) was performed for comparison of several group means. Pearson correlation was used to test for associations between variables. The level $p < 0.05$ was considered as the cut-off value for significance.

Results

During the period (1992–2004), a total of 256 children aged 1–16 years with femoral fractures were studied. More than half of the studied children were non-Qataris (51.6%). Of the total children, 82% of them were boys and 18% were girls with a male to female ratio of 4.6:1. The mean \pm SD age of the studied population was 9.3 ± 3.6 . Forty four and a half percent of children were aged 5–9 years old and comprised the largest group with femoral fractures, followed by 10–16 years (36.7%) and 1–4 years (18.8%). Overall, the average length of stay of the patients had a mean (SD) of 21.6 days (9.3); (range 1–91 days). Of the 256 fractured femurs, 38 were open (15%) and 218 were closed (85%). 139 children (54.3%) had follow up treatment for more than 2 years and the rest of them had only minor injuries.

Table 1 shows the site of the fracture. Of the 256 fractured femurs, 145 were on the left leg (56.7%) and 111 were on the right leg (43.3%). Of all the fractured femurs, 147 occurred in the middle third of the shaft (57.4%), 33 were in the proximal third (12.9%), 16 were at the neck (6.3%), 38 were at the lower third (14.8%), and 22 were condyles (8.6%). Furthermore, there was a statistically significant correlation between the duration of hos-

Table 1 Sites of fractures

Fracture site	No. of fractures (%) <i>n</i> = 256
Neck	16 (6.3)
Upper third	33 (12.9)
Middle	147 (57.4)
Lower	38 (14.8)
Condyles	22 (8.6)

pital stay and the fracture site ($r = 0.820$, $p = 0.01$), and between age ($r = 0.295$, $p = 0.01$) and type of injury ($r = 0.241$, $p = 0.01$).

Table 2 gives the mechanism of the injury. Most femoral fractures were secondary to automobile-pedestrian accidents (43.4%), followed by motor vehicle crashes (30.1%). The incidence of injuries from accidents involving motorcycles (10.9%) and all-terrain vehicles (10.9%) were similar. Likewise, injuries arising from skidoo (2.7%) and motorboat (2.0%) contributed a similar proportion of the total.

Table 3 presents the treatment of the femoral fracture. Most of the femoral fractures were treated conservatively (56.3%). Of these, the most common method of treatment was the use of skin traction and spica, and was used in 85 of the 144 children. Whereas 43.7% of the children needed operative treatment, with the insertion of a flexible intramedullary nail being the method of choice in 58 of the 112 children. The differences between ages of conservative vs. operative treatment was highly significant ($p = 0.008$) with younger children more likely to be treated conservatively. Length of hospitalization did not show any significant differences. Both age in years and length of stay in days are examples of parametric or continuous data, and are therefore suitable for analysis using a *t*-test.

Table 4 shows the associated injuries. The 298 associated injuries occurred in 240 of the 256 children (93.8%), while the other 16 (6.3%) sustained

Table 2 Mechanisms of injury

Type of accident	No. of injured (%) <i>n</i> = 256
Pedestrian hit by motor vehicle	111 (43.4)
Passenger in motor vehicle	63 (24.6)
<i>Other types of vehicles</i>	
Motorcycles	28 (10.9)
Bicycles	14 (5.5)
All-terrain vehicle	28 (10.9)
Skidoo	7 (2.7)
Motorboat	5 (2.0)

Table 3 Treatment of the femoral fracture

Mode of treatments	No. treated (%) <i>n</i> = 256
<i>Conservative treatment</i>	
Age in years (Mean \pm SD)	8.7 \pm 3.0
Length of hospitalization (days) (Mean \pm SD)	21.5 \pm 10.9
Skin traction and spica	85 (33.2)
Skeletal traction and spica	43 (16.8)
Closed reduction and spica	16 (6.3)
Total	144 (56.3)
<i>Operative treatment</i>	
Age in years (Mean \pm SD)	9.9 \pm 4.2
Length of hospitalization (days) (Mean \pm SD)	22.2 \pm 13.5
Flexible intramedullary nail	58 (22.7)
Open reduction and internal Fixation	31 (12.1)
Closed reduction and pinning	9 (3.5)
External fixation	8 (3.1)
Rigid intramedullary nail	6 (2.3)
Total	112 (43.7)

Comparison of age in conservative v age in operative treatment *t*-test = 2.666, *p* = 0.008 (very significant).

Table 4 Associated injuries

Type of injury	No. of injuries (%) ^a <i>n</i> = 298
<i>Fractures</i>	
Skull	16 (5.4)
Mandible	5 (1.7)
C-spine	10 (3.4)
Pelvis	17 (5.7)
Upper limb	38 (12.8)
Lower limb (non femoral)	53 (17.8)
Total non-femoral fractures	139 (46.6)
Intra-abdominal	16 (5.4)
Genitourinary system	14 (4.7)
Chest	22 (7.4)
Head	43 (14.4)
Soft-tissue laceration/abrasion	64 (21.5)

Data from charts of 256 patients femoral fractures secondary to motor vehicle accident reviewed at a major tertiary Hamad General Hospital between January 1992 and December 2004.

^a Percentage is calculated out of the total number of injuries 298.

an isolated femoral fracture Most notable was the incidence of non-femoral fractures being 139 (46.6%) of all the associated injuries. The lower limbs were the most common site for a second fracture accounting for 38.1% (53 of all 139), followed by upper limbs (27.4%). Soft-tissue injuries

accounted for 21.5% (*n* = 64) of the associated injuries, and was the second most common injury after associated fractures. Head injury was the third most-common associated injury (14.4%) but the most serious. The incidence of intra-abdominal injury was 5.4% (*n* = 16) of the associated injuries.

Discussion

Fractures of the femur in children are relatively common injuries (Beaty, 1995; Hedlund and Lindgren, 1986; Nafei et al., 1992). Motor vehicle collisions and automobile-pedestrian accidents are the most common mechanisms of injury for all fractures (Buckley et al., 1994; Taylor et al., 1994b). In the current study, we examined the associated injuries and the influence on the femoral fracture in children due to motor vehicle accidents. The ratio of male to female patients in this study is consistent with the general finding that boys predominate in childhood injuries (Bener et al., 1997; Hedlund and Lindgren, 1986; Newton and Mubarak, 1994; Hinton et al., 1999). Nafei et al. (1992) stated that motor vehicle-pedestrian accidents and accidents involving motor vehicle occupants are the leading causes of death of children between the ages of 6–9 and 14–17 years, respectively. There were 5 deaths in our study from motor vehicle-pedestrian accidents; the cause of death for all was head injury, resulting in a mortality rate of 1.9%.

Few studies have confirmed the high incidence of the associated injuries with femoral fracture (Bener et al., 1997; Hurman and Ginsburg, 1997). There were 43 head injuries (16.8%). Most associated injuries were non-femoral fractures (46.6%). Lower limb fractures (38.1%) were the most common associated fractures in this study, followed by the upper limb fractures (27.4%). Complications of the associated injuries were encountered most frequently in patients with head injuries and reported continuing complications at follow-up were hemi paresis 5 (2.0%), spastic 2 (0.8%), migraine 5 (2.0%), poor memory 1 (0.4%) and learning difficulties 4 (1.6%).

In the present study, most femoral fractures were secondary to automobile-pedestrian accidents (43.4%), followed by motor vehicle crashes (30.1%). This is consistent with the previous reported studies (Jawadi and Letts, 2003; Beaty, 1995). The risk for femoral shaft fracture caused by motor vehicle crashes was considerably higher in children than we have found in adults (Bener et al., 1997; Bener et al., 1998; Hedlund and Lindgren, 1986). Most children with femoral fracture need to be admitted to the hospital.

Conclusion

This study revealed that the fracture of the femur secondary to motor vehicle accidents is the most common injury in children in Qatar. There was an increased incidence of lower and upper limb injuries associated with femoral fracture in children involved in motor vehicle injuries. Most of the cases had multiple complications that influenced the length of stay in hospital.

References

- Beaty, J., 1995. Femoral shaft fractures in children and adolescents. *Journal of American Academy of Orthopedic Surgery* 3, 207–217.
- Bener, A., Al-Rufaie, O.F., Al-Suwaidi, N.K., 1997. Pediatric injuries in Arab Gulf Country. *Injury Prevention* 3, 224–226.
- Bener, A., Al-Salman, K.M., Pugh, R.N.H., 1998. Accident mortality and morbidity among children in a desert country. *European Journal of Epidemiology* 14, 175–178.
- Bener, A., 2005. The neglected epidemic: road traffic accidents in a developing country, State of Qatar. *Injury Control and Safety Promotion* 12, 45–47.
- Buckley, S.L., Gostchall, C., Robertson Jr., W., et al., 1994. The relationships of skeletal injuries with trauma score, injury severity score, length of hospital stay, hospital charges, and mortality in children admitted to a regional pediatric trauma center. *Journal of Pediatric Orthopedics* 14, 449–453.
- Hedlund, R., Lindgren, U., 1986. The incidence of femoral shaft fractures in children and adolescents. *Journal of Pediatric Orthopedics* 6, 47–50.
- Hinton, R.Y., Lincoln, A., Crockett, M.M., 1999. Fractures of the femoral shaft in children. *The Journal of Bone and Joint Surgery America* 81, 500–509.
- Huurman, W., Ginsburg, G., 1997. Musculoskeletal injury in children. *Pediatrics in Review* 18, 429–440.
- Jawadi, A.H., Letts, M., 2003. Injuries associated with fracture of the femur secondary to motor vehicle accidents in children. *The American Journal of Orthopedic Surgery* 32, 459–462.
- MacKenzie, W.G., 1994. Fractures of the femoral shaft. In: Letts, R.M. (Ed.), *Management of Pediatric Fractures*. Churchill Livingstone, New York, pp. 539–558.
- Mohan, D., Romer, C.J., 1991. Mortality and morbidity in developing countries. In: Manciaux, M., Romer, C.J. (Eds.), *Accidents in Childhood and Adolescent: The role of Research*. World Health Organization & INSERM, Geneva, pp. 31–38.
- Nafei, A., Teichert, G., Mikkelsen, S.S., Hvid, I., 1992. Femoral shaft fractures in children: an epidemiological study in a Danish urban population, 1977–86. *Journal of Pediatric Orthopedics* 12, 499–502.
- Newton, P.O., Mubarak, S.J., 1994. Financial aspects of femoral shaft fracture treatment in children and adolescents. *Journal of Pediatric Orthopedics* 14, 508–512.
- Taylor, M., Banerjee, B., Alpar, E., 1994a. Injuries associated with a fractured shaft of the femur. *Injury* 25, 185–187.
- Taylor, M.T., Banerjee, B., Alpar, E.K., 1994b. The epidemiology of fractured femurs and the effect of these factors on outcome. *Injury* 25, 641–644.

Available online at www.sciencedirect.com

