BLOODLESS TREATMENT OF FEMORAL DIAPHYSEAL FRACTURES IN CHILDREN

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SUMMARY

The purpose of this study is to analyze the progression of children presenting femoral diaphyseal fractures, conservatively treated, by evaluating clinical and radiographic complications, emotional changes and estimated costs for this kind of treatment.
Thirty-two patients were evaluated, with ages ranging from 6 to 16 years old, receiving healthcare within the period of January 1995 and August 2001. In this group, six patients were females and 26 were males, with a mean age of 8 years and five months old. Sixteen patients were further evaluated, with an average follow-up time of 42.2 months. In those patients, ten angle deformities and nine lower limbs discrepancies were seen.
During psychological evaluation, fifteen patients reported anxiety and restricted social life during treatment, and two patients lost school year. Eleven families reported difficulties in taking care of the child during the home-based phase of therapy. As for the analysis of costs, the treatment using traction followed by cast has shown to be 22.5% more expensive than surgery with flexible intramedullary nail.
Although clinical outcomes were satisfactory, allowing a fast return to usual daily activities, the bloodless treatment has shown to be more expensive than other available approaches, and may potentially trigger emotional changes in children and their families.

Keywords: *Femoral fractures, Children, Traumatology*

INTRODUCTION

Femoral fractures account for 15 to 20% of all fractures in children[1,2], with 70% being located at the diaphysis[3]. They occur most frequently in boys, at a ratio of 2.1:1[3].
Accidental traumas constitute 70% of the causes of femoral diaphyseal fractures in children younger than 15 years old[4], but, in patients younger than three years, physical abuse and negligence may be implied in 39% to 70% of the cases[5,6,7,8].
Treatment depends on age, type of fracture, association or not to other injuries, and family ability to take care of the child[6]. The optimal treatment method is still very controversial[3]. Viljanto et al.[9] point out the conservative approach as the treatment of choice, regarding osteosynthesis only for cases particularly selected among children younger than 16 years old. Casas et al.[10], however, indicate surgical treatment in patients above 10 years old, alleging that this age group presents a lower ability to remodel.
The bloodless treatment may consist of an immediate application of plaster, being considered as early when used within up to 72 hours after trauma, or preceded by a traction period, either cutaneous or skeletal.
There have been recent questionings about the use of traction until a provisory bone callus is formed, followed by pelvic-pedal plaster, because this extends the hospitalization time and increases treatment costs[9,10,11], as well as incurring in implications on child's social and educational development, due to the long period away from their usual activities[3,6]. Nevertheless, there are authors weighing that the method is efficient and causes little complications[12].
The objective of this study is to assess the treatment of femoral diaphyseal fractures in patients whose ages range from 6 to 16 years old, treated with traction followed by immobilization with pelvic-pedal plaster, evaluating, additionally to clinical and x-ray complications, emotional changes resulting from this treatment, and also a cost estimate of the various kinds of treatment for society.

CASE SERIES AND METHODS

Medical files of 182 patients with ages ranging from zero to 16 years old, hospitalized during the period of January 1995 and August 2001, with diagnosis of femoral diaphyseal fracture were retrieved from the Medical Files Service (S.A.M.E.) of the Irmandade Santa Casa de Misericórdia de São Paulo.
Inclusion criteria for this study were as follows: patients above six and below 16 years old treated by using a bloodless approach, with pelvic-pedal plaster with a minimum follow-up time of six months. Exclusion criteria were: all patients below 6 years old (46 patients), those submitted to any other kind of bloodless treatment (13 patients) or to one of the surgical approach forms (63 patients), and those with fractures associated to some baseline disease, which, in this research corresponded to eight cases of brain palsy, seven non-perfect osteogenesis, three fibrous dysplasia, three congenital short femur, two rachides, two myelomeningocele, one arthrogryposis, one endochondroma, and one case of osteopetrosis.

Study conducted by the Pediatric Orthopaedics and Traumatology Group, Department of Orthopaedics and Traumatology, Irmandade da Santa Casa de Misericórdia de São Paulo –Medical Sciences College, Santa Casa de São Paulo.

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Thus, 32 children met the inclusion criteria, being six females and 26 males, with a mean age of eight years and five months old at the moment of fracture.

The most common trauma mechanism was trampling, identified in 16 patients; high falls in 12, car accident in two; trauma caused by an object over a lower limb in two cases. Right and left sides were equally affected. In 16 cases, fracture occurred at the medial third of the femoral diaphysis.

Additionally to femoral diaphyseal fracture, a concurrence of other injuries associated to trauma was seen in six patients, four of them with skull-encephalic traumatisms; two with splenic injuries and two with fractures in other bones (patella and radius). In only two cases an exposure of the fracture core occurred, one being classified as type I and the other as type II, according to the criteria by Gustilo and Anderson[13].

All those patients were then invited by telegram and phone calls to come back to the service for re-evaluation. Only 16 patients showed up and were submitted to orthopaedic clinical evaluation and to x-ray studies, at anteroposterior and lateral planes, and to a scanning of the lower limbs. The average follow-up time was 42.2 months, ranging from nine to 88 months (Table 1).

Patients were also assessed by a psychologist (S.A), who employed a questionnaire specifically developed to this project and the drawing-story test with a topic by Trinca[14], which consists of a perspective-nature psychological investigation technique where the individual graphically and symbolically represents the experience of a given situation. Thus, we intended to evaluate the repercussion of hospitalization and kind of treatment in the social and emotional development of these children.

Furthermore, based on data regarding hospital invoicing, we got to a cost for maintaining a bed/day and the cost of one-hour use of the operating room, thereby we could estimate the total cost for treating these patients during hospitalization on SUS expenses. Similarly, we surveyed those costs in a private healthcare institution for comparison purposes.

RESULTS

Orthopaedic Analysis

By evaluating the 32 patients in this study during the hospitalization period, we verified that 30 were submitted to previous traction, for an average period of 19.3 days, ranging from seven to 28 days. From these, 29 were submitted to skeletal traction and one to cutaneous traction. One patient was previously kept in plastered splint and another one was submitted to pelvic-pedal plaster placement at the moment of hospitalization (immediate plaster).

We didn't find any complication reports related to the traction and to the plaster during the period of hospitalization, which ranged from nine to 31 days, with an average of 21.8 days.

Mean time for union was nine weeks, ranging from five to 13 weeks; after that period, 18 patients were kept in crutches for partial load and the others (14) were released for immediate ambulation, with total load.

In the anamnesis, fourteen patients did not report changes, one patient complained about quadriceps hypotrophy at the fractured thigh, and one reported knee pain at the ipsilateral portion of the fracture.

Regarding orthopaedic complications during follow-up, we saw a patient suffering a reduction loss, requiring a new reduction and immobilization with pelvic-pedal plaster, and another patient presented with re-fracture one year after initial fracture.

Through updated x-ray studies, we verified angle deformities in 10 patients, eight of them in antecurvatum, ranging from 5º to 20º, with an average of 12º (Figure 1). By evaluating the scanning, shortening occurred in nine patients, ranging from 0.5 to 2.0 cm, with an average of 1.0 cm (Figure 2) and three patients presented an overgrowth ranging from 0.25 to 1.0 cm, with an average of 0.7 cm.

The patient presenting re-fracture required two additional hospitalizations, one for reduction and fracture osteosynthesis with a compression plate, and the other for removing synthesis material. The patient evolving to reduction loss was hospitalized in order to

G	Age	Trauma	Exposure	S	Site	Initial treatment	Duration	Hospitalization	Union	Late Complications	Return	Load	Re-hospitalization	Follow-up	Complaints
F	12+8	Trampling	Closed	R	Medial third	Skeletal traction	20	23	6		6	Partial	N	69	no complaint
M	6+3	High fall	Closed	R	Medial third	Skeletal traction	12	15	9	shortening 1cm, antecurvatum 5º	9	Partial	N	9	no complaint
M	8+11	Direct trauma	Closed	L	Medial third	Skeletal traction	7	9	6	overgrowth 0.25cm, antecurvatum 10º	10	Total	N	34	no complaint
M	6+1	High fall	Closed	R	Proximal third	Skeletal traction	15	16	8	overgrowth 1cm, antecurvatum 10º	8	Partial	N	46	no complaint
M	6	Trampling	Closed	L	Medial third	Skeletal traction	9	10	9	shortening 0.5cm, antecurvatum 10º	9	Total	N	37	no complaint
F	8+11	fall from berth	Closed	R	Medial third	Cruropodalic splint	13	14	8	re-fracture, shortening 2cm	8	Partial	Re-fracture	39	no complaint
M	8+6	Trampling	Closed	L	Medial third	Skeletal traction	26	31	8		0	Total	N	26	no complaint
M	9	Trampling	Closed	R	Distal third	Skeletal traction	20	25	12	overgrowth 0.75 cm	12	Partial	N	14	no complaint
M	7+5	Trampling	Closed	R	Proximal third	Skeletal traction	20	21	13	antecurvatum 20º	13	Partial	Reduction loss	42	no complaint
M	6+7	High fall	Closed	R	Distal third	Skeletal traction	21	22	7	shortening 1.2cm	7	Total	Y	88	quadriceps hypotrophy
M	13+6	High fall	Closed	L	Medial third	Skeletal traction	28	31	0	shortening 1.5cm, varum 10º	0		N	58	R knee pain
M	11	Trampling	Closed	L	Proximal third	Skeletal traction	15	22	12	shortening 0.5cm	12	Total	Plaster removal	23	no complaint
M	7+9	Trampling	Closed Open Type	L	Medial third	Skeletal traction	15	17	9	shortening 1.75cm, antecurvatum 12º	9	Partial	N	39	no complaint
F	9+8	Trampling	II	L	Medial third	Skeletal traction	14	16	11	sht. 0.6cm, antecurvatum 16º,	11	Partial	N	23	no complaint
M	10+11	Car accident	Closed	L	Medial third	Skeletal traction	24	26	10	shortening 1cm	10	Partial	N	41	no complaint
M	13+6	High fall	Closed	R	Medial third	Skeletal traction	21	23	12	antecurvatum 10º	12	Partial	N	88	no complaint

Source: S. A.M.E. Legends: Pte: patient; G: gender; S: side: car: car accident; sht : shortening; age in years+months; duration and hospitalization in days; union and return in weeks; follow-up in months

Table 1: *Patients with femoral diaphyseal fracture, between 6 and 16 years old, receiving healthcare at this service between January 1995 and August 2001, re-assessed in this study.*

be submitted to a bloodless reduction and to a new pelvic-pedal plaster placement, achieving union within 13 weeks. After 42 months of follow-up, this patient presented with no complaints, but with a femoral antecurvatum of 20º.

Psychological Analysis

During the psychological evaluation of the 16 interviewed individuals, 11 mentioned a fear sensation during hospitalization, four reported no feelings, and only one did not answer the question. This fear sensation was due to the potential of not recovering previous function (for seven patients) and to the concerns regarding the procedures that would be performed (for four patients). Fifteen patients reported anxiety, irritation, social life restraints, weight gain and lack of hope during home care.

Profiting in school was not jeopardized in 14 cases, but two children were reproved. By returning to their daily activities, three children reported difficulties in social reintegration, two mentioned difficulties to perform tasks, one noticed an increased family dependence and one was embarrassed. The others did not report problems.

Regarding family's adjustment to treatment, 11 care providers reported difficulties to adjust due to: maternal duties overload, redistribution of tasks among family members, increased expenses and difficulties in transporting the child.

The perspective test revealed that treatment was little deleterious for eight children, very deleterious for five, and without great repercussions for one of them. Two patients refused to draw.

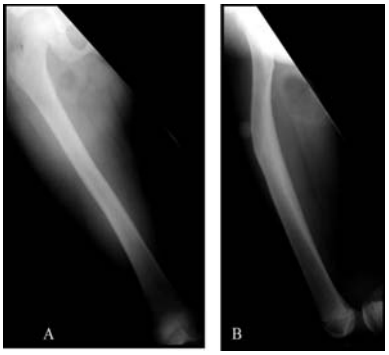

***Figure 1 -** PTBS, 7 years and 5 months. A, right femur anteroposterior plane. B, lateral plane indicating 20º of femoral antecurvatum.*

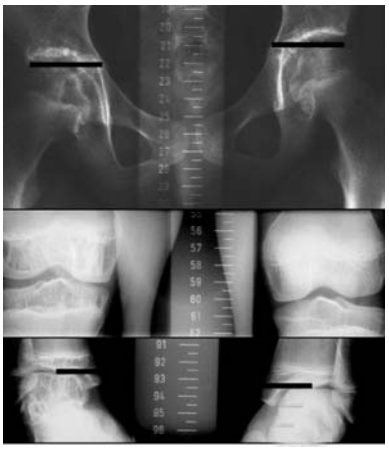

***Figure 2 -** 8 years and 11 months, lower limbs scanning showing a 2-centimeter shortening of the right lower limb.*

Costs Analysis

By taking into account hospital expenses, aside from medical fees, only including the stay in infirmary and the use of the operating room, the treatment for those patients in our institution - a large-size hospital-school - costs R$ 1,593.95/ patient in average. By using the same basis of calculation, we transferred it to other possibilities of treatment and an average cost of R$ 1,598.52 was found with the use of compression plate, R$ 2,060.31 with the use of linear external fixator, and R$ 1,234.80 with flexible intramedullary nails (Table 2).

DISCUSSION

Femoral fractures in children account for 1.6% of all injuries of the skeleton[10]. Accidental traumas account for 70% of the cases[1,2], with car accidents and trampling being the most common ones[9,15], reaching 30% of the cases, when we consider older children[4].

In this study, trampling was the major cause of fracture (50%), followed by high falls (34.3%), with open fractures in only two cases (6.2%).

Boys are most often affected, in this study corresponding to 26 patients (81.2%), with no prevalence of a given affected side, either of the right or the left side (50% each), which is also in accordance to literature[1,2,9,13]. The prevalence of males can be related to the fact that boys perform a higher number of recreational activities in the streets.

	DCP	TENS	External Fixator	Traction + plaster
Public Hospital	1,598.52	1,234.8	2,060.31	1,593.95
Private Hospital	7,533.7	3,964.25	8,341.75	8,056.25

Source: Management of the Department of Orthopaedics and Traumatology
Note: values in R$. The mean hospitalization time in the assessed period was: for osteosynthesis with plate: 21.8 days, TENS 7 days, external fixator 20.33 days, and traction + plaster 21.8 days.
TENS: titanium flexible intramedullary nail/ DCP: Dynamic compression plate

***Table 2 -** Costs of hospitalization and operating room use in a hospital-school and in a private healthcare institution.*

The fracture level found was mostly at the medial third of the femoral diaphysis (50%), being reported as the most common site in various studies[2,9].

Although we had not found complication reports in our medical files, whether because of healthcare professionals' negligence or not, a careful follow-up is recommended for theses patients during hospitalization under traction and also during the period of plastered immobilization, because literature reports complications ranging from ischemia and skin wounds[16], eschars, dermatitis, and sciatic nerve palsy[2], to knee dislocation[17].

In this study, only 16 from the 32 treated patients were re-assessed, with an average follow-up time of 42.2 months. Finding those children was very difficulty. This can be justified by the fact that they are not chronic patients, but victims of a traumatic event, therefore, a great number of them discontinue the outpatient follow-up after being cured. Besides, the majority come from low-income families, and many times with no fixed dwelling.

The average time for union ranges from 7.4 to 9.7 weeks[1,9,18]. We noticed a sufficient bone callus formation within 9 weeks; so, we recommended children to gradually resume their activities, with 18 of the 32 patients being recommended to initially use crutches for partial load support.

Sequels with the treatment using pelvic-pedal plaster for femoral diaphyseal fractures in children are described by many authors[2,4,7,8,10,16,17,18,19,20]. Among them, we can mention reduction losses with the establishment of angle and/ or rotational deformities, shortenings, re-fracture, overgrowth, joint stiffness, and vicious union.

During the period of plaster use, the only complication reported was a reduction loss in a 7-year, five-month-old boy who had been initially submitted to skeletal traction for 20 days and, by the end of that period, a pelvic-pedal plaster was placed. A new reduction and a new plaster under anesthesia were required. Among 50 children treated by this method, Neer and Cadman[16] found three reduction losses, demonstrating the importance of making parents or other care providers aware of the reduction loss potential during the use of the plastered device and the requirement of systematic reviews by the assistant doctor.

Two patients presented with some clinical complaint (quadriceps hypotrophy in one, and pain in the knee in another), but when assessing clinical and x-ray examinations, nine cases with shortening were found, ranging from 0.5 to 2.0 cm (average 1.0 cm), three cases of overgrowth ranging from 0.25 to 1.0 cm, and eight cases of angle deformities, particularly femoral antecurvatum (average 12º). One case of re-fracture also occurred.

In the study by Volpon et al.[12], where 64 patients treated with cutaneous or skeletal traction until bone callus formation followed by plaster were re-assessed, an average antecurvatum of 12º was found, and the mean discrepancy of lower limbs was 0.3 cm. They concluded that the treatment method is simple, without complications and provides good results, as well as Casas

et al.[10], who re-assessed 108 patients, being 41 children treated by using that approach, with ages ranging from 4 to 10 years.
Studies indicate that in children below 13 years old, a good remodeling may occur in angle deviations of up to 25º [2,4,18], but others point out as maximum acceptable deviations those angles of 15º at the coronal plane, 20º at the sagittal plane, and a shortening of up to 2.0 cm[6,17]. Thus, residual bone deformities observed in our patients after bloodless treatment with pelvic-pedal plaster do not represent clinically significant changes.
Classically, traction followed by plaster is a well accepted approach[2,6,15,18,20] and, in this study, it has been employed in 30 children (93.6%), who remained in hospital for an average time of 21.8 days. Sandars et al.[17], by assessing the answers of 286 members of the American Society of Pediatric Orthopaedics (POSNA) about the treatment of femoral diaphyseal fractures in children at various age groups, noticed that the use of traction followed by plastered immobilization was mentioned as a potential treatment for all groups. The mean hospitalization time in this study was 19.3 days, ranging from 13 to 23 days in other studies[1,2,14].
The extended hospitalization time is considered as one of the factors accounting for the high costs of this kind of treatment[11], being also described that children with femoral fractures remain in hospital for a longer time than those receiving healthcare in an emergency room as a result of other causes[4].
The indication of surgical treatment of fractures in children has increased lately, in part because of technical improvements, which reduce tissue trauma in a surgery and simplify procedures; on the other hand, this may be due to financial pressures, which are based in the high costs of hospitalization, and, ultimately, on the economical and social stress for the families of affected children[21], submitted to long periods of immobilization. Many studies describe the treatment employing traction followed by plaster as more expensive than surgical treatment[6,8,10,11], which may be, for example, 70% more expensive than a treatment employing flexible intramedullary nails[10,22].
When we assess the potential costs for treating femoral fractures in children in our institution, the use of flexible intramedullary nails has shown to be 22.5% cheaper than the method using traction, until bone callus formation, followed by plaster. This certainly happens because of the shorter hospitalization time. However, in children treated with external fixator, those costs were 29.36% higher than traction and plaster. This is due to the fact that, in our service, external fixation is used in polytraumatic children or in those with open fractures. These conditions, when associated to other injuries, extend patient's hospitalization time. Furthermore, these values were all obtained in a hospital-school, where a predetermined and little flexible schedule exists for operating rooms use, thus unnecessarily extending patients' hospitalization time as a result of schedule adjustment. If they were early operated, their hospitalization time would be reduced and, consequently, the costs of surgical treatment would be even lower.
There are some authors who consider surgical treatment costs as equivalent to those for traction followed by pelvic-pedal plaster[9]. However, Newton and Mubarak[10], demonstrated that costs in the U.S. increases according to the number of hospitalization days by approximately U$889 a day and by U$1,919 for each procedure when the operating room is used. Thus, it becomes obvious that treatments requiring a longer hospitalization time are even more expensive. This was also noticed in this study. Nevertheless, we must warn and advocate that costs should not be a primary determinant for the kind of treatment to be employed in children.
However, in addition to treatment's clinical outcome, another important issue is the eventual psycho-social repercussion resulting from treatment. Beaty[6], in a review of children with femoral diaphyseal fractures, calls the attention to the fact that long-lasting hospitalization for older children changes their self-image and interferes in their social and educational development. Morton et al.[4], warn about family difficulties to take care of the child and report personal losses resulting from their withdrawal from school and social life.
During the psychological evaluation, 15 of the 16 re-assessed patients complained about their limited social life and anxiety during immobilization period, 10 reported some difficulties to return to their usual activities and two missed the school year. When care providers were asked about, 11 reported difficulties in taking care of the child during treatment.
In this study, negative psychological aspects resulting from treatment with traction followed by plastered immobilization are, in a great part, in accordance to which is found in literature. However, we must highlight that, during interviews, the period of hospitalization was positively seen by many of the children, due to the meals, toys and attention provided to them. Maybe, in developing countries, hospitalization represent, sometimes, an opportunity of socialization and children's basic needs being met, such as eating, playing and being cared.

CONCLUSION

The concern with healthcare costs is real nowadays, and, more recently, this imposes a real pressure over medical indications to treatments. This is happening particularly in the controversial treatment of femoral fractures in children.
The treatment of femoral diaphyseal fractures in children between the ages of 6 and 16 years old, by employing traction and plaster, has provided satisfactory clinical outcomes in this study, and did not prevent them to be reintroduced in their usual activities. Notwithstanding, it has shown to be more expensive than other treatment options available, as well as causing emotional changes, which were attributed to the long time of withdrawal from children's social activities and family changes for home care.

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