Journal of Southeast Asian Orthopaedics
ISSN 2821-9848 (Print)
ISSN 2821-9864 (Online)
https://doi.org/10.56929/jseaortho-2025-0267 https://jseaortho.org

Comparison of Preoperative Pain Scores Between Knee Brace and Skeletal Traction in Patients with Femoral Shaft Fracture

Chavalit Iemsaengchairat, MD, Wasu Techapaitoon, MD, Apisan Chanajit, MD, Thanatat Wattanatanagorn

Department of Orthopedics, Nakhon Pathom Hospital, Nakhon Pathom, Thailand

Purpose: Femoral shaft fractures, often caused by traffic and occupational accidents, are non-urgent yet severely painful orthopedic injuries. Preoperative skeletal traction, the standard method to mitigate pain and restore bone length before definitive surgery, has potential complications, including infections, nerve injuries, and hardware displacement due to bone drilling. The aim of the study was to assess the efficacy of non-invasive knee brace traction as an alternative to preoperative management of femoral shaft fractures.

Methods: A randomized controlled trial was conducted with 62 patients equally assigned to receive either a knee brace (n=31) or skeletal traction (n=31). Outcomes included pain scores during traction application and maintenance, fracture shortening post-traction, operative duration, intraoperative blood loss, complication rates, and preoperative patient satisfaction.

Results: Mean pain scores during traction application were significantly lower in knee brace group (8.19 ± 0.99) than in the skeletal traction group (10.00 ± 0.00; $p<0.05$). During maintenance, the scores were 3.96 ± 0.72 and 4.64 ± 0.48, respectively ($p<0.05$). Post-traction femoral shortening was comparable between groups (1.66 ± 0.38 cm vs. 1.54 ± 0.39 cm; $p=0.1326$). Complication rates were 12.9% and 16.13% in knee brace and skeletal traction groups, respectively ($p=0.7184$). Patient satisfaction was significantly higher in the knee brace group (7.90 ± 0.91 vs. 6.93 ± 0.76; $p<0.05$).

Conclusions: Compared to skeletal traction, knee brace traction significantly reduced preoperative pain and improved patient satisfaction while achieving similar mechanical outcomes and complication rates. It may serve as a safe and non-invasive alternative for preoperative management of femoral shaft fractures.

Keywords: knee brace traction, skeletal traction, femoral shaft fracture, preoperative pain scores

Article history:
Received July 30, 2025 Revised: October 7, 2025
Accepted: October 27, 2025
Correspondence to: Chavalit Iemsaengchairat, MD
Department of Orthopedics, Nakhon Pathom Hospital, Nakhon Pathom, Thailand
E-mail: st_bank@hotmail.com

Femoral shaft fractures are common orthopedic injuries that typically result from high-energy mechanisms, such as road traffic accidents or occupational injuries. Although these injuries are not immediately life-threatening, they cause intense pain and substantial functional impairment.

Preoperative skeletal traction, traditionally applied using a transtibial pin, is widely used to reduce pain and preserve femoral length prior to

definitive fixation. However, this invasive method is associated with pain and several complications, including infected wounds, osteomyelitis, neurovascular injury, and pin dislodgement. To mitigate these risks, less invasive alternatives, such as skin traction, have been proposed [1,5]. Although skin traction reduces the invasiveness of treatment, its limited weight-bearing capacity prevents effective correction of femoral shortening [1,4].

The idea for this study originated when the researchers had the opportunity to use a novel method, traction with a hinged knee brace, in a patient who could not undergo skin or skeletal traction owing to dermatologic contraindications. This approach provided excellent pain relief and maintained femoral alignment without complications. Based on this observation, we hypothesized that knee brace traction could serve as an effective and safe alternative to skeletal traction in patients awaiting surgical fixation of femoral shaft fractures.

The aim of the study was to compare preoperative pain control between knee brace and skeletal traction, and to evaluate secondary outcomes, including fracture shortening, surgery time, rate of blood loss during surgery, complication rates, and patient satisfaction. Contemporary evidence questions the sustained benefits of preoperative traction in adults. The AAOS 2021 guideline does not recommend routine preoperative traction for older adults with hip fractures, emphasizing multimodal analgesia [8]. A 2021 systematic review and meta-analysis further demonstrated that skin traction provides only short-lived pain relief (approximately 1 h) with no effect at 4–6, 12, or 24 h, underscoring the need for alternative approaches [9].

METHODS

Study Design and Participants

This single center, randomized controlled trial was conducted at the hospital between October 2024 and June 2025. Patients aged 18–60 years, with traumatic femoral shaft fractures who could communicate in Thai were eligible for the study. The exclusion criteria were pathological femoral fractures, prior ipsilateral femoral fractures, contraindications to elective femoral surgery, and multiple organ trauma.

Block randomization (block size=4) generated by the principal investigator was used in this randomized controlled trial to allocate participants to either the knee brace or skeletal traction group. Baseline characteristics were assessed for comparability between groups, and any imbalances were prespecified for adjustment using regression analysis.

Ethical Considerations

The local research ethics committee approved this study (approval no. 066-2024). Written informed consent was obtained from all the participants.

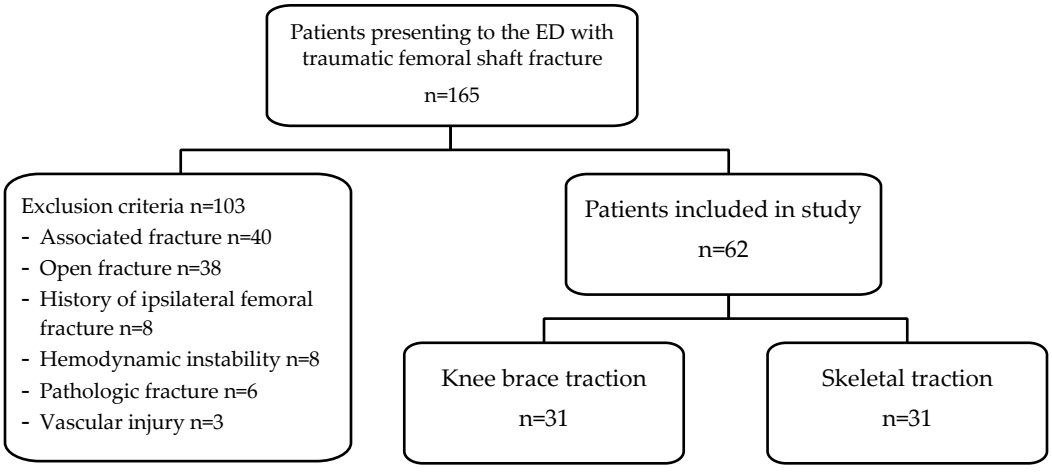

Fig.1 Flow diagram.

Randomization and Allocation

A total of 165 patients with traumatic femoral shaft fractures presented to the emergency department during the study period. Of these, 103 patients were excluded for the following reasons: associated fractures (n=40), open fractures (n=38), prior ipsilateral femoral fracture (n=8), hemodynamic instability (n=8), pathological fracture (n=6), and vascular injury (n=3). After applying these criteria, 62 patients were enrolled and randomized into either the knee brace or skeletal traction group (Figure 1). Randomization was performed using block randomization (block size=4) generated by the principal investigator.

Intervention

Both groups underwent preoperative traction using a standardized load of approximately 10% of the patient's body weight, in accordance with the institutional protocol [10] on the Böhler-Braun frame traction, as presented in Figure 2, followed by the same definitive surgical procedure of open reduction and internal fixation using a broad dynamic compression plate and screws. In the knee brace group, traction was applied with the knee flexed at 45° and the hinge brace securely locked to maintain a constant force (Figure 3). In the skeletal traction group, a 4.5-mm Steinmann pin was inserted transversely through the proximal tibia under a sterile technique with local anesthesia (10 mL of 1% lidocaine without epinephrine). To standardize analgesia, the baseline visual analog score (VAS) was recorded before any systemic morphine administration. Both groups then received IV morphine (0.05 mg/kg) approximately 15 min before traction application unless contraindicated. "During-application," the VAS was recorded immediately after hinge locking (knee brace) or immediately after pin insertion (skeletal traction). Thereafter, IV morphine (0.05 mg/kg) was administered every 3 h as needed at the patient's request. For maintenance traction, a load of 10% of body weight was used, consistent with the AO Surgery Reference recommendations [10].

For device safety, routine daily checks included verification of hinge-lock integrity and brace position, inspection of the skin under the brace for pressure or breakdown, assessment of distal pulses and capillary refill, and evaluation of swelling around the ankle and proximal thigh. Only the clinical findings were recorded, and no standardized numeric hinge-angle or displacement logs were collected.

Outcome Measures

Pain intensity was evaluated using the Visual Analog Scale (VAS) at three time points: (1) before application (baseline, prior to systemic morphine administration), (2) during application (immediately after hinge locking in the knee brace group or immediately after pin insertion in the skeletal traction group), and (3) 2 h after traction application. Radiographic assessment of femoral shortening was performed 24 h after traction using portable lateral radiographs. Intraoperative parameters, including operative duration and estimated blood loss, were recorded for all patients. Preoperative patient satisfaction was evaluated using a structured survey that allowed participants to rate their overall experience on a scale of 1–10. Adverse events were actively monitored and documented throughout the preoperative and perioperative periods. The complications of interest included wound infection, osteomyelitis, nerve injury, and traction device dislodgement.

Statistical Analysis

The sample size was calculated for a continuous-outcome non-inferiority trial with an alpha of 0.05, beta of 0.2, and non-inferiority margin (d) of 25%, yielding a minimum requirement of 28 patients per group [6,7]. Allowing for an anticipated 90% compliance rate, the final sample size was set at 31 patients per group. Analyses were performed on both intention-to-treat and per-protocol basis. Continuous variables, including pain scores, fracture shortening, operative time, estimated blood loss, and patient satisfaction, were compared using independent t-tests. Categorical variables, such as adverse event rates, were analyzed using chi-square tests. Statistical significance was set at $p < 0.05$.

Fig.2 Knee brace traction (left) and skeletal traction (right).

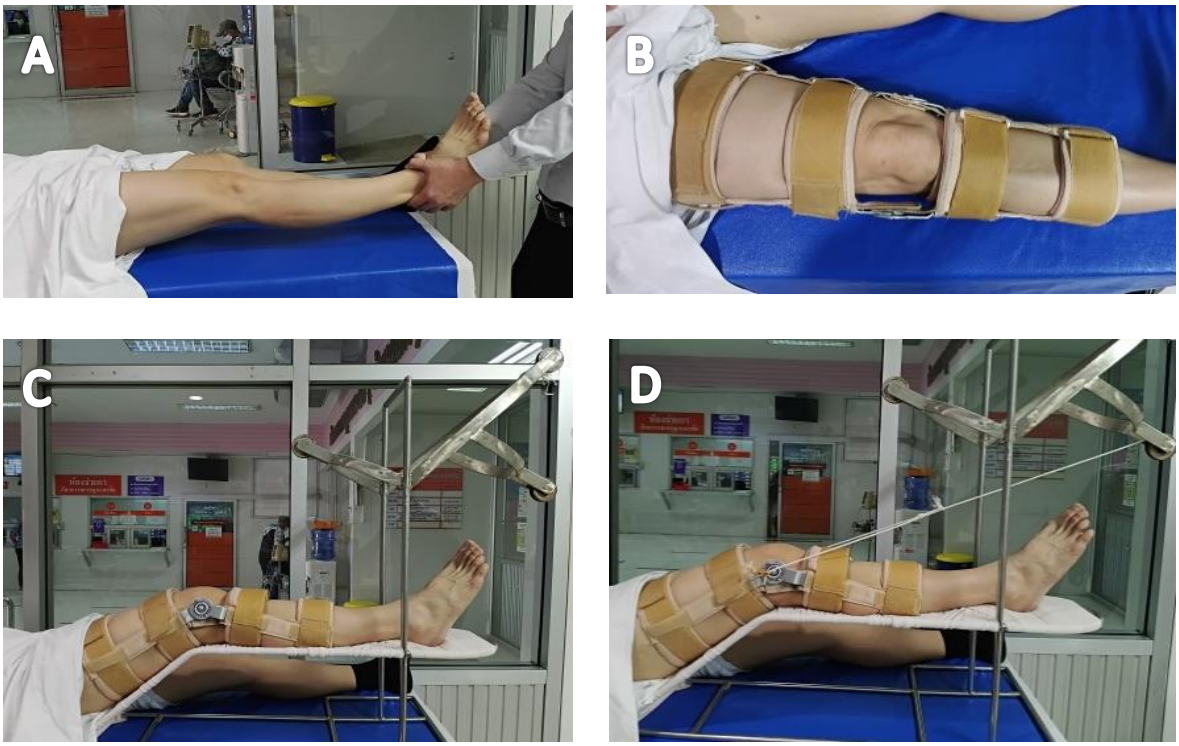

Fig.3 Application process of knee brace traction: (A) longitudinal traction, (B) application of the non-locking hinged knee brace, (C) lifting the leg and placing it on the Böhler-Braun frame with the knee brace locked at 45° of flexion, and (D) application of 10% of the patient's body weight as traction.

RESULTS

A total of 165 patients with traumatic femoral shaft fractures were screened during the study period. Of these, 103 patients were excluded based on the predefined criteria, leaving 62 eligible participants who were randomized equally into two groups: 31 patients in the knee brace traction group and 31 in the skeletal traction group (Figure 1). The baseline demographic and clinical characteristics of the two groups were comparable, with no statistically significant differences (Table 1). The mean age was 40.03 ± 12.97 years in the knee brace group and 41.06 ± 12.69 years in the skeletal traction group. The sex distribution was similar

(male/female: 22/9 vs. 21/10; p=0.7895), and the laterality of the fractures (right/left: 19/12 vs. 17/14; p=0.6067), time to surgery, and fracture type showed no significant differences between the groups.

Table 1 Patient characteristic.

Patient characteristics	Knee brace traction	Skeletal traction	P-value
Patient (N)	31	31	
Sex (male/female)	22/9	21/10	0.7895
Side (Right/Left)	19/12	17/14	0.6067
Age (years)	40.03 (12.97)	41.06 (12.69)	0.3782
Time to surgery (hours)	48.94 (13.94)	49.29 (13.28)	0.1260
Fracture type - WinquistII/III	20/11	23/8	0.2182

Pain Scores:

The mean pain score during traction application was significantly lower in the knee brace group than in the skeletal traction group (8.19 ± 0.99 vs. 10.00 ± 0.00; p<0.05). Similarly, during traction maintenance, the knee brace group reported significantly less pain (3.96 ± 0.72 vs. 4.64 ± 0.48; p<0.05). Baseline pain scores prior to traction application were comparable between the groups (7.96 ± 0.67 vs. 7.87 ± 0.55; p=0.2910).

Femoral Fracture Shortening:

Post-traction radiographic evaluation demonstrated no significant difference in femoral shortening between the groups (1.66 ± 0.38 cm in the knee brace group vs. 1.54 ± 0.39 cm in the skeletal traction group; p=0.1326).

Operative Parameters:

The mean operative time was 76.13 ± 10.42 min in the knee brace group and 74.19 ± 10.71 min in the skeletal traction group (p=0.2399). Estimated intraoperative blood loss was also comparable between groups (200 ± 46.74 mL vs. 203 ± 50.69 mL; p=0.3966).

Patient Satisfaction:

Preoperative patient satisfaction was significantly higher in the knee brace group (7.90 ± 0.91) than in the skeletal traction group (6.93 ± 0.76; p<0.05).

Complications:

The overall complication rate was 12.9% in the knee brace group (four cases of traction displacement) and 16.13% in the skeletal traction group (three cases of serous pin sites discharge and two cases of pin tract infection) [5], with no statistically significant difference (p=0.7184). None of the patients experienced compartment syndrome or significant brace-related circumferential discomfort.

DISCUSSION

This randomized controlled trial demonstrated that traction using a hinged knee brace significantly improved preoperative pain scores compared with skeletal traction in patients with femoral shaft fractures. Patient satisfaction was also significantly higher in the knee brace group. Other clinical outcomes, including fracture shortening after traction, operative time, intraoperative blood loss, and complication rates, did not differ significantly between the two groups. Compared with cutaneous (skin) traction, whose limited traction capacity restricts effective femoral length maintenance, the locked-hinge knee brace may transmit a greater axial load, thereby providing better pain relief and alignment control. These findings align with the contemporary evidence that questions routine traction. A 2021 systematic review of hip fracture populations reported no sustained analgesic benefit from preoperative skin traction, and the 2021 AAOS guidelines for older

adult hip fractures similarly do not recommend routine preoperative traction, emphasizing multimodal analgesia [8,9]. Although these data were primarily derived from patients with proximal femoral injuries, they underscore the limitations of skin traction and the rationale for evaluating noninvasive alternatives for femoral shaft fractures.

Two studies further support these findings in acute adult femoral fractures. In a randomized trial of diaphyseal femur fractures treated within 24 h, cutaneous traction was applied remarkably faster than skeletal traction, with no differences in post-traction pain, perioperative opioid consumption or operative reduction time [5]. Similarly, a clinical comparison from Korle Bu Teaching Hospital reported comparable preoperative pain control and no notable differences in intraoperative metrics between skin and skeletal traction, while highlighting device-specific limitations of skin traction that may restrict correction of femoral shortening [1]. In contrast, this study indicates that knee brace traction effectively addresses these limitations by providing considerable pain relief, avoiding the risks associated with tibial pin insertion [3], and achieving femoral length restoration comparable to that achieved with skeletal traction.

The complication rates were low and similar in both groups, although the complication types differed. In the knee brace group, the overall complication rate was 12.9% (four cases of dislodged traction), all occurring in patients with a high body mass index, one obese, and three morbidly obese patients (BMI >35). These factors may have contributed to ankle tightness, subsequent swelling, and reduced traction force, potentially leading to femoral shortening. In contrast, no brace dislodgement was reported among the remaining 27 patients, although minor loosening was occasionally observed and corrected through repositioning and tightening. In the skeletal traction group, the complication rate was 16.1%, consisting of three cases of serous discharge at the pin site and two cases of pin tract infection. No predictive factors for complications were identified in the skeletal traction group. These findings suggest that knee brace traction is safe and feasible for normal-weight and overweight patients; however, caution is warranted in obese and severely obese patients owing to the risk of knee instability. Although no strict time limit for knee brace traction has been established, we recommend using skeletal traction if traction is anticipated to exceed 7 days. Furthermore, knee brace traction should be avoided in patients with obesity or large thigh circumferences owing to instability risks.

This study has several limitations. First, the lack of blinding may have introduced bias in subjective outcomes such as pain and satisfaction scores. Second, patients with associated fractures were excluded to ensure group homogeneity. However, such patients often require prolonged preoperative immobilization in clinical settings, which could influence complication rates. Third, we focused on short-term outcomes; long-term parameters, including fracture healing rates, rehabilitation progress, and late complications, were not assessed. Fourth, the time from injury to initial traction was not prospectively recorded and was not analyzed; future studies should include this interval, given its potential effects on pain and swelling. Despite these limitations, we believe that long-term outcomes are unlikely to differ significantly between the two methods. Finally, although daily positional checks and safety assessments were performed as part of routine care, standardized measurements (e.g., hinge angle or displacement) were not recorded. Future trials should incorporate formal daily checklists and documentation protocols to quantify brace stability more accurately and detect subtle positional changes.

Although all patients in this trial underwent open reduction and plate fixation to standardize operative variables, we anticipate that using closed reduction with intramedullary nailing would not substantially alter preoperative shortening restoration, as this parameter is primarily determined by the traction modality applied before surgery. This aligns with the role of traction as a temporary intervention to achieve pain relief and alignment correction before surgery, rather than as a determinant of implant-related

outcomes. Future comparative studies should investigate whether the definitive fixation method influences postoperative parameters (e.g., operative time, blood loss, and union) when different preoperative traction strategies are used.

Future research should expand the inclusion criteria to encompass other clinical scenarios requiring preoperative traction, including acetabular, subtrochanteric, and distal femoral fractures, and involve both younger and older patients. Blinding of outcome assessors is recommended in future to minimize potential bias in subjective measures, such as VAS pain and satisfaction scores. Additional studies should evaluate the safety and efficacy of knee brace traction in obese and morbidly obese individuals, as knee stability may present a challenge in this subgroup. Moreover, future trials should incorporate standardized daily documentation of brace position (e.g., hinge angle and displacement) to better quantify positional stability and identify subtle changes. Finally, long-term follow-up assessing union rates, functional recovery, and overall quality of life will be essential to establish the clinical utility of knee brace traction.

CONCLUSION

This study demonstrated that traction using a hinged knee brace provides significantly greater pain relief and higher patient satisfaction than conventional skeletal traction while maintaining comparable mechanical alignment and operative outcomes. Given its non-invasive nature and low complication rate, knee brace traction represents a promising and safe alternative for the preoperative management of femoral shaft fractures. Further studies with larger cohorts and extended follow-ups are warranted to validate its applicability across broader patient populations and long-term outcomes.

REFERENCES

1. Agbley DYD, Holdbrook-Smith HA, Ahonon Y. A comparative evaluation of the efficacy between skeletal traction and skin traction in pre-operative management of femur shaft fractures in Korle Bu Teaching Hospital. Ghana Med J 2020;54:146-50.
2. Musajee M. Outcome of skeletal traction in patients with femoral shaft fractures at Kenyatta National Hospital [Dissertation]. Nairobi: University of Nairobi. 2012.
3. Bumpass DB, Ricci WM, McAndrew CM, et al. A prospective study of pain reduction and knee dysfunction comparing femoral skeletal traction and splinting in adult trauma patients. J Orthop Trauma 2015;29:112-8.
4. Dietzel M, Schöneberg LO, Schunn M, et al. Results after skin traction for femur shaft fractures in children below the age of four years. Eur J Trauma Emerg Surg 2022;48:3393-9.
5. Even JL, Richards JE, Crosby CG, et al. Preoperative skeletal versus cutaneous traction for femoral shaft fractures treated within 24 hours. J Orthop Trauma 2012;26:e177-82.
6. Pocock SJ. Clinical trials: A practical approach. New York: John Wiley & Sons; 1983.
7. Julious SA. Sample sizes for clinical trials with normal data. Stat Med 2004;23:1921-86.
8. American Academy of Orthopaedic Surgeons (AAOS). Management of hip fractures in older adults: Clinical practice guideline. Available from: https://www.aaos.org/quality/quality-programs/hip-fractures-in-older-adults/. Accessed December 3, 2021.
9. Kobayashi T, Ureshino H, Morimoto T, et al. Pain relief differentiated according to the length of time that preoperative skin traction was carried out for hip fractures: A systematic review and meta-analysis. Int J Orthop Trauma Nurs 2021;43:100886.
10. AO surgery reference. Traction for adult femur. Available from: https://surgeryreference.aofoundation.org/orthopedic-trauma/adult-trauma/tibial-shaft/basic-technique/fracture-management-with-limited-resources.