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Treatment of Femoral Shaft Fractures in Children Less than 5 Years of Age: A Study Comparing the Single Leg Spica with the Traditional Spica

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ABSTRACT

Objective: Femoral shaft fractures in paediatric patients pose significant challenges in management, with various treatment options available. Single-leg spica casting has emerged as a potential alternative to traditional spica casting, aiming to reduce family burden and material usage while maintaining clinical efficacy.

Methods: We conducted a prospective study involving 72 paediatric patients aged 1 to 5 years diagnosed with low-velocity femoral shaft fractures. Exclusion criteria encompassed high-energy fractures, open fractures, extension of fracture into metaphysis or physis, pathological fractures, simultaneous fractures involving the ipsilateral or contralateral leg, skeletal disorders, suspicion of child abuse, and developmental delay. Spica casting was employed as the treatment modality, with patients randomly assigned to receive single-leg walking spica casting or traditional spica casting based on surgeon experience. Clinical outcomes were assessed using trauma history, physical examination, radiographs, and the Impact on Family Scale. Data were analysed using IBM SPSS version 24, employing descriptive statistics and the Student's t-test for group comparisons.

Results: Single-leg spica casting significantly reduced family burden compared to traditional spica casting ($p < 0.05$). However, both methods demonstrated similar clinical outcomes in terms of hospital stay, time to callus formation, and time to union. The single-leg spica group required more wedge adjustments (16.67% vs. 5.56%, $p < 0.05$). Skin problems were slightly more prevalent in the traditional spica group at the time of cast removal, but all patients recovered uneventfully.

Conclusion: Our study supports the use of single-leg spica casting as an effective alternative in managing low-energy femoral shaft fractures in paediatric patients aged 1 to 5 years. The findings highlight the potential benefits of single-leg spica casting in reducing family burden and material usage while maintaining comparable clinical outcomes.

Keywords: Femoral Shaft Fractures, Leg Spica, Paediatrics

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INTRODUCTION

Femoral shaft fractures are among the most common injuries associated with polytrauma and can pose life-threatening risks. These fractures, occurring at a rate of 10-21 per 100,000 individuals per year, are significant concerns. However, the occurrence of atypical femoral fractures, ranging between 3.5% to 16%, as delineated by the American Society for Bone and Mineral Research, adds complexity to the scenario[(1)]. In children, the incidence of femoral shaft fractures stands at 1.6%, with a higher prevalence observed in males compared to females (2.6% vs. 1%, respectively)[(2)]. Femoral shaft fractures often

stem from incidents like road traffic accidents, are recognizable by signs such as limb shortening and other deformities when improperly treated[1][3][4]. They typically exhibit a bimodal distribution and are associated with comorbidities requiring Advanced Trauma Life Support (ATLS) evaluation and interdisciplinary care.[1][5]

Treatment options for paediatric femoral shaft fractures vary based on factors such as fracture pattern, child's weight and age, and surgeon experience[6]. Age is one of the most important factors that influences management decisions, with orthopaedic surgeons commonly resorting to spica casting for children under 5 years old, while those over 12 years old are often treated with intramedullary nailing[7]. Spica casting has served as a safe and effective non-operative method for managing diaphyseal femur fractures in paediatrics for nearly eight decades[8]. These fractures rank as the third most common lower extremity fractures in children, affecting approximately 1.6% patients[9]. North American Pediatric Orthopaedic surgeons predominantly favour spica casting for diaphyseal femoral shaft fractures in paediatric cases, excluding those involving polytrauma[10]. However, the American Academy of Orthopaedic Surgery suggests that spica casting is most effective for fractures with less than 20 mm of shortening and for children aged between 6 months to 5 years[11]. A study comparing walking hip spica and traditional hip spica casts revealed similar outcomes, with the former associated with reduced family burden, as measured by the Impact on Family Scale[12]. Despite the established efficacy of spica casting for femoral shaft fractures, limited literature exists comparing different types of spica casts and their clinical outcomes at the local level.

To address this gap, our study aims to compare the efficacy of walking/single-leg and traditional spica casts in treating low-velocity femoral shaft fractures. By doing so, we hope to contribute to a better understanding of treatment options for these fractures, especially in low-energy scenarios.

METHODOLOGY

In this prospective study conducted from February 1st, 2021, to July 30th, 2021, a total of 72 paediatric patients were enrolled following approval from the Review Board of the Institute and the Ethical Committee. Patients presented to the Emergency and outpatient departments with thigh trauma resulting in femoral fractures. Inclusion criteria comprised children aged 1 to 5 years, of both genders, diagnosed with low-energy femoral shaft fractures. Exclusion criteria encompassed high-energy fractures, open fractures, extension of fracture into metaphysis or physis, pathological fractures, simultaneous fractures involving the ipsilateral or contralateral leg, skeletal disorders, suspicion of child abuse, and developmental delay.

Written informed consent was obtained from parents or guardians of eligible patients. Spica casting was employed as the treatment modality, with data collected using a pre-designed form and kept confidential. Preliminary examinations, including trauma history, physical examination, and radiographs, were conducted. Patients were randomly assigned to two groups: group A received single-leg walking spica cast, while group B received traditional spica cast, based on surgeons' experience. Cast application occurred in the operating theatre under sedation or general anaesthesia. Patients received counselling on cast care and were scheduled for follow-up appointments at one, two, three, and six weeks. Cast removal typically occurred around the sixth week, after which family members completed the Impact on Family Scale.

Clinical outcomes, including malalignment, length of hospital stay, time to initial callus formation, time to union, and impact on family scale, were assessed and recorded in the predesigned form for each patient. Malalignment was evaluated based on established clinical standards, with age-specific criteria for varus/valgus and anterior/posterior alignment.

Data were analysed using IBM SPSS version 24, employing descriptive statistics for means, standard deviations, and frequencies. The Student's t-test was used for group comparisons, controlling for effect modifiers through stratification. Post-stratification chi-square tests were conducted, considering a significance level of $p \leq 0.05$.

RESULTS

In this study a total of 72 patients consented following the scrutiny of inclusion criteria. The patients were equally divided into two groups of 36 patients each. There were 46 (61.30%) males and 26 (34.70%) females in the study with the mean age of 3.26 ± 1.13 years and mean weight of 14.83±2.12 Kg respectively. Forty (53.30%) patients had injury to the right femur whereas 32 (42.70%) to the left. Patients presenting with a transverse fracture morphology were 43 (57.30%), those with oblique were 23 (30.70%) and with spiral numbered 6 (8.00%). Fifty-two (69.30%) patients presented

following Road Traffic Accident, 19 (25.30%) with history of fall and 1 (1.30%) patient presented with trauma to the left femur while playing. The demographic details of individual groups are shown in detail in Table 1. The mean age and weight were similar in both groups. Similarly, there were more males in both groups as compared to the females. Majority of patients presenting in both groups were following the Road Traffic Accident. Transverse morphology of the fracture was the most prevalent in both groups. The mean time to treatment from the onset of injury was one day.

The mean time of hospital stay, duration of callus development and time to union was similar in both groups (Table 2). Six (16.77%) in group A needed wedge modification of the cast in contrast to 2 (5.56%) in group B. In terms of complications 3 (8.33%) from group A and 6 (16.67%) patients of Group B developed complications. Two (5.56%) patients from group A and 3 (8.33%) from group B had to be taken to OR for re-adjustment of Hip spica cast. There was no Malunion in any patient of group A, but 1 (2.78%) patient in the group presented with malunion. One (2.78%) patient from group A and 2 (5.56%) patients from group B developed skin problems due to spica application.

Mobility of each patient was documented at each follow-up in terms of crawling or walking with the cast and the time at which the child was able to do so. At the time of the last follow-up 5(13.89%) patients were able to crawl and 31 (86.11%) walked with single leg spica, whereas none of the patients with traditional spica cast were able to crawl or walk. Mean time to develop the ability of crawling and walking in group A was 14.50 days and 23.10 days respectively. There was a substantial difference between the mean Impacts on Family Scale between the two groups. Group A had a score of 35.11±2.24 in contrast to 44.97±0.94 of group B (*P value*<0.05).

Table 1. Demographics of two Groups

	Single leg Spica cast N (36)	**Traditional Spica cast N (36)**	**P Value**
Mean Age (Years)	3.40 ±1.13	3.13±1.14	0.30*
Mean weight (Kg)	14.83±2.18	14.83±2.09	1.00*
Sex (no. [%])			
Male	20 (27.78)	26 (36.11)	0.14 ˇ
Female	16 (22.22)	20 (27.78)	
Side (no. [%])			
Right	20 (27.78)	20 (27.78)	1.00 ˇ
Left	16 (22.22)	16 (22.22)	
Mode of Trauma (no. [%])			
RTA	23 (31.94)	29 (40.28)	0.22 ˇ
Fall	23 (31.94)	7 (9.72)	
Other	1 (0.01)	0	
Morphology (no. [%])			
Transverse	24 (33.33)	19 (26.39)	0.04ˇ
Oblique	12 (0.17)	11 (15.28)	
Spiral	0	6(16.67)	
Mean Time to treatment Days	1	1	-

*Independent T- test
ˇ Chi-Square Test
-Not calculable due to 0 SD

Table 2. Outcome of two Groups

	Single leg Spica cast N (36)	**Traditional Spica cast** N (36)	**P Value**
Mean Hospital Stay Days	8.06±0.71	8.03±0.51	0.85*
Mean time to initial Callus Formation Days	15.42±1.23	15.00±1.07	0.13*
Mean time to Union Days	6.25±0.65	6.14±0.35	0.37*
Wedge Adjustment Yes No	6 (16.67) 30	2 (5.56) 34	0.26 ˇ
Complications (no. [%]) Return to OR Malunion Skin Problems None	2(5.56) 0 1(2.78) 33(91.67)	3(8.33) 1(2.78) 2(5.56) 30 (83.33)	0.64 ˇ
Mobility (no. [%]) Crawl Walk None	5(13.89) 31 (86.11) 0	0 0 36 (100.00)	<0.05 ˇ
Mean Impact on family scale	35.11±2.24	44.97±0.94	<0.05*

*Independent T- test
ˇ Chi-Square Test

DISCUSSION

The treatment of diaphyseal femoral fractures in paediatric patients aged 1 to 5 years has been subject to debate, with various methods and acceptance criteria considered. The accepted management approach currently involves the application of a Hip Spica Cast, as documented by Liau et al.,[7]. Our study aimed to compare the effectiveness of single-leg spica casting with traditional spica casting, similar to the findings of R T Tisherman et al.,[11], where they highlighted the efficacy of single-leg spica casting in managing low-energy paediatric femoral shaft fractures. Our study indicated a significant reduction in family burden associated with single-leg spica casting compared to traditional spica casting. This result is in accordance with a study done by Flynn et al.,2011 while another study done by Rokaya et al.,2020 presents results in contrast to our results where they found no difference at all in outcomes of both techniques[12,13]. According to the results of our study parents reported greater comfort in terms of carrying, mobilising, and transporting their child, along with improved hygiene maintenance. Moreover, single-leg spica casting required proportionately fewer materials, potentially resulting in significant cost savings for hospitals which is in accordance with the findings of a prior study by Jadoon et al (2023)., where they found the treatment modality to be cost effective.[14]

No significant difference between the two groups was found regarding the mean duration of hospital stay, time to callus formation, or time to union of the fracture. However, both groups required wedge adjustments during follow-up appointments, with a higher proportion observed in the single-leg spica group (16.67% vs. 5.56%). This discrepancy may be attributed to inadequate immobilisation of the proximal femur. The rate of wedge adjustments varied across studies, mainly due to differences in acceptability criteria. Stricter criteria may necessitate more frequent wedge adjustments, with the aim of reducing the need for future fracture re-reduction in the operating theatre.

A small percentage of patients in both groups required re-application of the spica cast in the operating theatre due to loss of fracture reduction. This was notably observed in patients who had undergone wedge adjustments, with overcorrection during wedging potentially contributing to the complication. Spontaneous loss of reduction was also noted in some patients during follow-up appointments, possibly due to decreased soft tissue

swelling over time at the fracture site. These findings align with previous studies by Flynn et al., indicating a higher requirement for re-reduction in patients treated with single-leg spica casting.[13]

Skin problems at the time of cast removal were observed in three patients, with a slightly higher incidence in the traditional spica group. However, all patients recovered uneventfully following cast removal.

While our study provides valuable insights, it is not without limitations. Increasing the sample size and conducting a multicenter study would enhance the study's strength and generalizability. Our study supports the use of single-leg spica casting as an effective alternative to traditional spica casting in managing low-energy femoral shaft fractures in paediatric patients aged 1 to 5 years. Despite some limitations, the findings highlight the potential benefits of single-leg spica casting in reducing family burden and material usage, while maintaining comparable clinical outcomes.

CONCLUSION

Our study supports the use of single-leg spica casting as an effective alternative in managing low-energy femoral shaft fractures in paediatric patients aged 1 to 5 years. Despite some limitations, the findings highlight the potential benefits of single-leg spica casting in reducing family burden and material usage while maintaining comparable clinical outcomes.

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