

Radiological effectiveness and cost analysis of the spica casting method without anesthesia in emergency room conditions for femoral shaft fractures in children under five years old

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ABSTRACT

BACKGROUND: This study aimed to compare the clinical, radiological, and cost-related outcomes of early spica casting performed without anesthesia in the emergency department and spica casting performed under general anesthesia in the operating room for the treatment of femoral shaft fractures in children under five years of age.

METHODS: One hundred eleven patients who underwent closed reduction and spica casting for femoral shaft fractures between 2020 and 2024 were retrospectively reviewed. Patients were divided into two groups according to where the spica cast was applied: Emergency Department Group (ED group, n=71) and Operating Room Group (OR group, n=40). The groups were compared in terms of age, sex, fracture type, radiological alignment, and treatment costs.

RESULTS: No statistically significant differences were found between the two groups regarding age, sex, fracture pattern, or final radiological alignment. However, treatment costs were significantly lower in the emergency department group. Complication rates were also similar between the groups.

CONCLUSION: Early spica casting performed in the emergency department without general anesthesia provides radiological outcomes comparable to those achieved in the operating room while offering a significant cost advantage. With appropriate patient selection, this method represents a safe and effective treatment option.

Keywords: Cost analysis; emergency department; femoral shaft fracture; non-anesthetic treatment; spica cast; pediatric trauma; radiological outcomes.

INTRODUCTION

Femur diaphysis fractures are among the significant orthopedic injuries encountered during childhood. The incidence of femur diaphysis fractures among pediatric long bone fractures is reported to be approximately 1.6%, and it has been noted that these fractures occur more frequently in male children.^[1,2]

Femur fractures in this age group usually occur as a result of falls, traffic accidents, or high-energy trauma. Femur fractures in children who are not yet walking should be carefully evaluated in terms of the possibility of child abuse. On the other hand, femur fractures resulting from low-energy trauma may indicate underlying pathological conditions such as osteogenesis imperfecta, neuromuscular diseases, or bone

Cite this article as: Tasdemir V, Gokdemir CE, Sayar F, Yurteri A, Ipci FB, Ilyas G. Radiological effectiveness and cost analysis of the spica casting method without anesthesia in emergency room conditions for femoral shaft fractures in children under five years old. *Ulus Travma Acil Cerrahi Derg* 2026;32:480-486.

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Ulus Travma Acil Cerrahi Derg 2026;32(4):480-486 DOI: 10.14744/tjtes.2025.03788

Submitted: 21.08.2025 Revised: 21.08.2025 Accepted: 22.12.2025 Published: 13.04.2026

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lesions. Therefore, a comprehensive physical examination and radiological assessment are essential in the initial evaluation of such a case.

In particular, a careful neurovascular examination should be performed in these patients who present with marked thigh swelling, deformity, and pain; other life-threatening injuries such as intra-abdominal organ injuries, thoracic trauma, and head trauma (known as the Waddell triad) should also be investigated simultaneously.^[3]

To reduce the risk of compartment syndrome, the affected extremity should be appropriately immobilized with a temporary splint after the initial assessment, and diagnostic imaging should be performed from the hip to the knee joint in a way that fully reveals the fracture line. In the radiological evaluation, not only the localization and type of the femur fracture should be considered, but also the presence of other concurrent extremity fractures or bone lesions should be excluded.^[4] The treatment plan for femur fractures in childhood is determined by considering the child's age, body weight, type of fracture, and other accompanying injuries.^[5]

In stable femoral fractures occurring from the newborn period up to 6 months of age, simple and movement-permitting methods such as the Pavlik harness are generally sufficient, thanks to the advantage provided by the thick periosteum. However, in children between the ages of 6 months and 6 years, closed reduction followed by pelvipedal casting (spica cast) is the most commonly preferred treatment method.^[4,6]

In this age group, successful outcomes can often be achieved without the need for surgical interventions. Table 1 summarizes the preferred treatment methods for different age groups.

If conservative treatment with a pelvipedal cast is to be applied, the acceptable reduction criteria become stricter as the child gets older. Table 2 presents the acceptable angulation and shortening limits for conservative treatment by age.^[7]

Previous studies have shown that early spica casting is a safe and effective method in young children. In fact, there are even studies in the literature comparing pelvipedal cast treatment with surgical approaches such as elastic intramedullary nailing.^[8,9] However, early spica casting applied in emergency settings without the use of general anesthesia and fluoroscopy has

not been sufficiently evaluated in the literature.

In this study, the aim was to investigate the safety and cost-effectiveness of early pelvipedal casting performed without anesthesia and fluoroscopy in emergency room settings for the treatment of femoral shaft fractures in children aged five years and under.

MATERIALS AND METHODS

Study Design and Patient Selection

In this retrospective cohort study, children aged five years and under who were treated in our clinic with a diagnosis of isolated femoral shaft fracture between January 2021 and December 2024 were analyzed (Non-Interventional Clinical Research Ethics Committee of University of Health Sciences, Konya City Hospital, approval no: 2025/74, date: 24.04.2025). The study was conducted in accordance with the principles of the Declaration of Helsinki.

The exclusion criteria were defined as the presence of an open fracture, concomitant fractures of other long bones or polytrauma, and a follow-up period of less than 12 months. A total of 111 patients who met these criteria were included in the study. The patients were divided into two groups according to the treatment method: those who received pelvipedal casting in the emergency department or outpatient clinic settings without sedation, general anesthesia, or live radiography (fluoroscopy) were defined as the study group (n=71). Those who underwent pelvipedal casting under general anesthesia, in the operating room, and with fluoroscopic guidance constituted the control group (n=40). After the possible risks and benefits of both methods were thoroughly explained to the families, the treatment method was chosen based on the family's consent and preference. No distinction was made between the groups regarding factors such as fracture type or comminution; every type of femoral shaft fracture was treated with the method deemed appropriate. Patient files and radiographs were retrospectively reviewed, and demographic data (age, sex, body weight), fracture side, initial treatment method, time to union, lower limb length discrepancy at the final follow-up, and follow-up duration were recorded. Lower limb length discrepancy (LLD) was defined as the difference in length between the injured side and the uninjured side at the final follow-up. LLD measurement and determination of

Table 1. Treatment options for femoral shaft fractures by age

Age Range	Preferred Treatment Methods
<6 months	Pavlik harness, pelvipedal casting, traction and casting
6 months-6 years	Closed reduction + pelvipedal casting (spica); surgical treatment is generally not required
6-11 years	Flexible intramedullary nail, submuscular plate osteosynthesis, external fixation (case-based)
>11 years	Adult-type surgical methods (rigid intramedullary nail, plate-screw applications)

Table 2. Acceptance criteria by age in conservative treatment (maximum allowable deformity)

Age Range	Varus/Valgus (°)	Flexion/Extension (°)	Shortening (mm)
<2 years	30	30	20
2–5 years	15	20	20
5–10 years	10	15	15
>11 years	5	10	10

union time were performed by two independent researchers, and interobserver reliability was assessed using Cohen's kappa (κ) statistic. The success of reduction was evaluated in both groups using anteroposterior and lateral femur radiographs taken after treatment, according to the acceptance criteria (Table 2). In the study group, reduction success was assessed solely via radiographs, while in the control group, it was evaluated immediately using fluoroscopic imaging under anesthesia and later confirmed with radiographs. In both groups, if proper alignment was deemed not achieved after casting, the cast was removed within the first 24 hours, and closed reduction with recasting using the same method was performed.

Treatment cost calculation was based directly on hospital care costs, converted from Turkish Lira to U.S. Dollars (using the average exchange rate for 2024). Since patients in the control group were treated under general anesthesia in operating room conditions, anesthesia drug and equipment costs, operating room usage fees, and hospitalization costs were included in the total cost. In the study group, since patients were treated without anesthesia and without hospitalization, only outpatient/emergency intervention fees and material costs were considered.

Pelvipedal Casting Technique (Without Anesthesia)

Patients were placed in a supine position on a flat surface. The fractured limb was carefully manipulated to approximately restore its anatomical axis, and a spica cast was applied in accordance with standard techniques. First, with the knee maintained at 90° flexion, a circular cast wrap was applied from below the foot to the entire lower limb using pre-soaked plaster bandages, ensuring the fracture site was fully encompassed. Once the cast began to harden, the contralateral hip and pelvis were included to complete the bilateral pelvipedal cast.

During this process, the hip was positioned in approximately 60°–90° flexion and ~60° abduction, and molding was applied to the distal fragment (in valgus and/or extension direction) to counteract any tendency toward apex anterior or varus angulation. The knee joint was set at roughly 30°–40° flexion to prevent excessive pressure points, and the distal femur was placed in slight external rotation.

After the cast application was complete, areas that could

cause pressure on the abdomen and perineum were checked; a small window was created at the umbilical level to reduce abdominal pressure, and adequate space was left for perineal hygiene. All patients were discharged on the same day after stabilization of vital signs following cast application (Figures 1 and 2).



Figure 1. Clinical appearance of early pelvipedal casting applied in the emergency department without the use of general anesthesia and fluoroscopy.



Figure 2. Radiographic view of the femoral fracture after casting in a case treated with early pelvipedal cast.

Table 3. Demographic data of the patient groups

Variable	Study Group (n=71)	Control Group (n=40)	p-value	Total (n=111)
Age (months, mean±SD, [min–max])	32.61±13.57 [7-60]	25.48±12.51 [10-52]	0.007	30.04±13.58
Sex (M/F)	41 / 30	26/14	0.546	67/44
Weight (kg, mean±SD)	15.04±3.84	15.43±3.92	0.618	15.18±3.86

Table 4. Lower limb length discrepancy by treatment group (at final follow-up measurement)

Limb Length Discrepancy (mm)	Study Group (n=71)	Control Group (n=40)	p-value	All Patients (n=111)
Mean±SD	6.13±7.66	8.43±6.94	0.029	6.96±7.46
Patients with lengthening	59 (%83)	32 (%80)	–	91 (%82)
Patients with shortening	7 (%10)	4 (%10)	–	11 (%10)
No discrepancy	5 (%7)	4 (%10)	–	9 (%8)

Statistical Analysis

For the statistical analysis of the obtained data, the chi-square test was used for categorical variables, and Student's t-test was used for continuous variables. The relationship between LLD and age, sex, and body weight was assessed using Pearson correlation analysis. A p-value of <0.05 was considered statistically significant.

Study Findings

During the specified period, a total of 135 patients who underwent pelvipedal cast treatment for femoral shaft fractures were identified. Of these, 24 patients who met the exclusion criteria (open fracture: 1, polytrauma: 4, follow-up <12 months: 19) were excluded. The remaining 111 patients comprised 71 in the study group (spica cast without anesthesia) and 40 in the control group (spica cast under general anesthesia). Demographic data are presented in Table 3. The mean age of patients in the study group was slightly higher compared to the control group (32.6±13.6 months vs. 25.5±12.5 months; p=0.007). There was no difference between the two groups in terms of sex distribution (study group: 58% male, control group: 65% male; p=0.546). Similarly, the mean initial body weights were comparable between groups (study: 15.04±3.84 kg; control: 15.43±3.92 kg; p=0.618). The mean follow-up duration for all patients was 14.7±2.2 months in the study group and 14.4±2.1 months in the control group, with no significant difference between groups (p=0.520).

In the study group, control radiographs taken after the initial cast application showed that reduction was in an acceptable position in 94% of cases (67 patients). In 4 patients (6%), where the reduction was deemed inadequate, the cast was removed within the first 24 hours, and closed reduction with pelvipedal casting was repeated using the same method. After this repeated procedure, proper alignment was achieved, and

these patients were also included in the final evaluation.

In the control group, since reduction was achieved under fluoroscopic guidance, no patients required early cast replacement. During follow-up, no cases of refracture or significant malalignment occurred in either group.

At the final follow-up examinations, significant lengthening of the injured limb was detected in 66 patients (93%) in the study group (59 patients with lengthening, 7 with shortening). In the control group, lengthening occurred in 36 patients (90%) on the injured side (32 with lengthening, 4 with shortening). The mean ipsilateral (injured side) lower limb length difference compared to the contralateral healthy side was 6.13±7.66 mm in the study group and 8.43 ± 6.94 mm in the control group (p=0.029). In the remaining 9 patients (8%; 5 from the study group, 4 from the control group), no measurable length difference between the two sides was observed. A comparison of the limb length discrepancy results between the two groups is presented in Table 4.

In both groups, femoral fractures healed without complications in all patients. There was no significant difference between the groups in terms of healing time (study group: 8.3±1.4 weeks; control group: 7.9±1.4 weeks; p=0.117). However, there was a marked difference between the two groups regarding treatment cost (p<0.001). In the study group, which did not require anesthesia or operating room use, the mean treatment cost was calculated as 74.73±5.14 USD, whereas in the control group, this value was 219.8±12.22 USD. The mean cost values are presented in Table 5.

The relationship between lower limb length discrepancy (LLD) and patients' age, sex, and body weight was evaluated using correlation analysis (Table 6). In the study group, very weak negative correlations were found between LLD and age

Table 5. Comparison of treatment costs between the two groups

Average Cost (USD)	Study Group (n=71)	Control Group (n=40)	p-value	Total (N=111)
Mean±SD	74.73±5.14	219.8±12.22	<0.001	127.0±7.69

Table 6. Correlation of lower limb length discrepancy with demographic variables

Variable	Study Group (r)	Control Group (r)	Overall
Age (months)	-0.152	-0.367	-0.248
Sex (M/F)	0.072	-0.122	-0.003
Weight (kg)	-0.034	-0.451	-0.166

and weight ($r=-0.152$ and $r=-0.034$), while in the control group, weak negative correlations were observed ($r=-0.367$ and $r=-0.451$). In both groups, no significant relationship was found between sex and the resulting length discrepancy ($p>0.05$).

The consistency of the measurements performed by the two researchers was found to be very high. For lower limb length discrepancy measurements, interobserver agreement was $\kappa=0.896$ (almost perfect agreement), and for time-to-union assessment, $\kappa=0.834$.

DISCUSSION

In this study, early pelvipedal casting applied in the emergency department (without general anesthesia and fluoroscopy) was compared with the conventional pelvipedal casting performed under general anesthesia in an operating room for the conservative treatment of femoral fractures in children under five years of age. Our findings indicate that the early spica casting technique performed without anesthesia achieved comparable success to the standard method in terms of radiological outcomes and complication rates.^[10-12]

In the study group, an average lengthening of 6.1 mm was observed on the fractured side, while in the control group, the mean lengthening was 8.4 mm; this difference was found to be statistically significant ($p=0.029$). Although this minimal difference does not create a clinically significant limb length discrepancy, its slightly greater presence in the control group is noteworthy. The mean time to union was approximately eight weeks in both groups and was statistically similar ($p>0.1$). No patient experienced delayed union or refracture.

The cost analysis revealed that the early casting method, which does not require anesthesia or operating room use, was significantly more cost-effective compared to the standard method (average ~\$75 vs. \$220; $p<0.001$). This finding demonstrates that the early spica casting technique offers a

substantial advantage, particularly in healthcare settings with limited resources.

Literature includes several studies on early casting applications in the emergency department. Williams et al. treated 82 cases of femoral fractures in children aged 6 months to 5 years with spica casting either in the emergency department or in the operating room, comparing pain management between the two groups. This study reported that children in the operating room group required more opioid analgesics in the postoperative period.^[13] On the other hand, in the group that received immediate casting in the emergency department, the rate of cast replacement due to inadequate reduction was found to be higher.^[10-14] Similarly, in our series, cast replacement was performed in 4 patients (5.6%) in the study group after the initial casting, as the reduction position was deemed unacceptable (particularly in cases with >2 cm shortening). In the control group, no additional intervention was required since adequate reduction was achieved under fluoroscopic guidance in all patients. Nonetheless, even in the few cases where optimal cast positioning could not be achieved on the first attempt under emergency conditions, satisfactory outcomes were obtained after repeat closed intervention.

In another study, Trottier et al. reviewed a series of 246 children under the age of six with femoral fractures and reported that only 3.7% of the patients treated with early spica casting required reintervention (cast adjustment or surgery), while 20.7% of cases developed an average limb length discrepancy of 9.4 mm.^[15] In our study, an average limb length discrepancy of approximately 7 mm was observed in patients from both groups, and in no case did this discrepancy reach a level (≥ 20 mm) requiring clinical intervention. Moreover, the slightly greater tendency for lengthening observed in the control group compared to the study group (8.4 mm vs. 6.1 mm) is consistent with similar findings reported in the literature.

Previous research on the treatment costs of femoral fractures has shown that conservative methods can deliver sim-

ilar outcomes at a much lower cost compared to surgical interventions.^[16,17] In another study examining 58 pediatric femoral fracture cases, it was reported that the total cost was significantly lower in patients treated conservatively.^[18] Similarly, Coyte et al. found substantially higher treatment costs in children who underwent surgical intervention.^[19] Yandow and colleagues, in their study comparing spica casting with traction, reported that despite similar clinical outcomes, the treatment cost was lower in the spica cast group.^[20] Hedin et al., in their cost analysis of various treatment methods for pediatric femoral fractures, emphasized that the most important factor determining total cost was the length of hospital stay.^[21]

In our study, all patients were treated with spica casting, with the only difference being whether the procedure was performed under general anesthesia in an operating room. In the study group, where general anesthesia and operating room use were not required, all patients were discharged the same day, resulting in no hospitalization costs. In the control group, however, due to an average one-day hospital stay and the need for anesthesia, the total cost was nearly three times higher. These findings support the economic advantage of conservative treatment, consistent with previous literature.

The functional and radiological success of early spica casting has also been widely reported in the literature.^[22,23] Illgen et al., in a study involving 114 pediatric femoral fractures in children under six years of age, stated that they achieved successful outcomes in 86% of cases without the need for cast changes or wedge removal.^[24] Ferguson and Nicol, in their prospective series of 101 cases under the age of ten evaluating early pelvipedal casting, reported that only four patients required cast revision due to loss of position.^[25]

In our current study, particularly in the study group treated without anesthesia, cast replacement was required in 5.6% of cases (4 patients) during the early period — a rate comparable to that reported by Ferguson et al. At the same time, regardless of whether anesthesia and fluoroscopy were used, good fracture union with low complication rates was achieved in all isolated femoral shaft fractures under five years of age, and no unacceptable limb length discrepancy exceeding 2 cm was reported. Four patients in the study group who initially presented with a length discrepancy of more than 2 cm were acutely corrected and included in the study.

Czertak et al. also reported high levels of functional and radiological success in patients treated with pelvipedal casting.^[25]

Although functional assessment was not performed in any of the patients in our study, radiographically satisfactory union was achieved in all cases. No patient developed a permanent limb length discrepancy exceeding acceptable limits (>2 cm). The successful outcomes we obtained suggest that, particularly in situations where resources are limited or the risk of general anesthesia is high, spica casting without anesthesia can serve as a safe and effective alternative for the treatment

of femoral fractures in young children. With appropriate patient selection and proper technique, we believe this method can achieve success rates comparable to those of treatments performed under standard operating room conditions.

Study Limitations

This study has several limitations. First, because of its retrospective design and the fact that data were obtained from a single center, the generalizability of the findings may be limited. Second, the assessment of reduction quality and fracture union was based on radiological criteria; clinical parameters such as functional outcomes or patient satisfaction were not evaluated. Furthermore, since the choice of treatment method in group comparisons was based on family preference, a fully randomized allocation could not be achieved. Although evaluations were conducted with large patient numbers in both groups to minimize this potential bias, prospective and randomized controlled studies are still needed.

CONCLUSION

In femoral shaft fractures of children under five years of age, the early pelvipedal casting method applied in the emergency department without the use of general anesthesia or live radiology demonstrated comparable reduction success, healing time, and complication rates to the standard operating room approach. Moreover, by eliminating anesthesia-related risks, reducing radiation exposure, and avoiding hospital admission, it was found to be significantly more cost-effective. This method also stands out as a safe treatment alternative for cases in which general anesthesia carries high risk or surgery is not feasible for various reasons.

In conclusion, when applied with appropriate patient selection, the early spica casting method without anesthesia offers an effective, reliable, and economical approach for the treatment of femoral fractures in preschool children.

Ethics Committee Approval: This study was approved by the Non-Interventional Clinical Research Ethics Committee of University of Health Sciences, Konya City Hospital (Date: 24.04.2025, Decision No: 2025/74).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: V.T., C.E.G., F.S.; Design: V.T., C.E.G., F.S.; Supervision: V.T., C.E.G., F.S.; Resource: V.T., A.Y., F.B.I.; Materials: V.T., A.Y., F.B.I., G.I.; Data collection and/or processing: V.T., A.Y., F.B.I., G.I.; Analysis and/or interpretation: V.T., F.B.I., G.I.; Literature review: V.T., F.B.I., G.I.; Writing: V.T., F.B.I., G.I.; Critical review: V.T., F.B.I., G.I.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

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ORİJİNAL ÇALIŞMA - ÖZ

Beş yaş altı çocuklarda femur cisim kırıkları için acil servis koşullarında anestezi olmadan yapılan spika alçı yönteminin radyolojik etkinliği ve maliyet analizi

AMAÇ: Bu çalışmanın amacı, 5 yaş altındaki çocuklarda femur diafiz kırıkları için acil serviste anestezi uygulanmayan erken dönem spika alçısı ile ameliyathane koşullarında genel anestezi altında uygulanan spika alçısı yöntemlerini klinik, radyolojik ve maliyet açısından karşılaştırmaktır. Bu sayede her iki yöntemin etkinliği ve maliyet verimliliği analiz edilmiştir.

GEREÇ VE YÖNTEM: 2020-2024 yılları arasında femur cisim kırığı tanısı alıp, kapalı redüksiyon ve spika alçısı işlemi uygulanan 71 çocuk retrospektif olarak incelendi. Hastalar, spika alçısının uygulandığı yere göre iki gruba ayrıldı: Acil Servis Grubu (AS Grubu, n=41) ve Ameliyathane Grubu (AY Grubu, n=30). Her iki grup, yaş, cinsiyet, kırık tipi, radyolojik hizalanma ve tedavi maliyetleri gibi kriterlere göre karşılaştırıldı.

BULGULAR: Gruplar arasında yaş, cinsiyet, kırık tipi ve son radyolojik hizalanma açısından anlamlı bir fark bulunmadı. Ancak, acil servis grubunda ortaya çıkan tedavi maliyetleri, ameliyathane grubuna kıyasla anlamlı derecede daha düşüktü. Ayrıca, her iki gruptaki komplikasyon oranları da benzer seviyelerde gözlemlendi.

SONUÇ: Acil serviste, genel anestezi kullanılmadan yapılan erken dönem spika alçısı uygulamaları, ameliyathane şartlarında yapılanlarla benzer radyolojik sonuçlar elde edilmesini sağlamakta ve önemli bir maliyet avantajı sunmaktadır. Bu yöntem, doğru hasta seçimi ile güvenli ve etkili bir tedavi alternatifini önerilebilir.

Anahtar sözcükler: Acil servis; anestezi tedavisi; femur shaft kırığı; maliyet analizi; pediatrik travma; radyolojik sonuçlar; spika alçı.

Ulus Travma Acil Cerrahi Derg 2026;32(4):480-486 DOI: 10.14744/tjtes.2025.03788