

Paediatric Femoral Fractures – The Royal Belfast Hospital for Sick Children Experience

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INTRODUCTION

Trauma is a leading cause of morbidity and mortality in children.¹ Only acute infections cause more morbidity than trauma in childhood.²

Although femoral fractures account for less than 2% of all orthopaedic injuries in children,³ they have a significant impact not only on the patient and their family network, but also on regional trauma resources.^{4,5}

The aim of this study was therefore to obtain baseline epidemiological data and evaluate the management of patients admitted with a femoral fracture to the Royal Belfast Hospital for Sick Children (RBHSC) fracture unit. We present and discuss our findings.

PATIENTS AND METHODS

We reviewed the charts and radiographs of all admissions to the RBHSC with a femoral fracture over a 12 month period.

From the charts, the following general data was recorded for each patient: age, gender, affected side(s), referring accident and emergency department, month of admission, relevant orthopaedic history and duration of inpatient stay. Specific to the femoral fracture the following data was recorded: mechanism of injury, associated injuries, whether the fracture was open or closed, the presence of neurovascular complications, initial management, transfusion requirements, definitive treatment and secondary interventions e.g. re-manipulations or revision of fixation.

From the radiographs, the site of the fracture was classified as proximal (portion superior to the distal aspect of the lesser trochanter), distal (distal femoral metaphysis, physis and epiphysis) or mid-shaft

(section between the proximal and distal femur). The duration of time to fracture union was estimated from the date of the initial femoral radiograph taken at the time of injury to the first radiograph demonstrating evidence of bony union.

RESULTS

Over the 12 month period, 43 patients were admitted to the RBHSC with a femoral fracture. One child sustained a fracture of both femurs during the period of the study but at different times. There was one case of bilateral femoral injuries. This therefore equated to a total of 44 admissions (45 femoral fractures) treated during the time frame of the study. The right femur was affected in 18 cases, the left in 27 cases.

There were 33 male and 11 female admissions (ratio- 3:1). Overall age ranged from 5 days - 13 years (average, 4.7 years). For males, age ranged from 5 days - 13 years (average, 5.1 years) whilst for females the average age was 3.7 years (range, 4

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months–12 years). The number of males and females in each age group are summarised in Table 1.

TABLE I

<i>Gender breakdown for each age group</i>		
<i>Age Group</i>	<i>Number of males</i>	<i>Number of females</i>
0-5	16 (48.5%)	7 (63.6%)
5-9	13 (39.4%)	3 (27.3%)
9-13	4 (12.1%)	1 (9.1%)

Nineteen admissions (43%) were via the RBHSC accident and emergency department (Table 2). Twenty-two admissions (50%) resulted from trauma due to falling. Road traffic accidents (pedestrian versus motor vehicle) and direct trauma accounted for 15 (34%) and 4 cases (9%) respectively. The remaining three cases were caused by a variety of modes of injury (Figure 1). Table 3 summarises the mechanism of injury for males and females in each age group.

Figure 2 demonstrates the observed seasonal variation of femoral fracture admissions. A peak was found in the spring and summer months, April through August, accounting for 59% of the total admissions. When comparing the mechanism of injury to the month of admission, 15 of the Spring/Summer admissions were due to traffic trauma (58%) compared to only 4 (22%) of those in Autumn/Winter.

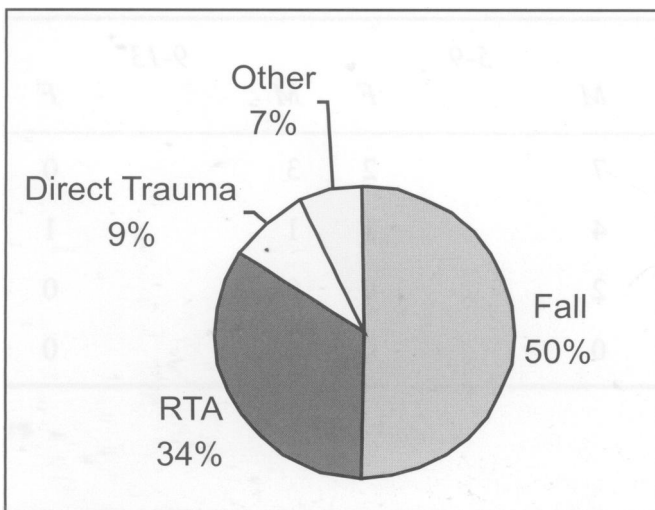


Fig 1. mechanism of injury for femoral fracture.

Table II

Referring accident and emergency departments to the RBHSC fracture unit

<i>Accident & Emergency Department</i>	<i>Number of Patients</i>
Royal Belfast Hospital for Sick Children	9
Antrim Area Hospital	7
Craigavon Area Hospital	5
Daisy Hill Hospital	4
Downe Hospital	2
Mid-Ulster Hospital	2
Mater Infirmorum Hospital	1
Lagan Valley Hospital	1
Whiteabbey Hospital	1
Coleraine Hospital	1
Letterkenny General Hospital	1

Trauma due to falling was more common in the Autumn/Winter months (50% compared to 35% for Spring/Summer). When considering gender, there was no marked difference between the number of males and females admitted during the Autumn/Winter and the Spring/Summer months (72% males, 27% females and 77% males, 23% females respectively). However, the average age for the Autumn/Winter admissions was 3.8 years compared to 6.3 years for the Spring/Summer group.

On evaluating the injury radiographs, 25 fractures affected the mid-shaft portion of the femur with the distal and proximal regions of the femur being involved in 14 and 6 fractures respectively. Table 4 summarises the site of fracture when compared to age and mechanism of injury.

Five patients had additional injuries including an open fracture of the contralateral tibia, a closed fracture of the ipsilateral tibia, a fracture of the ipsilateral clavicle and scalp haematoma, a fracture of the contralateral distal radius and a basal fracture of the contralateral femoral neck. In four of the cases the mechanism of injury was due to a pedestrian

Fig 2. Seasonal variation in femoral fracture admissions.

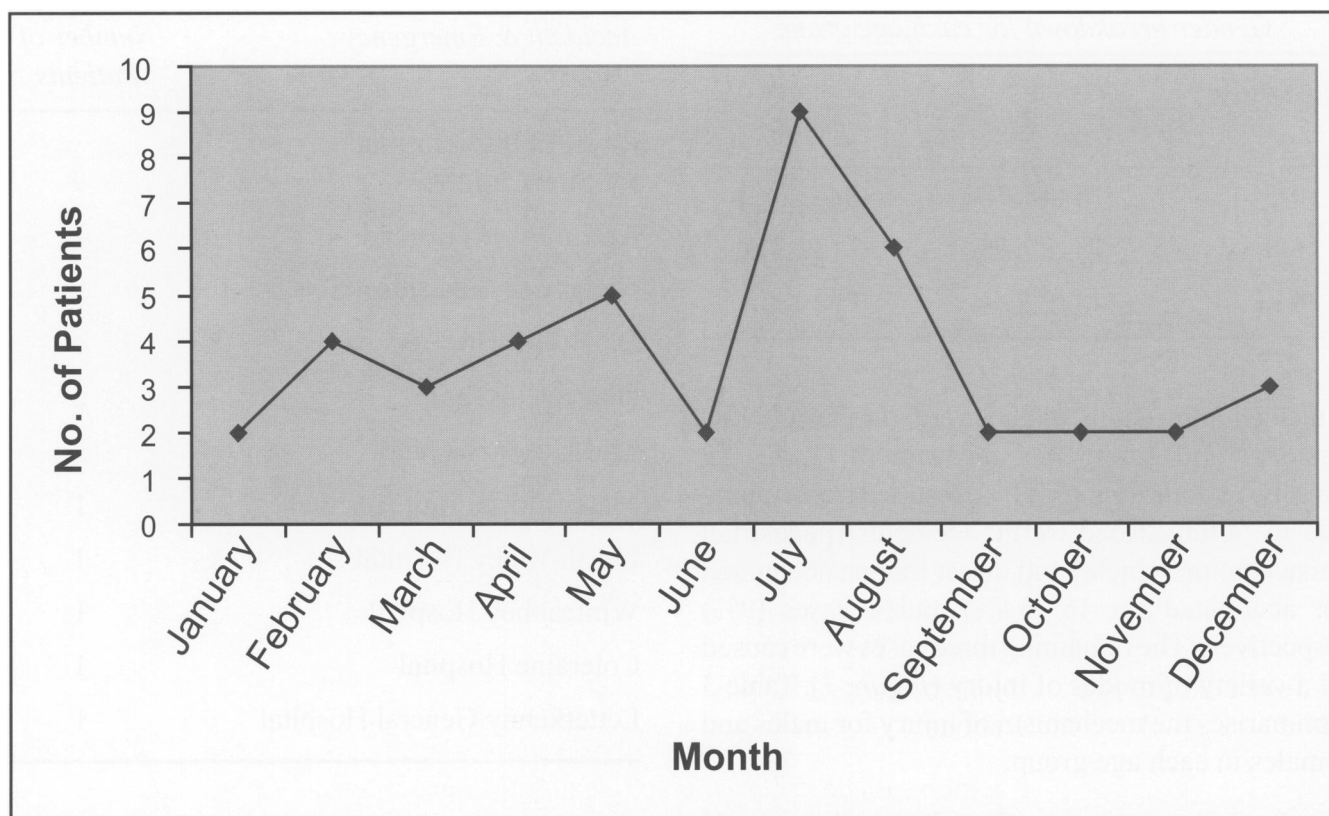


TABLE III

Mechanism of injury versus gender for each age group

<i>Mechanism of injury</i>	<i>0-5 years</i>		<i>5-9</i>		<i>9-13</i>	
	<i>M</i>	<i>F</i>	<i>M</i>	<i>F</i>	<i>M</i>	<i>F</i>
RTA	2	1	7	2	3	0
Fall	10	5	4	1	1	1
Direct trauma	1	1	2	0	0	0
Other	3	0	0	0	0	0

TABLE IV

Site of fracture compared to patient age and mechanism of injury

<i>Site of Fracture</i>	<i>Age</i>	<i>Mechanism of injury</i>
Distal	4 months - 13years, 6years	RTA 7 Fall 3 Direct trauma 3 Other 1
Midshaft	5 days - 13years, 3.5 years	RTA 5 Fall 17 Direct trauma 1 Other 2
Proximal	5 - 12years, 7.8 years	RTA 4 Fall 2

versus automobile road traffic accident (RTA). The remaining case was due to a fall from a height. There was only one open femoral fracture in the study population (2.3%). None of the patients had any neurovascular complications.

Two cases had associated orthopaedic conditions, which may have contributed to their femoral fracture. In one case, a subtrochanteric fracture occurred through a multicameral bone cyst. In the other case, a child with severe spina bifida and bilateral talipes equinovarus sustained a mid-shaft fracture of the right femur and a mid-shaft fracture of the left femur at the age of five days and four months respectively.

Initial management of the femoral fracture included the application of a Thomas splint,²⁶ Gallows traction,⁹ long-leg cast,⁶ skeletal traction,¹ skin traction,¹ closed reduction and percutaneous wiring¹ and insertion of flexible femoral nails.¹ Table 5 summarises the methods used for the definitive management of the femoral fracture.

Of the 45 femoral fractures 11 (24%), were treated by operative management. Time to theatre ranged from 0 - 4 days (average, 1.3 days). No operative complications were encountered. None of the patients required the transfusion of blood products.

For those treated in hip spica, the mean time to application of spica was 9.8 days (range, 2 - 21 days). Three patients returned to theatre for change

of hip spica due to loss of fracture alignment (one patient returned twice).

The average inpatient stay in the acute fracture unit was 9 days (range, 1 - 38 days). Nine children were transferred to the Children's ward in Musgrave Park Hospital for further rehabilitation.

Estimated time to union was on average 3 months, ranging from 1 - 11 months. Average time to union for each age group: 0 - 5 years, 45 days; 5 - 10 years, 65 days; and 10 - 13 years, 108 days. There were no cases of fracture non-union.

TABLE V

Definitive treatment methods for femoral fracture patients

<i>Definitive Treatment</i>	<i>No of Fractures</i>
Hip Spica	24
Long-leg Cast	8
Nancy Nails	5
Closed reduction plus k-wiring	3
Cannulated screws	2
Thomas Splint	2
ORIF [plating]	1

DISCUSSION

In this study, femoral fractures represented 5.1% of the total fracture admissions to the RBHSC, a figure that is comparable with other published series.^{2,6}

However, despite representing only a small proportion of the overall fracture admissions, the resource consumption of femoral fractures is considerably higher than all other childhood fractures.² In this study the average length of hospital stay was 9 days compared to only 1.5 days on average for children admitted with an uncomplicated forearm fracture.

The seasonal variation in femoral fracture admission rate that we observed is a well-recognised phenomenon.^{2,4,7,8} There is a peak in the admission rate in early summer and a trough in winter (*Figure 1*). The fall in admission rate at the end of October most likely coincides with the change from summer to winter time, whilst the peak in July and August suggests that it is related to the vacation seasons, with a higher rate of both free-time activities and traffic.

When comparing age and gender to the seasonal distribution, a comparable number of males and females were admitted during the Autumn/Winter and Spring/Summer months. However, the overall average age of those sustaining a femoral fracture during the Spring/Summer months was 6.3 years compared to 3.8 years for the Autumn/Winter group. This difference is probably related to the fact that traffic trauma is more common in the Spring/Summer months and that traffic trauma is more common in 5 - 13 year old children.

Overall, we found a male preponderance for femoral fractures which, concurs with other reported series.^{4,6,8-10} This is also consistent with the general finding that males predominate in childhood injuries.^{11,12}

Traffic trauma, falls, abuse, incidental findings, sporting injuries and pathologic fractures are the most commonly reported mechanisms of injury, with traffic trauma and falling accounting for the majority of cases.^{4,8,10,13,14} In this series, traffic trauma and trauma associated with falling accounted for 84% of femoral fracture admissions. Although in this study child abuse was neither reported nor suspected from the case notes, it is reported that femoral fractures

in children less than 1 year are often secondary to child abuse^{15,16} and should therefore be considered in such instances.

The aetiology of femoral fractures in children, the seasonal distribution and the region of the femur affected varies with the age of the child.^{4,6,8,10,13} In early childhood, the femur is relatively weak and can break under load conditions reached in normal play. However, during childhood, through a process of remodeling, children's bone changes from primarily weak woven bone to stronger lamellar bone. Strength is also increased by a change in geometry.¹⁷ Thus, in older children and adolescents, high-velocity trauma is required to reach the stresses necessary for fracture.

We found that for children under the age of 5 years, a fall was the most common mechanism of injury (65%) regardless of sex. This may be due to the fact that young children may have unprotected falls as a result of incompletely developed motor skills. However when considering the 5 - 13 years group, traffic trauma accounted for 75% femoral fractures with males having a five times greater incidence of femoral fracture at this age due to road traffic accidents. Furthermore, when comparing the age of the child and the mechanism of injury (*Table 4*) with the region of the femur affected, midshaft fractures were seen more commonly in younger children (average age, 3.5 years) and were more commonly associated with trauma due to a fall. Injuries to the proximal and distal femur were seen more commonly with older children (average age, 7.8 years and 6 years respectively) and were much more commonly associated with road traffic accidents. These findings can be explained partly by the changes in femoral osteology that occur with development as described but also by the difference in play and free-time activities between over and under five year old children and indeed between the two sexes.

Pathological femoral fractures are relatively uncommon in children but may occur as a result of generalised osteopenia in association with osteogenesis imperfecta, or neurological diseases such as cerebral palsy or spina bifida. Benign or malignant neoplasms may also give rise to pathological fractures. One child in this series with severe spina bifida sustained a fracture of both femurs

at different time intervals (5 days and 4 months). The first fracture may have been the result of birth trauma whilst the second fracture occurred during routine physiotherapy. One child fractured through the site of a multicameral bone cyst, although there was a definite history of a fall.

When a child is struck by a car, the femur is at the level of the bumper, the trunk is at the level of the hood and as a result of the impact, the child may be thrown into the air before landing on the road. This may result in a combination of injuries including a fractured femur, intra-abdominal or intra-thoracic injuries and a head injury ("Waddell's triad"). Rosenberg *et al.*¹³ demonstrated that the risk of developing shock was significantly higher for those patients with a combination of femoral fracture, associated fractures and injuries. Of the five patients who sustained injuries in addition to their femoral fracture, there was no documented evidence of shock at any stage nor did any of these patients require transfusion. However, should hypotension develop, the child should be evaluated for an additional source of blood loss other than the femoral fracture.

Options for the treatment of femoral fractures in children include traction, casting, external fixation, open reduction and plating, and flexible or locked intramedullary nailing. The choice of treatment is dependent on a number of factors including age, the child's size and bone age, the mechanism of injury and the presence of other injuries, the region of the femur affected, and the advantages and disadvantages of operative intervention.

On reviewing the initial fracture management of the patients in this study, it was deemed appropriate in all of the cases admitted to the unit. The majority of patients were treated definitively in a hip spica cast following an average of 9.8 days in traction, the aim of which is to minimise femoral shortening and allow the formation of early callus, thus providing some fracture stability prior to the application of hip spica. This time spent in traction accounts for a substantial portion of the overall duration of inpatient stay.

On reviewing the data collected for the patients treated in hip spica who returned to theatre, there was no obvious reason to account for this problem. Despite requiring revision of hip spica, all of the

cases proceeded to uneventful fracture union. A successful outcome was also achieved in those treated by operative intervention with no complications relating to their overall surgical management.

Although femoral fractures are dramatic and disabling injuries, both to the patient and their family, most unite without significant complications or sequelae. On evaluating fracture union in this series, the time to fracture union was rapid and age-dependent with the average time to union being 3 months. Delayed union, which is uncommon in children, was evident in only one case. There were no cases of non-union, which is in keeping with the fact that this complication is rare in paediatric femoral fractures.^{18,19}

In summary, femoral fractures represent a small but significant workload for the RBHSC fracture service. Whilst we accept that this study is retrospective and the limitations that this implies, much of the epidemiological data collected concurs with other reports in the literature regarding these injuries. Furthermore, conservative and operative treatment of these fractures, where appropriate, provided a satisfactory outcome in terms of successful fracture union with minimal complications. Reducing the inpatient duration of stay and time to hip spica application are controversial issues and require further evaluation in a more prospective manner.

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