

# EPIDEMIOLOGICAL STUDY OF CHILDREN DIAPHYSEAL FEMORAL FRACTURES

Cassiano Ricardo Hoffmann<sup>1</sup>, Eduardo Franceschini Traldi<sup>1</sup>, Alexandre Posser<sup>2</sup>

## ABSTRACT

**Objective:** To evaluate the personal, fracture, treatment and complication characteristics among patients with pediatric femoral shaft fractures attended at the pediatric orthopedic service of the Joana de Gusmão Children's Hospital. **Methods:** This was a retrospective cross-sectional study on a population consisting of patients with femoral shaft fractures, aged between birth and 14 years and 11 months, who were divided into four age groups. Information was obtained from medical records and was transferred to a survey questionnaire to present personal, fracture, treatment and complication variables. **Results:** The study population consisted of 96 patients. Their mean age was 6.8 years. The cases were predominantly among males, comprising closed fractures on the right side, in the

middle third with a single line. Regarding fracture etiology, traffic accidents predominated overall in the sample. Most of the patients (74 to 77.1%) presented femoral fractures as their only injury. Conservative treatment predominated in the group younger than six years of age, and surgical treatment in the group aged 6 to 14 years and 11 months. The complications observed until bone union were: discrepancy, infection and movement limitation. The mean time taken for consolidation was  $9.6 \pm 2.4$  weeks, varying with age. **Conclusion:** The features of these fractures were similar to those described in the literature and the treatment used showed good results. The Joana de Gusmão Children's Hospital has used the treatment proposed in the literature for pediatric femoral shaft fractures.

**Keywords** – Femoral Fractures; Child; Retrospective Studies

## INTRODUCTION

Pediatric diaphyseal fractures account for 1.4% to 1.7% of all fractures in the pediatric population<sup>(1)</sup>. They are more prevalent among males, with a ratio of 2.6:1. The distribution of the incidence is bimodal: the first peak between two and four years of age and the second during adolescence. There is also a seasonal distribution, with greater incidence during the summer months<sup>(2)</sup>.

Regarding etiology, the most frequent causes are traffic accidents and falls from a height<sup>(3)</sup>. Among younger children who still cannot walk, 80% of the injuries are caused by mistreatment, decreasing to 30% after they start to walk. During adolescence, around 90% of femoral fractures are caused by accidents with motor vehicles<sup>(2)</sup>. Increasing incidence of fractures caused by interpersonal violence has been

observed, most specifically among adolescents, such that occurrences of fractures caused by firearms is increasingly frequent in emergency services<sup>(3)</sup>.

The different treatment methods are dictated by the patient's age, characteristics of the trauma, conditions of the fracture and the family's social situation. Over the last decade, there has been a tendency towards surgical stabilization, particularly among children over the age of 10 years, in relation to nonsurgical treatment (traction and plaster-cast immobilization), given that the latter is associated with complications such as loss of reduction and shortening of the affected limb<sup>(4-6)</sup>. Surgical treatment (intramedullary nails and plates) has the aim of diminishing the hospital stay and social losses experienced by patients and members of their families, but this method is limited by the morbidity resulting from its complications,

1 – Resident Physician in Orthopedics and Traumatology, Joana de Gusmão Children's Hospital, Florianópolis, SC, Brazil.

2 – Orthopedist at Joana de Gusmão Children's Hospital, Florianópolis, SC, Brazil.

Work performed at Joana de Gusmão Children's Hospital, Florianópolis, SC, Brazil.

Correspondence: Rua Barão do Rio Branco 191, Centro, 89460-000 Canoinhas, SC, Brazil. E-mail: cassirh@hotmail.com

Work received for publication: May 12, 2011; accepted for publication: October 4, 2011.

The authors declare that there was no conflict of interest in conducting this work

This article is available online in Portuguese and English at the websites: [www.rbo.org.br](http://www.rbo.org.br) and [www.scielo.br/rbort](http://www.scielo.br/rbort)

such as infections and growth plate lesions<sup>(7)</sup>. External fixation is indicated in cases of exposed fractures, large soft-tissue injuries, multiple trauma (especially in cases that are hemodynamically unstable), extensive comminution and burns<sup>(2)</sup>.

The present study had the aim of evaluating the characteristics of pediatric patients with fractures of the femoral diaphysis who were attended at the Pediatric Orthopedics Service of the Joana de Gusmão Children's Hospital, with regard to the following variables: age, sex, side, etiology, exposure, location, associated lesions, fracture line and treatment type.

## MATERIAL AND METHODS

This was a retrospective cross-sectional study approved by the Research Ethics Committee of the Joana de Gusmão Children's Hospital.

The study population was composed of patients aged between birth and 14 years and 11 months who presented femoral diaphyseal fractures.

The inclusion criteria for this study were the following: 1) the patients should present femoral diaphyseal fractures in the proximal, middle or distal third; 2) the patient's ages should be between birth and 14 years and 11 months; 3) sufficient data had to be available in the medical files; 4) two years of follow-up was required; and 5) adequate radiographic documentation needed to be available.

The patients were divided into four age groups in accordance with the divisions proposed by Kasser and Beaty<sup>(2)</sup>: group I, formed by patients aged between birth and six months; group II, between six months and six years; group III, between six and 12 years; and group IV, between 12 years and 14 years and 11 months.

The information was obtained from the medical files and was transferred to the research questionnaire. The following variables were analyzed: name, medical file number, age, sex, etiology, side, exposure, associated lesions, fracture line, treatment type, complications, time taken to achieve consolidation and clinical-radiographic assessment after consolidation.

The fracture classification was done by applying the AO fracture classification system, thus categorizing the fracture line as simple, wedge or complex<sup>(8)</sup>.

After two years of clinical-radiographic follow-up, it was considered acceptable for children up to two years of age to present angulation of up to 30° in the frontal plane and 30° in the sagittal plane, with up to 15 mm

of shortening; between two and five years, 15° frontal, 20° sagittal and 20 mm shortening; between six and ten years, 10° frontal, 15° sagittal and 15 mm shortening; and between 11 years and 14 years and 11 months, 5° frontal, 10° sagittal and 10 mm shortening<sup>(2)</sup>.

The data obtained were entered into an electronic database. All the variables were distributed in the form of simple frequencies. For the numerical variables (age and time taken to achieve fracture consolidation), the central trend measurements (mean and median) were calculated. Comparisons between the proportions were given by the chi-square test. The significance level for all the analyses was 0.05.

## RESULTS

Between January 2004 and December 2009, 139 patients with femoral diaphyseal fractures were treated. Forty-three patients for whom insufficient data were available in the medical files, insufficient follow-up had taken place over the first two years after the fracture event and inadequate radiographic documentation was available were excluded. Thus, the study population was composed of 96 patients (Table 1).

The mean age found was 6.8 years, with a standard deviation of 4.7 years and median of 5.8 years.

Regarding the fracture etiology, traffic accidents predominated overall and in groups II, III and IV. Falls were responsible for the majority of the fractures in group I (Table 2).

In all the age groups, closed fractures predominated. There were 10 cases of open fractures: two in group III and eight in group IV. The open fractures were related to traffic accidents, firearm projectiles and falls from a height.

Fractures in the middle third of the femoral diaphysis predominated overall and in all the age groups. Group I included eight fractures in the middle third and six in the distal third. Group II presented 10 fractures in the proximal third, 20 in the middle third and four in the distal third. In group III, eight fractures were located in the proximal third, 16 in the middle third and two in the distal third; and in group IV, six were located in the proximal third, 12 in the middle third and four in the distal third.

Fractures with a simple line predominated overall and in all the age groups. In group I, all the patients present a simple fracture line. In group II, 30 patients

**Table 1** – Frequency distribution of study variables.

Characteristics	Absolute frequency (n)	Relative frequency (%)	95% CI
<b>Sex</b>			
Female	40	41.7	31.7 – 52.2
Male	56	58.3	47.8 – 68.3.
<b>Age group</b>			
Group I	14	14.6	8.2 – 23.3
Group II	34	35.4	25.9 – 45.8
Group III	26	27.1	18.5 – 37.1
Group IV	22	22.9	15.0 – 32.6
<b>Etiology</b>			
Falls	28	29.2	20.3 – 39.3
Traffic	52	54.2	43.7 – 64.4
Others	16	16.7	9.8 – 25.6
<b>Side</b>			
Right	50	52.1	41.6 – 62.4
Left	42	43.8	33.6 – 54.3
Bilateral	4	4.2	1.1 – 10.3
<b>Exposure</b>			
Closed	86	89.6	81.7 – 94.9
Open	10	10.4	5.1 – 18.3
<b>Location</b>			
Proximal 1/3	24	25	16.7 – 34.9
Middle 1/3	56	58.3	47.8 – 68.3
Distal 1/3	16	16.7	9.8 – 25.6
<b>Associated lesions</b>			
Yes	22	22.9	15.0 – 32.6
No	74	77.1	67.4 – 85.0
<b>Fracture line</b>			
Simple	86	89.6	81.7 – 94.9
Wedge	4	4.2	1.1 – 10.3
Complex	6	6.3	2.3 – 13.1
<b>Treatment type</b>			
Conservative	58	60.4	49.9 – 70.3
Surgical	38	39.6	29.7 – 50.1

Source: Primary data gathered from medical files at the Joana de Gusmão Children's Hospital between January 2004 and December 2009.

**Table 2** – Etiology of femoral diaphyseal fractures in relation to age group.

Group/etiology	Falls	Traffic	Others	Total
<b>Group I</b>	8 57.1%	2 14.3%	4 28.6%	14 100.0%
<b>Group II</b>	10 29.4%	18 52.9%	6 17.6%	34 100.0%
<b>Group III</b>	6 23.1%	18 69.2%	2 7.7%	26 100.0%
<b>Group IV</b>	4 18.2%	14 63.6%	4 18.2%	22 100.0%
<b>Total</b>	28 29.2%	52 54.2%	16 16.7%	96 100.0%
<b>Chi-square</b>	7.05	12.16	2.99	13.06
<b>P</b>	0.071	0.006	0.392	0.042

Source: Primary data gathered from medical files at the Joana de Gusmão Children's Hospital between January 2004 and December 2009.

presented a simple line; two, a wedge fracture; and two, a complex fracture. In group III, 22 patients presented a simple line; two, a wedge fracture; and two, a complex fracture. In group IV, 20 patients presented a simple line and two, a complex fracture.

The majority of the patients (74-77.1%) presented a femoral fracture as a single lesion, while 22 patients (22.9%) had one or more associated lesions. Table 3 shows the associated lesions that were most observed. It can be highlighted that one patient had more than one associated lesion.

All the patients in group I underwent conservative treatment, with immediate placement of a plaster cast. All the patients in group II underwent conservative treatment: 14 (41.2%) with immediate placement of a plaster cast and 20 (58.8%) with a plaster cast applied after cutaneous traction. In group III, 10 patients (38.5%) underwent conservative treatment: seven with a plaster cast after cutaneous traction and three with plaster after transkeletal traction; and 16 patients (61.5%) underwent surgical treatment: two with an external fixator and 14 with a flexible rod. In group IV, all the patients underwent surgical treatment: six with an external fixator, 10 with a flexible rod, two with a rigid nail and four with placement of a plate.

The mean time taken to achieve fracture consolidation in group I was 4.6 weeks, with a standard deviation of 0.8 and median of four weeks. The mean time taken to achieve fracture consolidation in group II was 10.1 weeks, with a standard deviation of 1.8 and median of 10 weeks. The mean time taken to achieve fracture consolidation in group III was 11.5 weeks, with a standard deviation of 1.4 and median of 11 weeks. The mean time taken to achieve fracture consolidation in group IV was 12 weeks, with a standard deviation of 1.4 and median of 12 weeks.

The patients in group I did not present any im-

**Table 3** – Lesions associated with femoral diaphyseal fractures in relation to age group.

Group/lesion	Other fractures	Cranioencephalic trauma	Other lesions	Total
<b>Group I</b>	1	0	2	3
<b>Group II</b>	1	0	2	3
<b>Group III</b>	4	1	3	8
<b>Group IV</b>	0	6	3	9
<b>Total</b>	6	7	10	23
<b>Chi-square</b>	5,82	17,22	1,25	13,06
<b>P</b>	0,120	0,006	0,743	0,042

Source: Primary data gathered from medical files at the Joana de Gusmão Children's Hospital between January 2004 and December 2009.

mediate or late complication. Four patients evolved with infection: one in group III and three in group IV. Changes to knee range of motion were observed in three patients: two in group III and one in group IV. There were no angular or rotational deviations greater than the standard that had been established.

In relation to lower-limb length discrepancies measured at the time of fracture consolidation, two patients (11.6%) in group II presented shortening of 2.5 cm and 3.2 cm, respectively; four (30.7%) in group III presented a mean discrepancy of  $2.2 \pm 1.3$  cm; and three (27.2%) in group IV presented a mean discrepancy of  $1.3 \pm 0.9$  cm.

## DISCUSSION

The approach used at our service for treatment pediatric femoral diaphyseal fractures was similar to what has been recommended by several authors. In most cases, it depended on the patient's age, the fracture characteristics and the family's social situation<sup>(6-12)</sup>.

In the sample analyzed, fractures in male subjects predominated, and this has also been reported by other authors<sup>(5,10,11,13-15)</sup>. In the small sample presented by Santili et al<sup>(16)</sup>, no difference was detected in relation to gender. In a study on fractures treated conservatively, Silva et al<sup>(4)</sup> observed that female subjects predominated.

Homogenous distribution of fractures in relation to the fractured side was also reported by Silva et al<sup>(4)</sup>, Volpon et al<sup>(6)</sup>, Linhart and Roposch<sup>(13)</sup>, Stands et al<sup>(14)</sup> and Casas et al<sup>(10)</sup>.

The proportion of open fractures (10.4%) was close to what was found by Cramer et al<sup>(5)</sup> (8.5%), Ferguson and Nicol<sup>(17)</sup> (9%), Hutchins et al<sup>(18)</sup> (10%) and Linhart and Roposch<sup>(13)</sup> (9.8%).

Fractures in other regions and cranioencephalic trauma are the associated lesions that have most often been described in the literature<sup>(5)</sup>. The proportion with associated lesions in the present study (22.9%) was similar to the proportions of 26.7% reported by Buechsenschuetz et al<sup>(12)</sup> and 22.3% of Silva et al<sup>(4)</sup>, who analyzed samples of similar age groups. Cramer et al<sup>(5)</sup>, who exclusively analyzed cases that were treated surgically, observed that 73.0% presented associated lesions. This high rate of associated lesions is, in itself, already enough to suggest that there should be greater indication of surgery.

In the literature investigated, there is no standardization regarding fracture line presentations. In 2002,

Buechsenschuetz et al<sup>(12)</sup> found that 35.2% of the fractures were oblique, 35.2% were transverse, 16.9% were spiral and 12.6% were comminuted. Volpon et al<sup>(6)</sup> reported that 39.8% of the fractures were transverse, 33.2% were spiral, 13.7% were short oblique, 9.0% were segmental-comminuted and 3.8% were long oblique. The data from the sample analyzed here (89.6% with a simple line, 4.2% with wedge fractures and 6.3% with complex fractures) are closer to what was observed by Silva et al<sup>(4)</sup>, who found that 82.6% of the fractures had a simple line, 13% were wedge fractures and 4.4% were comminuted fractures.

Casas et al<sup>(10)</sup> (85,3%), Cramer et al<sup>(5)</sup> (70,1%), Ferguson and Nicol<sup>(17)</sup> (75%), Linhart and Roposch<sup>(13)</sup> (70.5%) and Staheli et al<sup>(11)</sup> (73%) all reported that the fractures predominantly affected the middle third of the femur. In the present study, the fractures showed the same predominance, but with a proportion similar to what was described by Volpon et al<sup>(6)</sup> (58.3%).

The literature also presents traffic accidents as the most frequent mechanism, with the exception of children under the age of three years<sup>(3,9,10,13,16)</sup>.

Traffic accidents (in which children can be victims as pedestrians, passengers in vehicles or cyclists) are the leading cause of accidental deaths in the age group from zero to 14 years in Brazil. The way in children are transported in cars may be as important as factors such as the speed of the vehicle and road conditions. The best protection for children in cars is to use safety seats, which have been regulated in Brazil through Resolution 277 of the National Traffic Council. On September 1, 2010, inspection actions started to be implemented by the traffic authorities<sup>(19)</sup>.

Several published papers have defined treatment methods according to age. Silva et al<sup>(4)</sup>, Volpon et al<sup>(6)</sup>, Casas et al<sup>(10)</sup> and Sahin et al<sup>(15)</sup> recommended conservative treatment as the preferred choice for femoral diaphyseal fractures in children. On the other hand, Cramer et al<sup>(5)</sup>, Linhart and Roposch<sup>(13)</sup> and Santili et al<sup>(16)</sup> advocated surgical treatment for children and justified this as an indication that would allow rapid recovery with a low number of complications. Sanders et al<sup>(9)</sup> investigated the preferences of the members of the Pediatric Orthopedic Society of the United States regarding treatments for femoral fractures in children and adolescents, and observed that surgical treatment was only indicated from the age of six years onwards. In the present study, it was observed that 60.4% of the

fractures were treated conservatively and 39.6% surgically. Conservative treatment predominated in age groups younger than six years and surgical treatment in the age group from six years to 14 years and 11 months.

The complications encountered among the cases treated at our hospital reproduced the ones most described in the literature, i.e. loss of reduction and shortening<sup>(2)</sup>. In a sample of 85 fractures that were treated either conservatively or surgically, Stans et al<sup>(14)</sup> identified 11 cases (12.9%) in which the final shortening was greater than or equal to 1 cm. Silva et al<sup>(4)</sup> analyzed conservative treatment administered to 67 patients and observed that there were discrepancies of less than 1 cm in 27 (40.3%) and 1-2 cm in 16 (23.9%). At the time of consolidation, nine cases (9.4%) of the present sample showed shortening: two (11.6%) in group II, with shortening of 2.5 cm and 3.2 cm, respectively; four (30.7%) in group III with a mean discrepancy of  $2.2 \pm 1.3$  cm; and three (27.2%) in group IV with a mean discrepancy of  $1.3 \pm 0.9$  cm.

The mean time taken to achieve consolidation among the fractures studied coincided with data in the literature. Staheli et al<sup>(11)</sup> observed that in infants, fractures consolidated in four weeks; at the age of two years, in six weeks; between the ages of three and 10 years, from six to eight weeks; and over the age of 10 years, in eight to 12 weeks. Casas et al<sup>(10)</sup> reported that among children aged four to ten years who were treated conservatively, the mean time taken to achieve consolidation was 9.7 weeks. Silva et al<sup>(4)</sup> observed that the mean time taken to achieve consolidation was

eight weeks among children aged three to 13 years.

The great number of losses due to insufficient data in the medical files and insufficient follow-up was a limiting factor in this study.

It is important to emphasize to physicians that filling out the forms for the medical files is important. Families need to be told that follow-up throughout the course of treatment is important.

Raising the public's awareness about preventive measures against traffic accidents and better inspection are needed in order to diminish the incidence of pediatric femoral diaphyseal fractures.

## CONCLUSION

The patients attended at the Orthopedics and Traumatology Service of the Joana de Gusmão Children's Hospital with a diagnosis of femoral diaphyseal fracture were mainly males. The age group most affected was between six months and six years. Traffic accidents predominated as the etiology.

Closed femoral diaphyseal fractures predominated. The most common location was the middle third and the fracture line type most often encountered was the simple type.

The treatment most used was conservative, in the age group under six years, and surgical in the age group from six years to 14 years and 11 months. The Joana de Gusmão Children's Hospital used the treatment proposed in the literature for pediatric femoral diaphyseal fractures.

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