International Orthopaedics (SICOT) (2003) 27:145–148
DOI 10.1007/s00264-003-0443-z

ORIGINAL PAPER

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Traction spica cast for femoral-shaft fractures in children

Accepted: 13 January 2003 / Published online: 26 March 2003

Abstract We treated 20 children for an isolated femoral shaft fracture using distal tibial traction incorporated into a spica cast with the knee in full extension. Patients were discharged from the hospital at a mean of 5.1 days following injury. All fractures healed, and there were four minor complications. At a mean follow-up of 35 (13–72) months, all patients were asymptomatic with normal function. All but one fracture healed in acceptable alignment, and there was no clinically significant leg-length discrepancy. The method is relatively simple to employ and may be advantageous in a setting of limited resources.

Résumé Nous avons traité 20 enfants pour une fracture de la diaphyse fémorale isolée avec une traction tibiale distale incorporée dans le spica avec le genou en extension complète. Les malades ont quitté l'hôpital en moyenne 5.1 jours après le traumatisme. Toutes les fractures ont consolidé, et il y avait 4 complications mineures. À une moyenne de suivi de 35 (13–72) mois tous les malades étaient assymptomatiques avec une fonction normale. Toutes les fractures sauf une ont guéri avec un alignement acceptable, et il n'y avait aucune différence de longueur cliniquement. La méthode est relativement simple à emploi, et peut être avantageuse dans un cadre de ressources limitées.

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Introduction

Many successful methods have been reported in the management of femoral-shaft fractures in children, and the choice of a particular method is generally based upon the age of the patient, the fracture pattern, the presence of associated injuries, and the experience of the surgeon. Both social and economic variables are also important, especially in developing countries. The treatment approach for the same fracture in a developing country may also be influenced by the cost and availability of implants, the availability of adequately trained health care providers, the lack of adequate sterility in many surgical suites, and the availability of hospital beds. Minimizing complications is essential from both a personal and economic standpoint. Traction is often the most effective way to manage such injuries. However, as the demand for inpatient beds is often much higher than their availability, early discharge is beneficial. These considerations have led to the development of a modified traction spica cast. The goal of this study is to present our preliminary clinical and radiographic data using such traction spica cast for isolated femoral-shaft fractures in children.

Material and method

From 1996 to 1998, 31 consecutive children with a femoral-shaft fracture were entered into a prospective study. Patients between the ages of 3 and 12 years with an isolated fracture of the femoral shaft met the criteria for inclusion. Fractures in the subtrochanteric and supracondylar locations were excluded, as were pathologic fractures. Twenty of these patients have returned for follow-up at more than 1 year following initial injury.

Clinical evaluation included gender, age, side of involvement, mechanism of injury, and neurovascular examination at the time of injury. Records were also reviewed at the most recent follow-up to identify presence of symptoms, limitations in activity, or clinical deformity. AP and lateral radiographs were reviewed at the time of presentation, healing, and latest follow-up. Femoral alignment (AP and lateral planes) was measured at the time of healing and at latest follow-up. For patients between 2 and 5 years of age, acceptable alignment included varus or valgus angulations of ≤15°

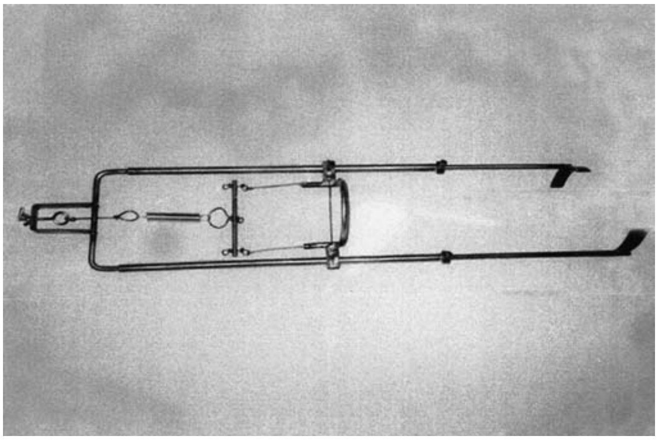

Fig. 1 The traction brace

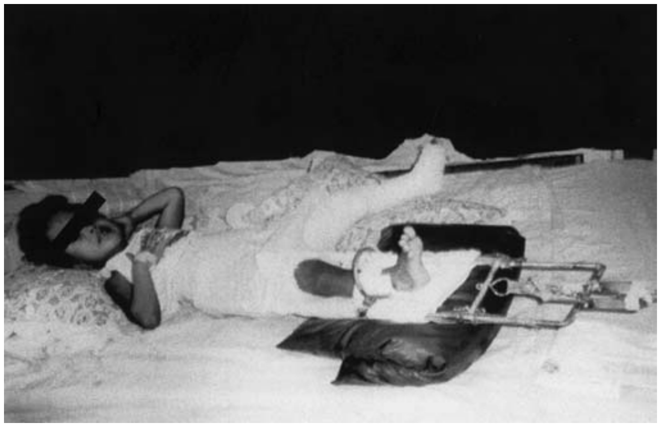

Fig. 2 Patient in traction spica cast

and anterior or posterior angulations of ≤20° [12]. For patients between 5 and 11 years of age, acceptable alignment included varus or valgus angulations of ≤10° and anterior or posterior angulations of ≤15° [12].

Treatment Protocol

Upon admission to the hospital, patients were placed in either Buck's or split Russell's traction while being evaluated for coexisting injuries. When feasible, they were placed in a traction spica cast under either general anaesthesia or sedation with Ketamine.

Using sterile technique, a Kirschner wire (0.062 in.) was placed through the distal tibia (anterior to the fibula) at a distance 5–7 cm proximal to the tip of the lateral malleolus. Xeroform or Vaseline gauze was then applied, followed by a felt pad. The felt pads were then secured by plastic balls or disc plates to prevent lateral pin migration. The K wire was then attached to a traction bow and placed under tension. While manual traction was maintained, the patient was placed in a one and one-half hip spica cast, with the fractured side casted above the knee. Each femur was abducted 35–45°, externally rotated 10–15°, and flexed 20–30° (up to 45° for proximal fractures). The knee was flexed 10–15° on the normal side, and kept in full extension on the side of the fracture.

The length of the traction brace (Fig. 1) was adjusted based upon the child's size, and the device was incorporated into the spica cast with plaster (sheet wadding was applied to the brace at points of contact with the cast to facilitate later removal). The brace was aligned along the longitudinal axis of the extremity in 10–15° external rotation. The traction bow was attached to the brace and then to a tensioning device (preferably with 18-gauge wire). Traction was provided by a coiled steel spring, and the device was tensioned by turning the wing nut until the desired degree of overlap was achieved on radiographs. Rubber strips from the inner tube of a tire may be substituted for the steel spring if this device is unavailable. Traction force was measured with a hand-held, spring-loaded fish scale. We found that it typically takes 2.5–4.5 kg of traction. In children younger than 10 years of age, the goal was to achieve at least 1 cm of overlap. In those patients older than 10 years of age, the goal was an end-to-end reduction without shortening. The leg was supported by a cloth hammock while in the traction device, and pin sites were cleansed daily with a few drops of 70% alcohol. The completed traction spica is shown in Fig. 2.

Following discharge from the hospital, patients were followed clinically and radiographically at weekly intervals until healing was sufficient to warrant removal of the device (usually 3–4 weeks). The traction apparatus and pin were removed under sedation. The spica cast was then extended down to the foot with the knee flexed 10–15°. The cast was also cut back above the knee on the uninvolved side. Patients remained in the spica cast until healing was complete, typically 8–12 weeks of total immobilisation. Following removal of the spica cast, patients used crutches for an additional month.

Results

Clinical and radiographic findings are summarised in Table 1. Mean age was 7.2 years (range 7 months–11 years), and there were 15 males and five females. Mean follow-up was 35 (range 13–72) months. Eleven fractures occurred on the right side and nine on the left. Mechanisms of injury included falls (15) and vehicular accidents (5). Nineteen fractures were closed, and the single open fracture was Gustilo grade 1. The fracture occurred at the middle third in 16 patients, three in the proximal third, and one in the distal third. Only one fracture was comminuted. Neurovascular examination was normal in all patients at both presentation and at follow-up.

Mean traction force was 3.3 (range 1.8–5) kg. Mean amount of shortening while in traction was 2.6 (range 1.4–4.0) cm. Mean time in traction was 4.5 (range 2–7) days, and mean time for spica cast immobilisation was an additional 49.4 (range 32–64) days. Mean hospital stay was 5.1 (range 3–8) days. All fractures united, and there were no refractures. At follow-up, 16 of 20 patients had equal leg lengths on clinical examination, while three had shortening of the injured extremity; a single patient had 0.5 cm of overgrowth.

Acceptable alignment in the AP and lateral planes was obtained in 19/20 patients at follow-up. Overall, neutral alignment in the AP plane was observed in 8/20 cases, while 11/18 cases were aligned in varus (mean 6.0°, range 1–12°). A single femur was aligned in 3° of valgus. On the lateral radiograph, 8/20 patients had neutral alignment, while 11/20 had anterior angulation (mean 6.8°) and a single femur was angulated posteriorly (2°). Hip rotation was symmetric in 16/20 patients at the time of follow-up, and four patients had 10° of rotational

Table 1 Clinical and radiographic findings in 20 patients. *Pt* patient number, *Gen* gender, *Mech* mechanism of injury, *MVA* motor vehicle accident, *Casting* time in days from admission to placement of traction spica, *Hosp* total number of days spent in hospital, *Rot* rotation at followup examination, *int* internal, *ext* external, *LLD* leg-length discrepancy (negative values represent shortening of the affected extremity), *na* not available, *N* normal

Pt	Gen	Age (years)	Mech	Casting (days)	Hosp (days)	Time in cast	Alignment (AP)	Alignment (Lateral)	Rot	LLD initial	LLD F/U	Follow up (months)
1	M	7	Fall	5	5	48	6° varus	6° anterior	N	−3.0	0	39
2	M	8	MVA	5	4	54	5° varus	2° anterior	10° ext	−2.4	0	31
3	M	11	MVA	6	8	64	12° varus	11° anterior	10° ext	−2.5	0	20
4	M	10	Fall	4	5	48	Neutral	Neutral	N	−4.0	−1.0	19
5	M	9	Fall	2	4	55	4° varus	10° anterior	N	−2.5	0	54
6	M	7	Fall	5	6	60	Neutral	Neutral	N	−2.5	0	53
7	M	9	Fall	4	5	53	2° varus	10° anterior	10° int	−1.4	0	34
8	F	8	MVA	4	5	53	7° varus	Neutral	N	−3.8	0	72
9	M	5	Fall	4	5	47	1° varus	10° anterior	N	−2.3	0	49
10	F	4	Fall	3	4	42	Neutral	Neutral	N	−1.8	0	26
11	M	5	Fall	2	3	52	8° varus	2° anterior	10° int	−3.0	0	22
12	F	7	Fall	4	4	na	Neutral	4° anterior	N	−2.8	0	72
13	M	3	Fall	3	3	50	Neutral	Neutral	N	−1.8	0	13
14	M	9	Fall	5	5	32	Neutral	2° posterior	N	−2.5	0	60
15	F	5	Fall	4	5	42	2° varus	2° anterior	N	−2.3	0	17
16	M	11	Fall	7	8	51	Neutral	Neutral	N	−2.5	0	16
17	M	9	Fall	6	7	44	Neutral	Neutral	N	−2.5	−0.5	37
18	M	4	MVA	7	na	47	3° valgus	10° anterior	N	−3.0	+0.5	36
19	M	6	Fall	5	5	43	10° varus	10° anterior	N	−2.0	0	17
20	F	8	MVA	4	5	53	7° varus	Neutral	N	−3.8	0	15

malalignment. All patients remained asymptomatic, and there were no cosmetic concerns.

Four minor complications were identified in the series: Two superficial pin-site infections required a short course of oral antibiotics. A single presacral decubitus ulcer healed with trimming of the cast and daily dressing changes at home. One patient developed an allergic reaction to the casting materials, which required removal of the cast.

Discussion

A host of options are available for treating femoral-shaft fractures in children, including skin or skeletal traction with or without spica casting [1, 9, 11, 13], an immediate spica cast, a spica cast incorporating skin traction or skeletal traction [4, 6, 14, 17, 18, 19, 20], external fixation [2, 3, 16], or internal fixation with flexible intramedullary nails [2, 5, 7, 10, 21] or compression plating [8, 22]. Although prolonged traction (with or without delayed spica casting) is a time-honoured method, it may be beneficial for both the patient and the health care system to use a method that facilitates earlier discharge.

In developing countries, other factors may influence the choice of a particular method, including the presence of adequately trained providers, equipment, and inpatient beds. The optimal treatment method in this setting should be relatively simple to apply, rely upon resources available locally, be associated with few complications, and facilitate early discharge.

The concept of a traction spica cast is not new. Techniques involving either skin traction or skeletal traction have been associated with adequate results and early discharge from the hospital [4, 6, 14, 17, 18, 19, 20]. Staheli and Sheridan reported success with a spica cast incorporating bilateral skin traction [20]. Using this technique, the proximal fragment is controlled by the "well leg traction principle", while the distal fragment is controlled by traction on the affected side. Hospitalisation averaged 3 days, and only two patients had more than 10° of angulation (anterior), while 25% had a 10–20° difference in rotation between the extremities. Mean leg-length discrepancy was less than 2 mm.

Moore and Schafer described a technique using adhesive skin traction incorporated into a one and one-half hip spica cast [17]. Control of the proximal fragment was achieved with perineal straps made of muslin stuffed with cotton. A rectangular iron rod was incorporated into the cast from mid thigh to a point beyond the foot, and the traction was maintained by securing the traction straps to the rod distally.

Splain and Denno employed a proximal tibial traction pin incorporated into a single spica cast [19]. The affected limb was immobilised in extension at the knee, and less than 1 cm of shortening was accepted. Excellent results were obtained in 16 patients between 4 and 11 years of age, with no significant leg-length discrepancy and a single case of rotational malalignment.

Celiker et al. treated 65 children with a distal femoral traction pin (Kirschner wire) incorporated into a one and one-half spica cast (1.5–2 cm. of shortening accepted) [4]. Hip position was determined by the location of the fracture, and the knee joint was maintained at 90° flexion. No angular or rotational deformities were reported after healing, and regarding leg lengths, several patients had overgrowth less than 1 cm. No complications were noted.

Miller et al. described the pontoon spica cast, in which a distal femoral traction pin was incorporated into a spica cast with 90° flexion at both the hip and the knee [14]. The lower leg portion was bivalved, which enabled range of motion and strengthening exercises to be started early. The pin was removed after 2–3 weeks. Only one of 20 patients had angulation >10°, and complications included wire breakage (1) and superficial infection (1). No significant leg-length discrepancy was noted at follow-up.

Our overall results compare favourably with all of these studies. All fractures healed, and at 35 months' follow-up, all patients were asymptomatic and functioned normally. All but one fracture (12° varus) healed in acceptable alignment, and no clinically significant discrepancy in leg length was identified at follow-up. In our opinion, the traction apparatus used in this study offers several advantages: Since the traction pin is not incorporated into the cast, a constant traction force may be applied, and there is less chance of pin breakage or lateral motion. The force of traction may be adjusted as muscle spasm subsides. Theoretically, the risk of skin complications should be less in comparison with techniques employing skin traction. The traction apparatus may also be reused.

Distal tibial traction was selected for several reasons. The pin can be placed without image intensification and does not have to be parallel to the mechanical axis of the limb (relies upon ligamentotaxis through the knee). Proximal tibial traction also relies upon ligamentotaxis; however, there is a risk of physeal injury, which may result in a recurvatum deformity [2, 15]. We did not identify any cases of knee pain during treatment, nor was symptomatic knee instability observed at follow-up. Miller and Welch identified knee subluxation or dislocation in 7 of 10 patients treated in proximal tibial 90–90 traction [15]. In the present technique, the knee is maintained in full extension, and the line of traction is parallel rather than perpendicular to the joint in the sagittal plane. We accepted more initial shortening than commonly reported in the literature, yet no clinically significant discrepancy in leg lengths was encountered at a mean follow-up of 35 months. Additional distraction may have occurred after subsidence of muscle spasm prior to callus formation.

In summary, these preliminary results suggest that the traction spica cast is an excellent option for managing isolated femoral shaft fractures in children. This technique is applicable in a setting of limited resources, is associated with a low incidence of complications, and offers results comparable to other treatment methods. The length of hospitalisation is shortened, which frees up inpatient beds and allows patients and their families to resume a more normal lifestyle throughout the course of treatment.

Acknowledgement The authors wish to thank Dr. M. Palabyab, Dr. S. Peli, Dr. A. Angala, Dr. E. Guevarra, Dr. H. Chua, and Dr. G. Cunanan for their help in completing this study.

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