Available online at www.medicinescience.org

ORIGINAL ARTICLE

Medicine Science International Medical Journal

Medicine Science 2021;10(1):262-7

Outcomes of diaphyseal femur fractures treated by long- and short-term traction methods in pre-school children

Savas Camur[1], Haluk Celik[1], Bekir Eray Kilinc[2], Yunus Oc[3], Muhammed Sefa Ozcan[2], Adnan Kara[4]

[1]Health Science University, Umraniye Training and Research Hospital, Department of Orthopaedics and Traumatology, Istanbul, Turkey
[2]Health Science University, Fatih Sultan Mehmet Training and Research Hospital, Department of Orthopaedics and Traumatology, Istanbul, Turkey
[3]Medilife Bağcılar Hospital, Clinic of Orthopaedics and Traumatology Istanbul, Turkey
[4]Medipol Mega University Hospital, Department of Orthopaedics and Traumatology, Istanbul, Turkey

Received 30 November 2020; Accepted 18 January 2020
Available online 18.03.2021 with doi: 10.5455/medscience.2020.11.246

Abstract

This study aimed to compare the effects of the traditional short- and long-term traction methods on the union and angulation of femoral fractures in pre-school children. Thirty-six patients aged 0–6 years, with diaphyseal femur fractures, who had undergone a conservative treatment, were included in the study. The patients were divided into two groups according to their traction times before the application of the hip spica cast: 0–10 days of traction (Group A) and 11–21 days of traction (Group B). After the completion of the union and the removal of the casts, bone scans were performed and the angulations in the coronal and sagittal planes were comparatively evaluated, as well as the lengths of the lower extremities. The mean age of the patients was 4.2 ± 1.94 years. Hip spica casts were applied to 17 patients after short-term traction and 19 patients after long-term traction. The mean length of hospital stays of the patients who were applied the hip spica casts after short-term and long-term tractions were 8.4 and 19.3 days, respectively. A statistically significant difference was observed between groups A and B regarding hospital stay ($p < 0.001$). After the removal of the casts, the angulation values of groups A and B were 13.5 ± 5.28° and 13.69 ± 8.84° in the coronal plane and 14.75 ± 6.66° and 14.46 ± 10.95° in the sagittal plane, respectively. The shortness value of the groups was 1.67 ± 0.75 and 1.56 ± 0.95 cm, respectively. There was no statistically significant difference between both groups in terms of angulation and shortness ($p > 0.05$). Hip spica casting after short-term traction can be used as a safe alternative method in the treatment of diaphyseal femur fractures in preschool children due to its adequate stability and shorter length of hospital stay.

Keywords: Pediatric femur fractures, hip spica cast, traditional method, traction

Introduction

Diaphyseal femur fractures constitute approximately 2% of all childhood fractures, and it is 2.6 times more common in boys than in girls [1]. In school-age children and adolescents, surgical methods such as flexible/rigid intramedullary nails, submuscular plates and fixation with external fixators that allow early mobilisation are preferred in the treatment of isolated diaphyseal femur fractures, while non-surgical methods are more commonly used in pre-school children [2].

Unlike in adults, fractures in pre-school children have a high remodelling capacity due to their developing bone structure, the presence of an open physis and a thick periosteal layer and the fact that they have different biomechanical responses to mechanical pressure. Thus, the conservative treatment has increased success due to this high remodelling capacity [2,3].

Factors such as the patient's age and weight, location of the fracture, degree of angulation and shortness, whether it is an open or a closed fracture and the existence of accompanying fractures and injuries are vital when choosing the treatment method. Several methods such as pavlik harness, closed reduction with immediate spica casting and spica casting after skin and skeletal traction have been described in the conservative treatment of diaphyseal femoral fractures. Recently, closed reduction with immediate casting was preferred over the traditional post-traction spica casting methods

***Coresponding Author:** Savas Camur, Health Science University, Umraniye Training and Research Hospital, Department of Orthopaedics and Traumatology, Istanbul, Turkey . E-mail: savascamur@yahoo.com

due to shorter hospital stay and better outcomes [4]. In the traditional method, traction is performed until the solid callus is formed in the third week, which can also be seen radiologically, and this treatment extends the hospital stay. There is only a limited number of studies on the efficacy of short-term traction application in terms of its shortening of the length of hospital stay [5].

In this study, the treatment outcomes of diaphyseal femur fractures in preschool children using a hip spica cast after a traditional long-term traction versus short-term traction methods were compared in terms of coronal and sagittal plan angulation, leg length inequality and hospital stay. We hypothesised that hip spica casting after short-term traction would yield comparable results as with traditional long term traction, with adequate stability and a shorter length of hospital stay.

Materials and Methods

Ethical approval for the study (with a file number of 06/25/2019-2454) was obtained from our institutional ethics committee, and informed consent could not be obtained from the patients due to the retrospective design of the study.

Ninety-six patients were treated with conservative methods in our hospital between 2001 and 2013. Of the 96 patients, 36 patients with 36 diaphyseal femur fractures who were present for their last follow-up visit were included in the study.

Patients under one year of age and over 6 years, those who underwent immediate reduction with hip spica casting and those with open fractures were excluded from the study.

Hip spica casts were applied under anaesthesia in the operating room after 0–10 days of traction in patients with a shortness of < 2–3 cm in the coronal-sagittal plane and an angulation of < 20 degrees (Figure 1). Traction was conducted for 11–23 days in patients with a shortness of > 3 cm and an angulation of > 20 degrees. Patients who presented a radiological callus in their weekly radiographies, loss of fracture sensitivity and pathological movements were applied the hip spica casts in their own patient wards.

The appropriate traction type was applied according to the fracture line location, patient's age and weight and presence of accompanying injury. Skeletal, split Russell's and Bohler Braun splint tractions were applied to 2, 14 and 20 patients, respectively (Figure 2). Tractions with minimum and maximum weights of 1.5 and 3 kg, respectively, were applied. During the traction treatment, skin and pin base checks were performed at regular intervals.

The main cast position consisted of hip spica casting at approximately 60 to 90 degrees of hip and knee flexion, at 30 degrees of leg abduction and 15 degrees of external leg rotation (Figure 3).

Patients were observed for 24 hours after the hip spica cast application for the evaluation of compartment syndrome and neurovascular complications.

The first radiographs after cast application and radiographs after the cast removal were evaluated. Valgus-varus angulation (coronal angulation) was measured in the anterior-posterior femur radiographs, and anterior-posterior angulations (sagittal angulation) were measured in the lateral radiographs (Figure 4).

Figure 1. Hip spica cast aplication under anestesia

Figure 2. Bohler Braun splint traction

Figure 3. Hip spica cast

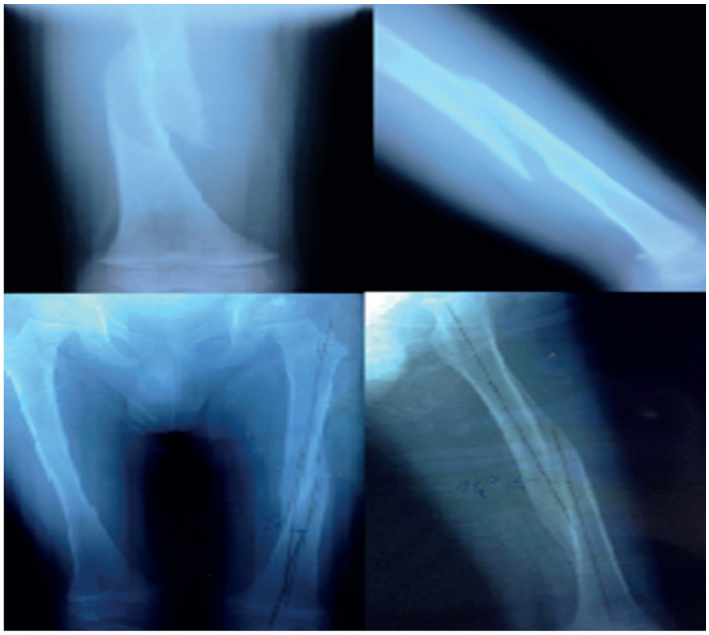

Figure 4. Fracture and the last follow up x- rays

Limp-length inequality was determined through the bilateral measurements and the comparison of the distance between the anterior superior iliac spine and the medial malleolus. Patients were divided into two groups according to their traction time: 0–10 days (Group A) and 11–23 days (Group B). These two groups were compared in terms of limp-length inequality as well as coronal and sagittal angulation.

Statistical methods

All statistical analysis was performed with the statistical software named SPSS ver. 22.0 (IBM-SPSS Inc., Chicago, Illinois). The results were presented as mean ± standard deviation. The Mann-Whitney U Test was used in the measurement of the angulation in coronal and sagittal planes and the duration of hospital stays and cast. A p-value <0.05 was considered statistically significant.

Results

This study included 36 patients; 25 (69.4%) were males and 11 (30.6%) were females. The mean age of the 36 patients was 4.20 ± 1.74 years, and the mean age of the female and male patients was 4.7 and 4 (range, 1–6 years old in both sexes), respectively.

Regarding injury mechanisms among our patients, our findings were as follows: 15 fell at home (41.6%), two fell from stairs (5.5%), three fell from a height (8.3%), two fell in the playground (5.5%), five were injured in a traffic accident outside the car (13,8%), three were injured in a traffic accident inside the car (8.3%), four had a heavy object fall on them (11%) and two had pathological fractures (5.5%) (osteogenesis imperfecta and spina bifida).

Regarding the classification of diaphyseal femur fractures according to their locations, six (16.7%) were located in the proximal, 26 (72.3%) in the middle, and four (11%) in the distal one-third.

Of the 36 patients, 17 were applied closed repositioning and a hip spica cast after short-term (0–10 days) traction, and 19 were applied a hip spica cast following long-term (11–23 days) traction after a callus was observed in the radiograph, fracture sensitivity was noticed on physical examination and the pathological movements were lost.

Traction time was evaluated according to the condition of the fracture, degree of angulation and shortness and the general condition of the patient. The shortest traction time was 3 days as the longest traction time was 23 days.

There was no statistical difference in the angulation and shortness measurements between the cases with the short traction time (0–10 days) and long traction time (11–23 days) after the removal of the cast ($p > 0.05$) (Table 1).

The casts were checked during the routine follow-up visits of the patients, and the fracture line and fracture alignment were

examined using the radiographs. The mean casting time of the group A and B patients were 6.47 ± 1.00 (5–8) and 4.84 ± 0.68 (4–6) weeks, respectively. After the plaster was removed, patients were gradually allowed weight-bearing.

Table 1. Comparison of shortness an angulation of two groups

After the cast removal	Traction Time		*P**
	0-10 Days (n=17) Mean±SD (median)	11-23 Days (n=19) Mean±SD (median)	
Angulation AP	13.50±5.28 (13.00)	13.69±8.84 (10.00)	0.682
Angulation LAT	14.75±6.66 (12.50)	14.46±10.95 (10.00)	0.247
Shortness	1.67±0.75 (1.75)	1.56±0.95 (1.50)	0.561

* Mann-Whitney U Test

Discussion

There are many surgical and non-surgical treatment methods for paediatric femoral fractures, and none of them have a certain superiority over the other. There has been a tendency of using surgical methods for treating paediatric fractures that can be treated with conservative methods [6]. Among these treatment options, only the method of acute casting and delayed casting after traction have level 2 evidence in the guideline that was published by the American Academy of Orthopedic Surgeons (AAOS) for pre-school childhood period (from 6 months to 5 years old). Evidence levels of all other surgical and non-surgical methods are controversial and lower in all age groups [7,8].

Non-surgical methods include pavlik harness application, immediate casting and delayed casting. The treatment method depends on many factors such as age, weight, swelling condition of the extremity and the surgeon's experience.

In recent years, closed reduction with immediate hip spica casting has become increasingly common among the non-surgical treatment methods in preschool children instead of the delayed hip spica casting. The most important advantage of closed reduction with immediate hip spica casting is that it shortens the length of hospital stay. This is a more cost-effective method, which is more affordable in terms of hospitalisation expenses and has social advantages for the child and family [9]. Close follow-up is required after the procedure, especially in the first weeks until the formation of the soft callus (7-12 days), when adequate fracture stability has been achieved [10,11]. The disadvantage of immediate spica cast is the need for re-reductions and cast changes due to the loss of reduction and shortening in this period [12]. Illgen et al. and Thelogis reported a reduction loss of 21.7% and 27%, respectively, and that new surgical and non-surgical interventions were needed due to this loss [13]. This finding indicates that a loss of reduction occurs in one patient out of every 4–5 patients; however, in our study, none of our patients who were applied traction required any additional interventions due to a loss of reduction during the follow-ups.

Although the treatment protocol may be different in each case, post-traction casting in patients with high degrees of angulation and shortness is a successful and reliable method and is used as the primary treatment method for those who do not have any surgical indication. Several studies reported that traction and hip spica casting are safe treatment methods, having a low rate of complications such as limb-length inequality and angular deformity in paediatric closed diaphyseal femur fractures [14,15].

Diaphyseal femur fractures in preschool children can easily tolerate 15 degree of coronal and 20 degree of sagittal plane angulations and a shortness of up to 2 cm due to their high remodeling potential [16].

In our study, the coronal and sagittal plane angulations and shortness values, which were obtained after the cast removal, were reported to be within the acceptable limits. There was no statistical difference between the two methods regarding angular deformities and lower limb length inequalities. ($p > 0.05$).

In our study, the shortness in the group B patients was found to be > 2–3 cm and angulation was > 20 degrees, indicating decreased soft tissue support and increased fracture instability. However, we believe that a traction period of 7–12 days will provide sufficient reduction of the fracture, and the combination of the soft callus, which is formed during this period, and the hip spica cast can provide adequate stability as the solid callus, which is formed during long-term traction.

Long hospital stay is the disadvantage of post-traction spica cast treatment, and it also has negative psychosocial effects on children and families and increases treatment costs. In most studies, post-traction spica cast treatment was reported to have a higher cost than all other treatment methods [17,18]. Serin et al., in a series of 61 cases, found that the mean traction duration was 19.8 days (16–26 days) in 31 patients who underwent traction and were applied spica casts [19].

In our study, the mean hospitalisation time of the patients who were applied hip spica cast after short-term traction (group A) was 8.4 days, and the mean hospitalisation time of the patients who received the conventional long-term traction and were applied hip spica cast was 19.3 days ($p < 0.0001$). Spica cast treatment after short-term traction reduces the length of hospital stay, negative psychosocial effect on children, burden on the hospital management and expenses of the patient's family, similar to immediate spica casting application when compared to traditional casting after long-term traction.[20-22].

Simple complications such as plaster softening, soiling and superficial skin irritation are more frequent, especially in patients treated with early hip spica cast [23]. Rarely, hip spica casting has serious complications such as superior mesenteric artery syndrome, peroneal nerve damage and compartment syndrome [24]. In our study, no significant complications requiring a cast revision (wedging or removing and re–spica casting) were encountered, since the cast was applied after the swelling had resolved.

The retrospective nature of the study and the small number of patients in the two groups are among the limitations of the present study. Besides, the fact that we perform the casting process under sedation in the short-term traction method creates a disadvantage in terms of anaesthesia risks and costs compared to the long-term traction method [25].

Conclusion

Preschool childhood diaphyseal femur fractures can be successfully treated using many conservative treatment methods. Due to its sufficient stability and short length of hospital stay, hip spica cast application after short-term traction can be used as a safe alternative method to immediate hip spica casting and hip spica casting methods after traditional long-term traction.

Conflict of interests
The authors declare that they have no competing interests.

Financial Disclosure
All authors declare no financial support.

Ethical approval
Ethical approval for this study (with a file number of 25/06/2019-2454) was obtained from Şişli Hamidiye Etfal Clinical Research Ethics Committee, and informed consent was obtained from all patients prior to the study.

References

1. Rewers A, Hedegaard H, Lezotte D, et al. Childhood femur fractures, associated injuries, and sociodemographic risk factors: a populationbased study. Pediatrics. 2005;115:543-52.

2. Khoriati, AA, et al. The management of paediatric diaphyseal femoral fractures: a modern approach . Strategies Trauma Limb Reconstr. 2016;11:87-97.

3. Harvey AR, Bowyer GW, Clarke NMP. The managementof paediatric femoral shaft fractures. Curr Orthop. 2002;16:293–9.

4. P. González-Herranz Et al Diaphyseal femur fractures in children. Treatment update. Rev Esp Cir Ortop Traumatol. 2011;55:54-66.

5. Aksoy B ,Ozturk K, Kara A N, Olcay E, Güven B, Şener B T. Çocuk femur cisim kırıklarının pelvi-pedalik alçı içinde cilt traksiyonu ile tedavisi ve erken sonuçları. Acta Orthop Traumatol Turc.1996;30:128-31.

6. Wilkins KE. Operative management of children's fractures: is it a sign of impetuousness or do the children really benefit? J Pediatr Orthop. 1998;18:1-3.

7. Kocher MS, Sink EL, Blasier RD, et al. American academy of orthopaedic surgeons- clinical practice guideline on treatment of pediatric diaphyseal femur fracture. J Am Acad Orthop Surg. 2009;17:718–25.

8. Khoriati AA, Jones A, Gelfer Y, Trompeter A. The management of paediatric diaphyseal femoral fractures: a modern approach. Strategies Trauma Limb Reconstr. 2016;11:87–97.

9. D'Ollonne T, Rubio A, Leroux J, Lusakisimo S, Hayek T, GriffetJ. Early reduction versus skin traction in the orthopaedic treatment of femoral shaf t fractures in children under 6 years old. J Child Orthop. 2009;3:209–15.

10. Serin S. Kılıçoğlu,Mikroskobi düzeyinde kırık iyileşmesi. Ankara Üniversitesi Tıp Fakültesi Mecmuası.2002;55:143-50.

11. Dokmeci MO, Kalender AM, Sevimli R, et al.The effect of ibandronate on fracture healing in rat tibia model .SM J Orthop. 2016;2:1041.

12. Podeszwa DA, Mooney JF III, Cramer KE, et al. Comparison of Pavlik harness application and immediate spica casting for femur fractures in infants. J Pediatr Orthop. 2004;24:460-2.

13. Illgen R 2nd, Rodgers WB, Hresko MT, et al. Femur fractures in children: Treatment with early sitting spica cast. J Pediatr Orthop. 1998;18:481–7.

14. Aranson DD, Singer RM, Higgins RF. Skeletal traction for fractures of the femoral shaft in children.a long term study. J Bone Joint Sug Am. 1987;69:1453-9.

15. Casas J,Gonzales-moran G, Albiana J.Femoral fractures in children from 4 years to 10 years: conservative treatment. J Pediatr Orthop B. 2001;10:56-62.

16. Wallace ME, Hoffman EB. Remodelling of angular deformity after femoral shaft fractures in children. J Bone Joint Surg Br. 1992;74:765–9.

17. Newton PO, Mubarak SJ. Financial aspects of femoral shaft fracture treatment in children and adolescents. J Pediatr Orthop. 1994; 14: 508-512.

18. Nork SE, Hoffinger SA. Skeletal traction versus external fixation for pediatric femoral shaft fractures. A comparison of hospital costs and charges. J Orthop Trauma .1998;12:563-8.

19. Serin E,Yılmaz E, Belhan O. Çocuk Femur Cisim Kırıklarının Tedavi Sonuçları. Hacettepe Ortopedi Dergisi .2001;11:65-70.

20. Ferguson J,Nicol RO. Early spica treatment of pediatric femoral shaft fractures.. J Pediatr Orthop. 2000;20:189-92 .

21. Sarkar S, Bandyopadhyay R, Mukherjee A. Titanium elastic nail - Complications in the treatment of paediatric diaphyseal fracture of femur. Open Orthop J. 2013;7:12-7.

22. Reeves RB, Ballard RI, Hughes JL. Internal fixation versus traction and casting of adolescent femoral shaft fractures. J Pediatr Orthop. 1990;10:592-5.

23. Younis MH, Mahmoud K, Kawas A, Ibrahim T. Early versus late hip spica casting for paediatric femoral shaft fractures. J Pediatr Orthop B. 2019;28:122–6.

24. Tisherman RT, Hoellwarth JS, Mendelson SA. Systematic review of spica casting for the treatment of paediatric diaphyseal femur fractures. J Child Orthop. 2018;12:136-44.

25. Rabattu P-Y, Courvoisier A, Bourgeus,E , Eid A, Durand C, Griffer J. Spica cast as an alternative to general anesthesia for lower limb MRI in young children. J Orthop Trauma. 2014 ;15:55–8.