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Original Research

Dynamic Femur Fracture Brace vs Hip Spica Cast for Pediatric Femoral Shaft Fractures: A Retrospective Comparative Cohort Study

Virginia F. Casey, MD[1]; Calvin C. Chandler, MD[2]; George D. Graham, MD[2]; Steven L. Frick, MD[3,*]

[1] OrthoCarolina, Charlotte, NC, USA
[2] Atrium Health Musculoskeletal Institute, Charlotte, NC, USA
[3] Atrium Health – OrthoCarolina, Wake Forest University School of Medicine, Charlotte, NC, USA

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ABSTRACT

Background: Femoral shaft fractures constitute 1.6% of pediatric fractures and are a leading cause of pediatric orthopaedic hospitalization. The prefabricated DF2 functional brace offers an alternative to traditional spica casting, which is effective but has limitations. This study compares short-term outcomes and complications between the DF2 brace and spica casting in the management of pediatric femoral shaft fractures.
Methods: A retrospective comparative cohort study analyzed 40 patients aged 1–5 years with diaphyseal femur fractures treated between September 2021–August 2024 in a single level 1 trauma center. Twenty patients treated with the DF2 brace were compared with 20 spica cast patients with similar ages, weights, and fracture patterns. Primary outcomes included fracture union, time to weight-bearing, and radiographic alignment. Secondary outcomes encompassed hospital admission rates, length of stay, and complications.
Results: Demographics were similar between groups (mean age 2.2 years, 80.0% male). Hospital admission rates were significantly lower in the DF2 group (35.0% vs 75.0%, $P = .011$) with shorter median length of stay (6.1 vs 22.9 h, $P = .0004$). 90.0% of spica cast patients underwent general anesthesia in an operating room compared to none in the DF2 group. All fractures achieved radiographic union by 6 weeks, with similar time to brace/cast removal and weight-bearing (DF2: 41 days, Spica: 39 days, $P = .19$). Statistically significant differences in final sagittal plane angulation were found in the DF2 group (DF2: 7° vs. Spica: 0°, $P = .038$), but no malunions occurred. The DF2 group had more emergency department returns (3 patients vs 1 patient), while the spica group had two cases of skin breakdown. In 2024, our preferred treatment method for isolated pediatric femoral shaft fractures changed from spica casting to functional bracing.
Conclusion: The DF2 brace demonstrated similar short-term clinical outcomes compared to spica casting while significantly reducing hospital admissions, length of stay, and need for general anesthesia. Our study replicates previously presented work that the DF2 brace represents an attractive alternative for managing pediatric femoral shaft fractures, optimizing healthcare resource utilization without compromising treatment efficacy.
Key Concepts:
(1) The DF2 brace's modular design with adjustable compression and hip hinge system enables straightforward application in the emergency department under conscious sedation, facilitating femur fracture stabilization without requiring general anesthesia or operating room resources.
(2) The DF2 brace demonstrated similar short-term clinical outcomes to traditional spica casting for pediatric femoral shaft fractures while significantly reducing hospital admissions, length of stay, and need for general anesthesia.
(3) All patients in both treatment groups achieved radiographic bone union by 6 weeks, with comparable time to weight-bearing and no observed malunions.
(4) Our institution's treatment approach shifted dramatically from 100% spica casting in 2021–2022 to 90.5% DF2 bracing by mid-2024, reflecting rapid adoption based on favorable clinical outcomes and healthcare resource utilization.
Level of Evidence: Level III retrospective case-control study

* Corresponding author: 2001 Vail Ave 6th floor MSKI, Charlotte, NC 28207, USA.
E-mail address: Steven.frick@atriumhealth.org (S.L. Frick).

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Introduction

Femoral shaft fractures represent approximately 1.6% of all pediatric fractures and have been reported as the leading cause of pediatric orthopaedic hospitalization, with an estimated incidence of 26 per 100,000 children annually [1–3]. Management of these fractures has evolved, with treatment strategies varying based on the patient's age, fracture pattern, and associated injuries [4]. Hip spica casting, with cast material spanning from the patient's torso to below the knee, has been the standard treatment for children between 6 months and 5 years of age [5,6].

The spica cast application process often occurs under general anesthesia and requires skill and experience from the provider to apply the cast safely and maintain fracture alignment. The ideal position for femoral shaft fracture management with hip spica casts has been controversial, and improper position can necessitate cast removal and reapplication [7–9]. As a result, this process is dependent on provider knowledge and expertise, which, while under general anesthesia, introduces additional risks and healthcare costs [10].

Beyond the technical application challenges, various complications have been associated with spica casts that can impact patient comfort and caregiver burden. Common issues include skin irritation, pressure sores, and blisters [11]. Additional studies have also observed that spica casts placed using traction with the hips and knees positioned in flexion can elevate the risks of compartment syndrome [12]. Consequently, physicians may recommend admitting patients for 24-h observation following spica cast application to monitor for neurovascular compromise [13], in addition to educating caregivers how to care for the patient in the cast and arranging for safe car transport. Following discharge, the rigid nature of the cast and instructions to keep it dry can make it particularly difficult for caregivers to maintain hygiene, especially during diaper changes and toileting [14]. Spica casts, once applied, cannot be easily adjusted to accommodate changes in patient needs.

In response to these challenges, innovative technologies have emerged to provide alternatives to traditional spica casting. One such advancement is the prefabricated Dynamic Femur Fracture (DF2) brace (OrthoPediatrics, Warsaw, IN). This device offers potential advantages in terms of patient comfort, ease of use, and adaptability, and is designed to provide stable immobilization of femoral shaft fractures while addressing many of the limitations associated with spica casts. Key DF2 brace features include adjustable compression to maintain a snug fit throughout the treatment period and in response to changes in thigh swelling, the ability to perform dressing changes and hygiene care without removing the device, and the option for surgeons to adjust limb positioning as needed [15].

While promising, the clinical efficacy and safety of the DF2 brace compared to traditional spica casting require evaluation. The clinical award paper at the 2022 POSNA annual meeting by Andras et al. highlighted the growing use and early positive reports of functional bracing in clinical practice in a prospective, randomized trial [16,17]. Our institution's early adoption of this technology provides an opportunity to evaluate its efficacy in treating pediatric femoral shaft fractures and potentially replicate their findings. All DF2 braces used in this study were purchased by our institution at standard pricing, with no funding provided by OrthoPediatrics. None of the authors or pediatric orthopaedic surgeons involved in the study has financial or other conflicts of interest to disclose. The purpose of this study was to compare clinical outcomes, complication rates, and healthcare resource utilization between patients treated with the DF2 brace versus spica casting for low-energy pediatric femoral shaft fractures. We hypothesized that the DF2 brace would demonstrate similar fracture healing and clinical outcomes with the same or fewer complications compared to traditional spica casting.

Materials and methods

With institutional review board approval, we conducted a retrospective comparative cohort study at a single level 1 pediatric trauma center between January 2021 and August 2024. Through our trauma registry database, we queried all patients aged 1–5 years with femoral shaft fractures defined by ICD-10 codes S72.3XXA (Initial encounter for fracture of shaft of femur) and S72.399A (Other fracture of shaft of unspecified femur, initial encounter). All patients included in the study were selected based on having a low-energy femoral shaft fracture with a simple fracture pattern (spiral or transverse) with less than 2 cm (cm) of initial shortening. All fractures were managed by one of five pediatric orthopaedic surgeons at our level 1 trauma center, each with a minimum of 12 years of clinical experience.

Patients were excluded if they had high-energy mechanism of injury (struck by car, fall from an appreciable height, fracture comminution, excessive initial fracture shortening), pathologic fractures, open fractures, additional injuries on presentation, initially treated by method other than DF2 brace of spica cast, or had a history of ipsilateral femur fracture.

A control group from the patients treated with spica casts was selected from patients with similar age, size, and fracture pattern to patients in the DF2 group (age within 6 months, weight within 2 kg, and fracture pattern to their closest comparison). These criteria were selected based on variables identified in a published clinical practice guideline to guide decision making for patients with these injuries [18]. For both groups, follow-up protocols varied according to the on-call attending surgeon's preferences, typically consisting of clinical evaluations and radiographic imaging at 2, 4, and 6 weeks after fracture reduction. Assessment for bone union usually occurred at 6 weeks, with subsequent follow-up scheduled according to the physician’s discretion.

The DF2 brace comes in six preset sizes based on thigh and calf circumference and consists of a pelvic girdle strap, adjustable metal hip hinge, polyethylene outer leg sleeve with adjustable straps, removable foot plate, and a stockinette (Fig. 1). The brace is designed to be applied in the emergency department (ED) with conscious sedation and allows for adjustable compression and modified limb positioning through a hip hinge system that can be locked at desired degrees of flexion and abduction [16](Fig. 2). Once the brace is applied, patients are discharged home with non-weightbearing recommendations.

Hospital charts were reviewed from the time of initial ED encounter to the time of discharge to calculate length of hospital stay in hours. Radiographic measurements were performed by a single pediatric orthopaedic surgeon with over 25 years of experience who was not involved in the clinical care of the patients. Fracture shortening was

Figure 1. Patient correctly placed in DF2 brace at the time of injury.

measured on both anteroposterior and lateral radiographs by measuring the distances between the apices of fracture segments in millimeters (mm) and then taking the larger of the measurements (Fig. 3). At the fracture apex, angular deformity was measured in both coronal (positive = valgus angulation, negative = varus angulation) and sagittal planes (positive = apex anterior, negative = apex inferior) (Figs 4 and 5). Malunion was determined to be present if femoral angulation and shortening did not meet the criteria established by Kasser et al. [13]. Acceptable reduction not constituting malunion was defined as angulation $\leq 15^\circ$ in the coronal plane, $\leq 20^\circ$ in the sagittal plane, and limb shortening ≤ 2 cm as supported by previous literature for this age group [19–23]. Malrotation was determined by clinical examination by experienced pediatric orthopaedic clinicians. Assessment of limb length discrepancy was performed through either radiographic measurement of bilateral femurs on standing radiographs, or documentation of any limb length discrepancy in clinical notes (Fig. 6).

Data collection encompassed patient demographics (age, sex, weight), injury characteristics (mechanism, date of injury, fracture pattern), and treatment details, including timing and type of immobilization (DF2 brace or spica cast). Radiographic parameters were documented at presentation (initial displacement and angulation) and follow-up to assess healing progression and final alignment. Clinical outcomes included time to union and weight-bearing status. All complications were recorded, such as skin concerns, loss of reduction, and unplanned ED visits. Charts were reviewed for messages from families to office staff as a proxy for the impact on the family of caring for a patient in a spica cast or functional brace.

Study data were collected and managed using REDCap (Nashville, TN) electronic data capture tools hosted locally [24,25]. Standard descriptive statistics were used, including frequency and proportion as well as measures of central tendency. All numerical variables were tested for normality using Shapiro-Wilk tests. As all variables demonstrated non-normal distribution, Wilcoxon rank-sum tests were used for all numerical comparisons. Categorical variables were compared using Chi-square or Fisher's exact tests as appropriate based on cell frequencies. Statistical significance was set to $P < .05$, and all statistical analyses were performed using Statistical Analysis System version 9.4 (Cary, NC; (http://www.sas.com/software/sas9)).

Figure 3. Measuring radiographic shortening at the time of initial injury.

Results

Initial screening by ICD-10 code identified 170 patients - 147 treated with spica casts and 23 with DF2 braces. A total of 71 spica casts met final inclusion criteria. Of the 23 DF2 brace patients, three were excluded: two subtrochanteric fracture patterns and one a ballistic injury with severe comminution, leaving 20 patients in the initial DF2 cohort. One patient in the DF2 group was lost to follow-up, and was included in initial calculations, but was excluded from outcome analysis along with the paired spica cast control patient.

The study included 40 patients, 20 treated with DF2 braces and 20 similar patients selected from the group treated with spica casts. Median age was 2.2 years, median weight of 13.9 kg, and 80.0% of patients were male. There were no statistical differences in demographic characteristics, including age, weight, and sex distribution between groups ($P > .05$). Median initial fracture shortening was comparable (DF2: 8 mm vs. Spica: 8 mm, $P = .81$), with 40% of all fractures being non-shortened. One fracture with mild visible shortening was excluded from shortening analysis, as only intraoperative fluoroscopy was available, and a measurement of initial shortening in mm was not possible. Mechanisms of injury were ground-level falls (45.0%), falls from height <3 m (73.5%), twisting injuries (10.0%), motor vehicle collisions (2.5%), and direct blow injuries (5.0%) (Table 1).

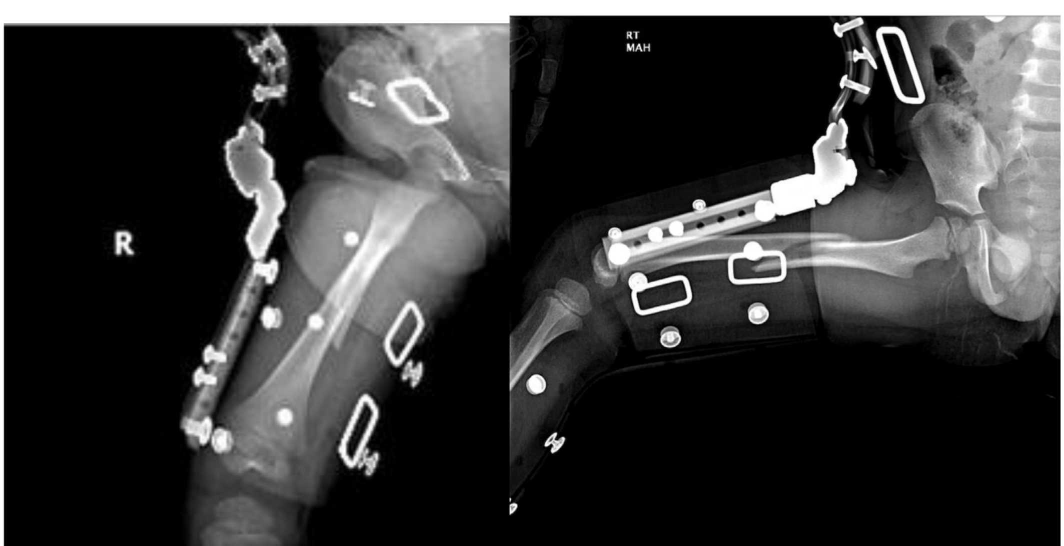

Figure 2. DF2 immobilization with hip-hinge system.

Figure 4. Measuring varus-valgus angulation on anterior-posterior radiographs.

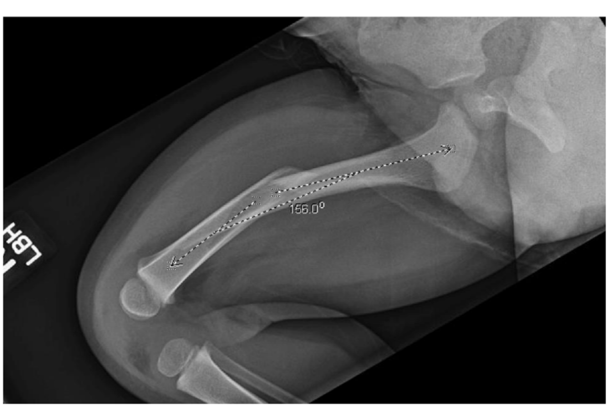

Figure 5. Measuring anterior-posterior angulation on lateral radiographs.

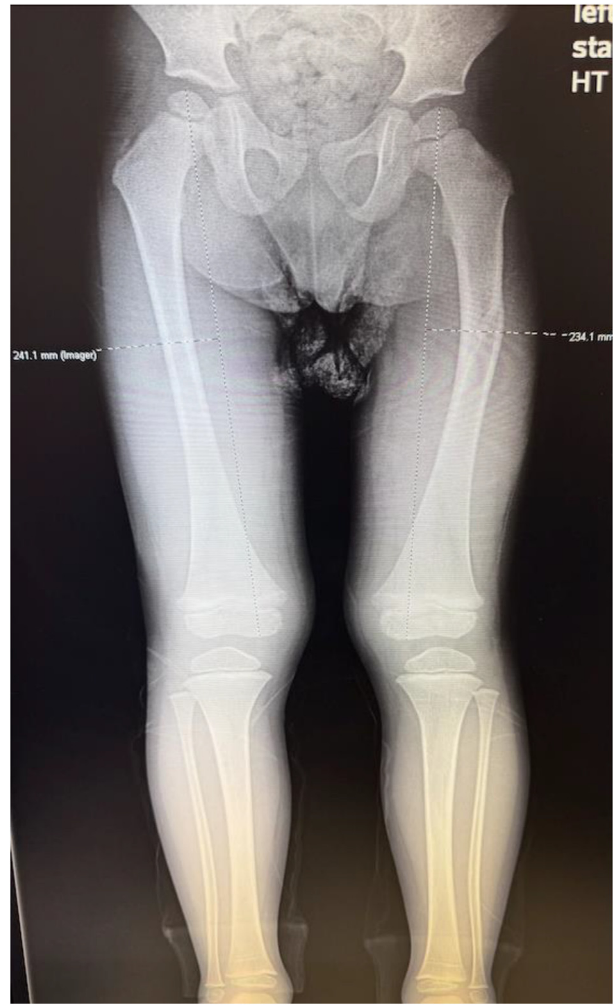

Figure 6. Assessment of limb length discrepancy on standing radiographs.

Significant differences were noted in initial hospital resource utilization. The DF2 group demonstrated lower hospital admission rates (35.0% vs. 75.0%, $P = .011$) and shorter median length of stay (6.1 vs. 22.9 h, $P = .0004$). Notably, while 90.0% of those treated with spica casts had general anesthesia and operating room (OR) intervention for cast application (median operative time 45 min), no DF2 patients required general anesthesia and OR usage for brace application (Table 2).

The average follow-up was 40.5 days, and all patients in both groups showed radiographic bone union at or before 6 weeks. Those with DF2 braces had more radiographs taken than those with spica casts (3 vs 2, $P = .036$). However, there were no differences in clinic visits or messages to clinic offices. Time until weight-bearing was similar between groups (DF2: 41 days vs. Spica: 39 days, $P = .11$). Final radiographic outcomes showed comparable final coronal plane angulation (DF2: 7° vs. Spica: 3°, $P = .47$), though final sagittal plane angulation differed significantly (DF2: 7° vs. Spica: 0°, $P = .038$). Changes in angulation from initial to final radiographs were similar between groups in both planes. No patient treated with the DF2 brace was noted to have clinically significant angular or rotational asymmetry or shortening. More DF2 patients returned to the ED within 6 weeks (3 vs. 1), though this difference was not statistically significant ($P = .61$). Of the ED returns, two patients in the DF2 group presented with brace-related concerns of loosening, while one patient from each treatment group presented for pain management. The spica cast group experienced two cases of skin breakdown, while no

Table 1.
Demographic Comparison of DF2 Brace vs. Hip Spica Cast.

Variable	DF2 N = 20	Hip Spica N = 20	Overall N = 40	*P*-value
Age, median (IQR)	2.1 (1.8,2.5)	2.2 (1.8,2.5)	2.2 (1.8,2.5)	.91
Weight, median (IQR)	13.9 (12,14.8)	14 (12.1,15.1)	13.9 (12,15)	.89
Sex				
Male	4 (20%)	4 (20%)	8 (20%)	1.0
Female	16 (80%)	16 (80%)	32 (80%)	
Initial fracture shortening (mm)				
Median (IQR)	8 (0,13)	8 (0,12)	8 (0,12.3)	.81
None (=0)	8 (40%)	8 (40%)	16 (40%)	.89
≤ 20 mm	12 (60%)	11 (55%)	23 (57.5%)	
Missing	0	1 (5%)	1 (2.5%)	
Fracture pattern				
Spiral	20 (100%)	20 (100%)	40 (100%)	n/a
Transverse	0	0	0	
Mechanism of injury				
Direct blow	1 (5%)	1 (5%)	2 (5%)	
Fall from height < 3 m	7 (35%)	8 (40%)	15 (37.5%)	
Ground level fall	9 (45%)	9 (45%)	18 (45%)	
MVC	0	1 (5%)	1 (2.5%)	
Twisting	3 (15%)	1 (5%)	4 (10%)	

Table 2.
Initial Encounter Comparison of DF2 Brace vs. Hip Spica Cast.

Variable	DF2 N = 20	Hip Spica N = 20	Overall N = 40	*P*-value
Admitted	7 (35%)	15 (75%)	22 (55%)	.011
Length of stay, hours (range)	6.1 (3.1,23.5)	22.9 (3.2,87.6)	16.9 (3.1, 87.6)	.0004
Went to operating room	0	18 (90%)	18 (45%)	n/a
Operation time, mins (range)	n/a	45 (17,102)	45 (17,102)	n/a

skin complications were observed in the DF2 group. Neither group demonstrated nerve palsy or malunion (Table 3).

Over the time frame of the study, in the calendar years 2021 and 2022, all isolated low-energy pediatric femur fractures managed non-operatively were treated with spica cast application under general anesthesia (n = 38), with no patients receiving DF2 braces. In 2023, 31 patients (96.9%) received spica casts while 1 patient (3.1%) was treated with a DF2 brace. During 2024 through August, 19 patients (90.5%) received DF2 braces, and only 2 patients with femoral shaft fractures (9.5%) underwent general anesthesia for spica cast application at our level 1 trauma center (Table 4).

Discussion

The management of pediatric femoral shaft fractures continues to evolve, with emerging technologies potentially changing traditional methods. The lead author became aware of the successful use of this brace for pediatric femur fractures in 2016 after a POSNA trauma session presentation by Dr. Andrea Kramer. At the 2022 POSNA annual meeting, the clinical award paper was a prospective randomized trial comparing functional bracing to spica casting that showed equivalent short-term outcomes, after which the DF2 brace became available for use in late 2023. The first DF2 brace in our center was applied in November 2023. The brace was rapidly adopted in our practice as the preferred method of treating isolated low-energy femoral shaft fractures in children less than 5 years old, and the initial positive early experience prompted us to perform this comparative replication study.

Our patients treated with the DF2 brace achieved fracture union rates comparable to spica casting, with all patients in both groups showing radiographic signs of union by 6 weeks. This aligns with previous literature demonstrating successful union rates of 86–100% with spica casting in this age group [9,26,27]. Time to weight-bearing and time to brace or cast removal were similar between groups as well, with recommendations to weight bear as tolerated generally occurring at the time of brace or cast removal. We found DF2 bracing provides adequate stabilization for normal fracture healing progression with no appreciable differences in time of immobilization. This is comparable with other literature, which suggests an average 42 days of immobilization until union is typical for those treated early with spica casts [27,28]. Radiographic outcomes were different between treatment methods, with the DF2 group having statistically significantly greater final sagittal plane angulation (7° vs 0°). The increase in sagittal angulation may reflect the dynamic nature of the brace compared to the rigid immobilization of spica casting. Likewise, both treatment groups included patients with sagittal plane angulation of up to 17°. While substantial, these cases were not associated with clinical deformity or delayed weight bearing, and remained within acceptable ranges of angulation with remodeling potential that do not constitute a malunion [20–23]. We observed adequate angulation and varus deformity control with reduction maintained following brace application (Fig. 7).

Complication profiles differed between groups but did not reach statistical significance, potentially related to our small sample size. No patient had neurovascular compromise, contractures, nerve palsy, or malunion. The spica group's skin complications (10.5%) were lower than previously published rates of skin complications with spica casting of 28–33% [11,29]. The absence of any skin complications in the DF2 group could signal an advantage in skin care and hygiene management.

Table 3.
Outcome and complication comparison of DF2 brace and hip spica cast (N = 38).

Variable	DF2 N = 19	Hip Spica N = 19	Overall N = 38	*P*-value
Total # of clinic visits <6mo: median(Range)	3 (0,6)	2 (1,3)	3 (0,6)	.23
Total # radiographs taken <6mo: median(Range)	3 (0,6)	2 (1,3)	3 (0,6)	.036
Total # of phone calls/message encounters <6mo: median(Range)	0 (0,3)	1 (0,8)	0.5 (0,8)	.16
Time until Brace/Cast removed, days (Range)	41 (32,52)	39 (28,63)	39 (28,63)	.11
Time until weight bearing as tolerated, days (Range)	41 (32,52)	39 (28,124)	39 (28,124)	.19
Evidence of bone union at last visit	19 (100%)	19 (100%)	38 (100%)	1.0
Radiographic outcomes: median (range)				
Final coronal angulation, degrees	−7 (−14,6)	−3 (−14,7)	−4.5 (−14,7)	.47
Final sagittal angulation, degrees	7 (0,17)	0 (−8,17)	0 (−8,17)	.038
Coronal angulation, degrees Δ	−4.5 (−20,15)	0 (−16,19)	0 (−20,19)	.23
Sagittal angulation, degrees Δ	0 (−16,19)	0 (−14,17)	0 (−16,19)	.29
Complications				
Returned to emergency department	3 (15.79%)	1 (5.26%)	4 (10.53%)	.61
Skin breakdown	0	2 (10.53%)	2 (5.26%)	n/a
Nerve palsy	0	0	0	
Malunion/Limb length discrepancy	0	0	0	

Table 4.
Annual distribution of non-operative treatment modalities for isolated femoral shaft fractures in patients aged 1–5 Years.

Variable	DF2 N = 23 (24.5%)	Hip Spica N = 71 (75.5%)	Overall N = 94
2021	–	16 (100%)	16
2022	–	22 (100%)	22
2023	1 (3.1%)	31 (96.9%)	32
2024 (Jan–Aug)	19 (90.5%)	2 (9.5%)	21

Likewise, the higher rate of emergency department returns in the DF2 group is important to note, as two of the cases were the result of questions regarding brace positioning and loosening, with the other case being for pain control. This may reflect a learning curve for both families and doctors associated with a new technology and emphasizes the need to educate caregivers regarding brace adjustments and positioning, as well as standardized protocols for checking brace hinge tightness [16].

The most important finding of our study was the marked reduction in hospital admissions and OR utilization that occurred in our system after the adoption of DF2 bracing as the preferred treatment for isolated femoral shaft fractures. While spica cast patients typically required general anesthesia and OR resources, all DF2 braces were successfully applied in the ED setting. This translated to a significant reduction in hospital admission rates (35.0% vs. 75.0%) and median length of stay (6.1 vs. 22.9 h). Previous studies have reported mean hospital stays of 1–4 days for spica cast application, comparable to our spica group [3,28,30]. We postulate that the DF2 brace's design, which is modular and can accommodate swelling following initial fracture and brace application, facilitates ED application and timely discharge home. Additional length of stay in the spica group is likely attributed to time waiting for OR availability, as well as safe recovery and monitoring following general anesthesia. These findings suggest potentially substantial implications for healthcare resource utilization and cost efficiency, particularly in the context of escalating OR time and hospital admission expenses [31]. Current estimates place OR costs at $37 per minute, while overnight pediatric hospital observation averages $2,559 per night [32,33]. Although a formal cost analysis was not performed in this study, based on our averages, this suggests potentially $4,539 in additional inpatient resources avoided when patients receive DF2 bracing in the ED with same-day discharge. While the DF2 brace group does incur costs related to conscious sedation and ED resources, previous research on alternatives to spica casting in the OR has found these costs to be lower overall, with projected savings of $5,000-$6000 by avoiding costs associated with the OR [34]. In comparison, the DF2 brace, which costs approximately $2,500 without insurance, likely still represents a cost reduction compared to the combined expenses for hospital admission, OR time, and general anesthesia.

While our cohort size is small, it is similar to the 29 spica patients and 27 brace patients presented by Andras et al. [17]. Several limitations warrant important consideration. First, as a retrospective study, we cannot account for selection bias in treatment choices. Additionally, the lack of standardized initial injury radiographs makes assessment of initial fracture angulation and shortening unreliable, as a simple change in limb position or application of traction during radiography would change the measurements. Last, our follow-up period is short, with most patients having less than 3 months of follow-up, which is insufficient to definitively assess long-term outcomes such as limb length discrepancy. Our institution, however, has the only pediatric orthopaedic physicians in the region, and we did not receive calls or see patient returns for parental concerns after discharge. We also maintained a minimum 6-month window between injury and data collection for all patients to attempt to capture any patients having complications or difficulties. At last follow-up, all patients were clinically healed, doing well, and were cleared by their pediatric orthopaedic surgeon for discharge from care, with instructions to return for development of limp, reinjury, or other concerns with the lower extremity. Future prospective studies with extended follow-up of at least 12 months post-injury are necessary to determine whether clinically significant differences emerge between treatment modalities over time.

In conclusion, our data support the DF2 brace as a viable alternative to spica casting for low-energy isolated pediatric femoral shaft fractures, replicating the findings of the 2022 Andras et al. presentation. Since our first use of the DF2 brace in November 2023, the positive clinical outcomes combined with our observations of positive caregiver acceptance led to rapid adoption of DF2 bracing as the preferred treatment for isolated femoral shaft fractures among all five pediatric orthopaedic surgeons at our institution. By mid-2024, our center had completely transitioned away from spica casting for isolated low-energy femoral

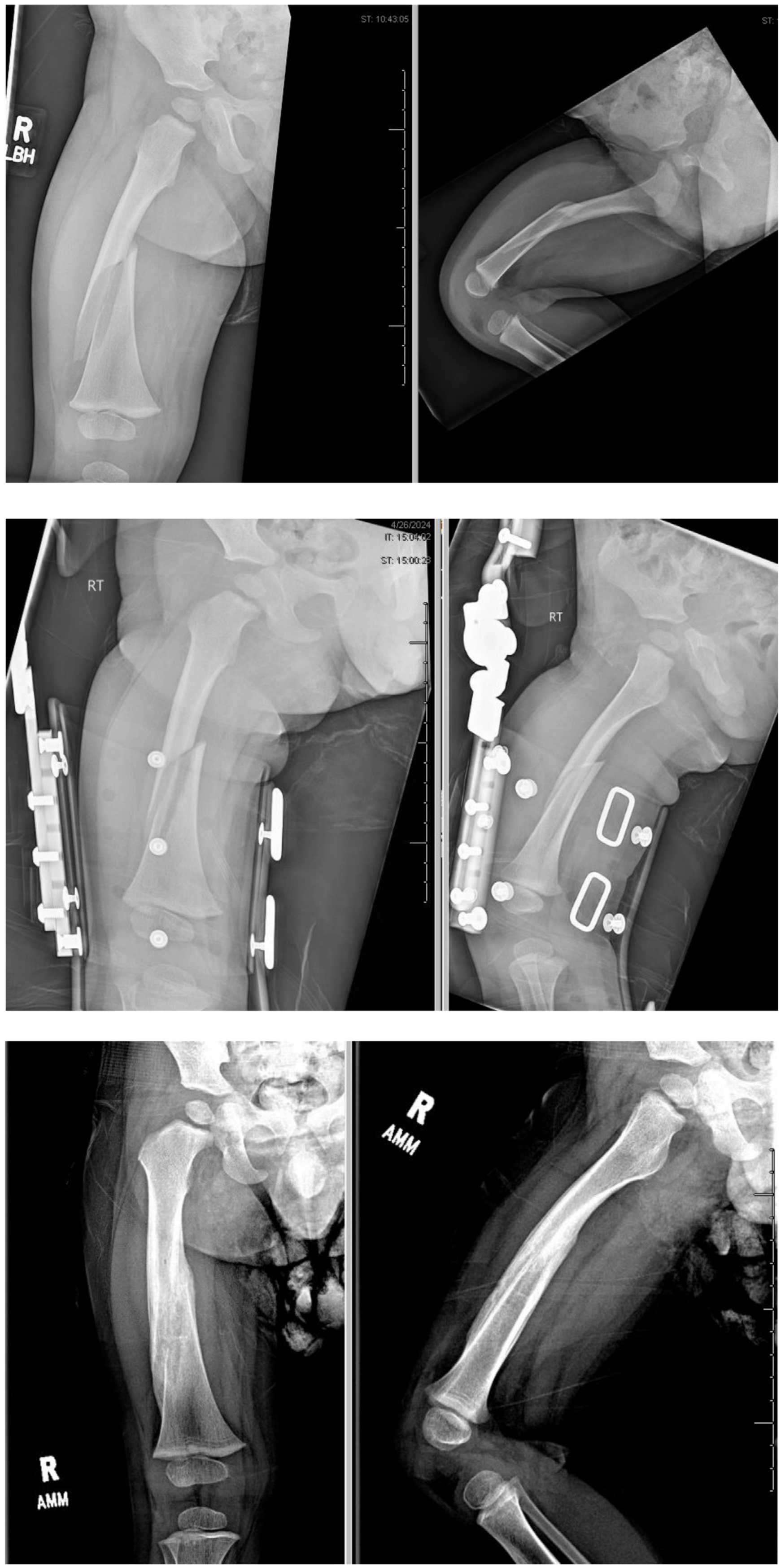

Figure 7. Case with varus and apex anterior angulation deformity at initial presentation (A), corrected with brace application in ED with post-reduction films (B), and maintained with evidence of union at 6-week follow-up (C).

shaft fractures in this age group, with no children having OR visits and general anesthesia for spica cast application, and instead undergoing application of the DF2 brace in the emergency department under conscious sedation. This practice change has the potential to benefit patients, families, and health care providers; however, further experience and studies from other centers are warranted to confirm these findings.

Additional links

- **JPOSNA®**: Functional Bracing of Femur Fractures in Young Children Avoids Anesthesia and Spica Casting with Equivalent Outcomes: A Randomized Prospective Study
- **JPOSNA®**: Functional Bracing for Pediatric Femoral Shaft Fractures

Author contributions

Virginia F. Casey: Writing – review & editing, Supervision, Conceptualization. **Calvin C. Chandler:** Writing – original draft, Formal analysis, Data curation. **George D. Graham:** Writing – review & editing, Data curation. **Steven L. Frick:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Consent for publication

The author(s) declare that no patient consent was necessary as no images or identifying information are included in the article.

Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] Hedlund R, Lindgren U. The incidence of femoral shaft fractures in children and adolescents. J Pediatr Orthop 1986;6(1):47–50.
[2] Rewers A, Hedegaard H, Lezotte D, Meng K, Battan FK, Emery K, et al. Childhood femur fractures, associated injuries, and sociodemographic risk factors: a population-based study. Pediatrics 2005;115(5):e543–52.
[3] Nakaniida A, Sakuraba K, Hurwitz EL. Pediatric orthopaedic injuries requiring hospitalization: epidemiology and economics. J Orthop Trauma 2014;28(3):167–72.
[4] Kocher MS, Sink EL, Blasier RD, Luhmann SJ, Mehlman CT, Scher DM, et al. Treatment of pediatric diaphyseal femur fractures. J Am Acad Orthop Surg 2009;17(11):718–25.
[5] Thompson JD, Buehler KC, Sponseller PD, Gray DW, Black BE, Buckley SL, et al. Shortening in femoral shaft fractures in children treated with spica cast. Clin Orthop Relat Res 1997;338:74–8.
[6] Sargent MC. Single-leg spica cast application for treatment of pediatric femoral fracture. JBJS Essent Surg Tech 2017;7(3):e26.
[7] Tisherman RT, Hoellwarth JS, Mendelson SA. Systematic review of spica casting for the treatment of paediatric diaphyseal femur fractures. J Child Orthop 2018;12(2):136–44.
[8] Miller ME, Bramlett KW, Kissell EU, Niemann KM. Improved treatment of femoral shaft fractures in children. The "pontoon" 90-90 spica cast. Clin Orthop Relat Res 1987;219:140–6.
[9] Illgen R, Rodgers WB, Hresko MT, Waters PM, Zurakowski D, Kasser JR. Femur fractures in children: treatment with early sitting spica casting. J Pediatr Orthop 1998;18(4):481–7.
[10] Mansour AA, Wilmoth JC, Mansour AS, Lovejoy SA, Mencio GA, Martus JE. Immediate spica casting of pediatric femoral fractures in the operating room versus the emergency department: comparison of reduction, complications, and hospital charges. J Pediatr Orthop 2010;30(8):813–7.
[11] DiFazio R, Vessey J, Zurakowski D, Hresko MT, Matheney T. Incidence of skin complications and associated charges in children treated with hip spica casts for femur fractures. J Pediatr Orthop 2011;31(1):17–22.
[12] Large TM, Frick SL. Compartment syndrome of the leg after treatment of a femoral fracture with an early sitting spica cast. A report of two cases. J Bone Joint Surg Am 2003;85(11):2207–10.
[13] Flynn J, Skaggs D, Rockwood C, Wilkins K, Beaty J, Kasser J. Femoral shaft fractures. In: Rockwood and Wilkins' fractures in children; 2009. Philadelphia.
[14] Hughes BF, Sponseller PD, Thompson JD. Pediatric femur fractures: effects of spica cast treatment on family and community. J Pediatr Orthop 1995;15(4):457–60.
[15] OrthoPediatrics. DF2® brace. 2024.
[16] Sanders JS, Owen J, Andras LM. Functional bracing for pediatric femoral shaft fractures. Journal of the Pediatric Orthopaedic Society of North America 2024/08/01;8.
[17] Chen V, Sanders JS, Skaggs DL, Kay RM, Andras LM. Functional bracing of femur fractures in young children avoids anesthesia and spica casting with equivalent outcomes: a randomized prospective study. Journal of the Pediatric Orthopaedic Society of North America 2022/08/01;4(3).
[18] Kocher MS, Sink EL, Blasier RD, Luhmann SJ, Mehlman CT, Scher DM, et al. American Academy of Orthopaedic Surgeons clinical practice guideline on treatment of pediatric diaphyseal femur fracture. J Bone Joint Surg Am 2010;92(8):1790–2.
[19] Resch H, Oberhammer J, Wanitschek P, Seykora P. [Rotational deformities following pediatric femoral shaft fracture]. Aktuelle Traumatol 1989;19(2):77–81.
[20] Malkawi H, Shannak A, Hadidi S. Remodeling after femoral shaft fractures in children treated by the modified blount method. J Pediatr Orthop 1986;6(4):421–9.
[21] Irani RN, Nicholson JT, Chung SM. Long-term results in the treatment of femoral-shaft fractures in young children by immediate spica immobilization. J Bone Joint Surg Am 1976;58(7):945–51.
[22] Shapiro F. Fractures of the femoral shaft in children. The overgrowth phenomenon. Acta Orthop Scand 1981;52(6):649–55.
[23] Wallace ME, Hoffman EB. Remodelling of angular deformity after femoral shaft fractures in children. J Bone Joint Surg Br 1992;74(5):765–9.
[24] Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)–a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inf 2009;42(2):377–81.
[25] Harris PA, Taylor R, Minor BL, Elliott V, Fernandez M, O'Neal L, et al. The REDCap consortium: building an international community of software platform partners. J Biomed Inf 2019;95:103208.
[26] Leu D, Sargent MC, Ain MC, Leet AI, Tis JE, Sponseller PD. Spica casting for pediatric femoral fractures: a prospective, randomized controlled study of single-leg versus double-leg spica casts. J Bone Joint Surg Am 2012;94(14):1259–64.
[27] Czertak DJ, Hennrikus WL. The treatment of pediatric femur fractures with early 90-90 spica casting. J Pediatr Orthop 1999;19(2):229–32.
[28] Epps HR, Molenaar E, O'connor DP. Immediate single-leg spica cast for pediatric femoral diaphysis fractures. J Pediatr Orthop 2006;26(4):491–6.
[29] Podeszwa DA, Mooney JF, Cramer KE, Mendelow MJ. Comparison of Pavlik harness application and immediate spica casting for femur fractures in infants. J Pediatr Orthop 2004;24(5):460–2.
[30] Flynn JM, Garner MR, Jones KJ, D'Italia J, Davidson RS, Ganley TJ, et al. The treatment of low-energy femoral shaft fractures: a prospective study comparing the "walking spica" with the traditional spica cast. J Bone Joint Surg Am 2011;93(23):2196–202.
[31] Russell H, Hall M, Morse RB, Cutler GJ, Macy M, Bettenhausen JL, et al. Longitudinal trends in costs for hospitalizations at children's hospitals. Hosp Pediatr 2020;10(9):797–801.
[32] Childers CP, Maggard-Gibbons M. Understanding costs of care in the operating room. JAMA Surg 2018;153(4):e176233.
[33] Fieldston ES, Shah SS, Hall M, Hain PD, Alpern ER, Del Beccaro MA, et al. Resource utilization for observation-status stays at children's hospitals. Pediatrics 2013;131(6):1050–8.
[34] Pidgeon TS, Schiller J. Preliminary report-the long leg cast with a pelvic band: a novel approach to treatment of pediatric femur fractures. Pediatr Emerg Care 2017;33(5):329–33.