Application of Hip Spica Cast to Treat Femoral Shaft Fractures in Children: Long-Term Follow-Up

Selina R. Silva, MD[*]; Elizabeth A. Szalay, MD[*a]; Charlotte E. Orr, MD[*b]; Brielle Payne Plost[*], MD; Geneva Tranchida, BS[†c]

[*]Department of Orthopaedics & Rehabilitation, The University of New Mexico Health Sciences Center, Albuquerque, New Mexico

[†]School of Medicine, The University of New Mexico Health Sciences Center, Albuquerque, New Mexico

Changed Affiliations
[a]Died December 29, 2014
[b]OrthoIndy, Indianapolis, Indiana
[c]Department of Orthopaedic Surgery, University of Minnesota, Minneapolis, Minnesota

Corresponding Author Selina R. Silva. Department of Orthopaedics & Rehabilitation, MSC 10 5600, 1 University of New Mexico, Albuquerque, NM 87131 (email: ssilva@salud.unm.edu).

Funding The authors received no financial support for the research, authorship, and publication of this article.

Conflict of Interest The authors report no conflicts of interest.

ABSTRACT

After treatment using hip spica casts, femoral shaft fractures in children can appear well reduced in the operating room. However, the resulting bone length may quickly angulate or shorten. We describe a technique that places a well-molded hip spica cast to help decrease the risk of revision procedures and malunited fractures. We compared results of patients aged 1 to 6 years treated by one pediatric orthopaedic surgeon using the casting technique described (Group A, n = 25) to those treated by other orthopaedic surgeons who did not use the technique (Group B, n = 46). Although not statistically significant, results indicated less shortening and varus angulation in the patients who underwent the described casting technique. Findings of the current study may help guide and recommend this technique in treating children with femoral shaft fractures.

Keywords: Hip Fracture, Children, Plaster Casts, Femur

INTRODUCTION

Children between the ages of 6 months to 5 years with femoral shaft fractures typically undergo surgical treatment with hip spica casts.[1] Complications of hip spica casts can include skin breakdown, malalignment of the fracture, excessive shortening or overgrowth at the fracture site resulting in limb-length discrepancy, and compartment syndrome. Femoral shaft fractures treated in a cast tend toward apex lateral deformity and can shorten excessively.

Few studies have specifically examined techniques using one-and-one-half hip spica cast application for treating femoral fractures. In 1995, Fraser[2] described a hammock suspension technique used in children aged under 2 years with femur fractures. Two years later, Czertak and Hennrikus[3] described use of a below-knee cast to pull traction on the femoral fracture owing to muscle pull while the remainder of the hip spica cast was applied. They emphasized using a valgus mold at the fracture side and the importance of padding the popliteal fossa. In 2006, Mubarak et al[4] reported an increased risk of compartment syndrome if a below-knee cast was applied first and then used for traction on the femoral fracture. Gill et al[5] later described an inexpensive hip spica table by use of a "box-and-bar" technique.

However, no study has reported on the technique currently proposed for treating displaced femoral shaft fractures in children. In the current study, we examined short- and long-term results of using one-and-one-half hip spica casts as described by the senior author (EAS). We hypothesized that this technique may result in fewer problems (ie, with bone shortening, malangulation, and limb-length discrepancy) compared to those of techniques used by other orthopaedic surgeons.

TECHNIQUE

The described technique involving a one-and-one-half hip spica cast uses a padded fracture table (Figure 1). The patient's hips and knees are held in gentle flexion, and with traction applied to the fractured femur (Figure 2A). The surgeon applies the thigh piece of the cast first (Figure 2B). Three to four layers of cast padding are evenly applied to the thigh (Figure 3A). After this, the fiberglass is rolled under slight tension around the thigh

Figure 1. Padded hip spica table.

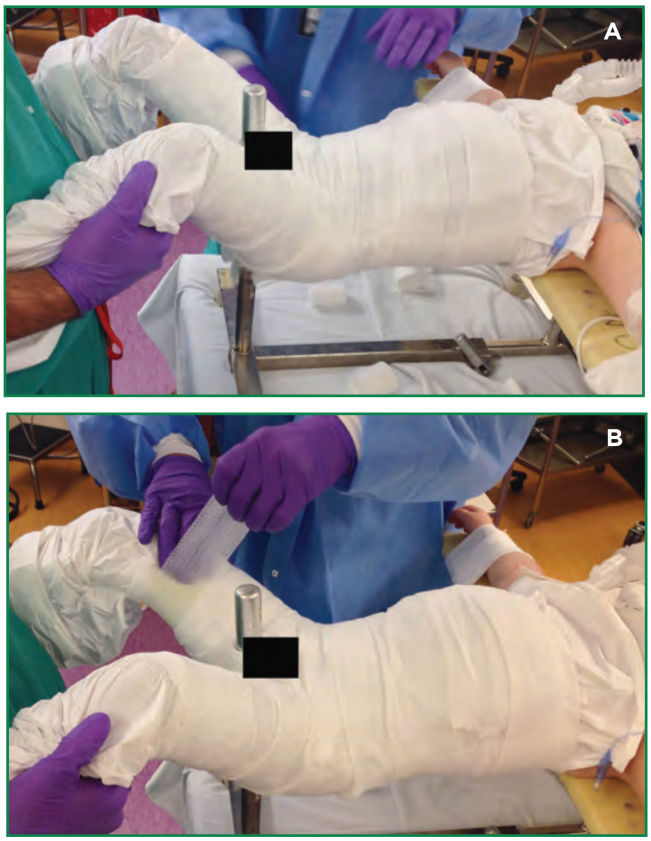

Figure 2. Surgeon technique for applying a one-and-one-half hip spica cast. A) Assistant holds hips and knees in a slightly flexed position with traction applied to the fractured femur. Cast padding has been evenly applied. B) Surgeon rolls fiberglass under slight tension around the thigh.

and molded into a quadrilateral shape to minimize risk of bone malangulation (Figure 3B). The quadrilateral shape also provides improved control of the diaphyseal bone in its cylindrical soft-tissue envelope. When the quadrilateral thigh piece has hardened, the remainder of the hip spica cast is applied to the lower extremities, including the ipsilateral foot (Figures 4A through 4C).

Figure 3. Quadrilateral mold applied to the thigh piece. A) Cast padding layers are evenly applied to the thigh. B) The fiberglass is molded into a quadrilateral shape to minimize angulation.

Patient Recruitment

After receiving approval from our Human Research Review Committee (HRRC #12-365), we reviewed medical records using current procedural terminology codes relating to treatment of femoral shaft fractures from January 1, 2004 to June 1, 2011 (n = 377).

Inclusion criteria were as follows: radiographs available in our facility's digital radiograph database, patients aged 1 to 6 years at time of injury, treatment using a hip spica cast, diaphyseal and displaced femoral fractures, and no medical comorbidities that would affect bone density. Exclusion criteria were non-displaced fractures and treatment with operative fixation. After applying inclusion and exclusion criteria, a total of 71 patients were eligible for analysis. Of the 71 patients, twenty-seven completed a joint survey (obtained over the phone or returned in the mail).

Figure 4. Application of the rest of the one-and-one-half hip spica cast. A) The cast is applied to the ipsilateral foot. B) Finished applying the cast to the ipsilateral foot. C) Final cast in place.

Evaluation

We measured bone shortening and angulation seen on radiographs obtained immediately after the first cast was applied and obtained at final application of the cast. The results of the joint surveys were evaluated for limb-length discrepancies and angulation in the coronal plane only. We compared results of patients treated by the senior author (EAS) to those of patients treated by other surgeons at three different intervals: in the initial cast, at the clinic visit during which the cast was removed (using radiograph findings), and long-term follow-up (using the joint survey).

Group A comprised patients casted using our proposed technique, whereas patients in Group B were casted using other techniques by orthopaedic surgeons in our practice. Measurements included angulation, shortening, and limb-length discrepancy. Patient demographics such as mechanism of injury, associated injuries, city of residence, body mass index, age, and gender were recorded (Table 1). We looked for complications such as necessity of return to the operating room, skin breakdown, infection, altered rotation of the limb, nerve palsy, compartment syndrome, and contracture, or revision surgical treatment. Analysis was done through basic percentages of variables including demographic data, measured bone angulation, and measured bone shortening at the time of initial casting, final casting and long-term follow-up.

Table 1. Demographics as percentages of the 71 patients included in the study[a]

Variable	*No. patients (%)*
Mechanism of Injury	--
Fall	62 (87.3)
Pedestrian vs auto	6 (8.5)
Motor-vehicle collision	2 (2.8)
All-terrain vehicle collision	1 (1.4)
Associated injuries[b]	--
None	66 (93)
Skull fracture	2 (2.8)
Scalp laceration	2 (2.8)
Ramus fracture	1 (1.4)
Clavicle fracture	1 (1.4)
Residence	--
Urban	55
Rural	45
Mean age at time of injury, y	2
Sex	--
Male	63
Female	37
Fracture pattern	--
Oblique	82
Transverse	17
Comminuted	1

--, not applicable.
[a]These values show percentages of patients except in the mean age at time of injury (shows years).
[b]One patient had a ramus fracture and scalp laceration.

Table 2. Results of initial casting, final casting, and long-term follow-up of patients using described casting technique (Group A) and other techniques (Group B)[a]

Measured variables	*Initial casting*		*Final casting*		*Long-term follow-up*	
	Group A (n = 25)	*Group B (n = 46)*	*Group A (n = 25)*	*Group B (n = 46)*	*Group A (n = 9)*	*Group B (n = 18)*
Mean shortening, mm	6	10	12	18	--	--
Mean varus angle,°	1	0	5	8	2	1
Mean anterior angle,°	10	2	15	11	--	--
> 2 cm shortening, %[b]	0	2.2	1.7	3.5	--	--
> 10° varus/valgus[b]	8	11	16	35	--	--
> 10° anterior/posterior[b]	50	13	62	53	--	--
Mean limb-length discrepancy, mm	--	--	--	--	6	9

--, not applicable.
[a]In total, the initial and final casts were applied to 71 patients (Group A, 25 patients; Group B, 46 patients). Long-term follow-up was reported on 27 patients (Group A, 9 patients; Group B, 18 patients).
[b]Corresponding values reflect percentages of patients in each group with the noted angulation.

RESULTS

Average follow-up was 40 months (range, 16 weeks-6 years) Table 2 shows results of the different casting technique used between groups. In Group A, less instances of acute bone shortening, long-term limb-length discrepancy, and varus malangulation were noted. There was slightly more apex anterior malangulation in Group A, however. Of the patients in Group B who completed the joint survey, a total of 11% had limb-length discrepancy of greater than 2 cm at long-term follow-up. This level of discrepancy was not noted in Group A.

At long-term follow-up, one-third of patients in each group had varus or valgus malangulation of more than 5°. No patient in either group developed compartment syndrome or underwent revision procedures. One patient in each group returned to the operating room for repeat casting (Table 2).

DISCUSSION

The techniques and results of using hip spica casting for treating femoral shaft fractures in children can vary. In the current study, we aimed to describe a new technique created by the senior author (EAS) and determine whether the proposed technique would result in fewer complications. Malangulation with apex anterior was slightly higher in Group A, which is acceptable because this deformity is in the plane of motion of the knee joint. Differences between the groups in bone angulation and shortening were small. Complication rates were low and almost equal between groups; again, it should be noted that we studied a small number of patients.

Studies have focused on internal fixation for treating femoral fractures in preschool children. Ramo et al[6] found promising outcomes with flexible intramedullary nail fixation for treating femoral fractures in children aged 4 and 5 years, with a low complication rate. The study also detailed some problems that can occur with closed treatment of femoral fractures in this age group, including bone malunion and shortening. We believe that these problems can be avoided with placement of a well-molded hip spica cast as outlined in current study. Jauquier et al[7] concluded that immediate hip spica placement for treating femoral fractures in preschool-aged children was as effective and more efficient than flexible nailing. They noted that the technique used when placing a cast may be related to how well the fracture maintains alignment.

Our study was limited in analysis regarding long-term follow-up because many patients did not complete the joint survey. Furthermore, many phone numbers were out of service or the calls were unanswered, and many patients lived in remote areas without available transportation. One parent did not bring a participant to avoid subjecting the child to more physician visits or tests. Further research would include attempting to recontact the patients who did not respond and collecting data over several more years to increase statistical power. Although we had an insufficient sample size for a power analysis, we noted a trend toward less bone shortening and apex varus malangulation at both the short- and long-term follow-ups in the group casted by the described technique (Group A).

REFERENCES

1. Kocher MS, Sink EL, Blaiser RD, et al. Treatment of pediatric diaphyseal femur fractures. J Am Acad Orthop Surg. 2009;17(11):718-725.
2. Fraser KE. The hammock suspension technique for hip spica cast application in children. J Pediatr Orthop. 1995;15(1):27-29.

3. Czertak DJ, Hennrikus WL. The treatment of pediatric femur fractures with early 90-90 spica casting. J Pediatr Orthop. 1999;19(2):229-232.
4. Mubarak SJ, Frick S, Sink E, Rathjen K, Noonan KJ. Volkmann contracture and compartment syndromes after femur fractures in children treated with 90/90 spica casts. J Pediatr Orthop. 2006;26(5):567-572.
5. Gill IP, Kolimarala V, Montgomery RJ. Application of hip spica cast using a box-and-bar technique. Ann R Coll Surg Engl. 2008;90(8):700.
6. Ramo BA, Matus JE, Tareen N, Hooe BS, Snoddy MC, Jo CH. Intramedullary nailing compared with spica casts for isolated femoral fractures in four and five year old children. J Bone Joint Surg Am. 2016 Feb 17;98(4):267-275.
7. Jauquier N, Doerfler M, Haecker FM, Hasler C, Zambelli PY, Lutz N. Immediate hip spica is as effective as, but more efficient than, flexible intramedullary nailing for femoral shaft fractures in preschool children. J Child Orthop. 2010 Oct;4(5):461-465.