**Cukurova Medical Journal**
ÇUKUROVA ÜNİVERSİTESİ TIP FAKÜLTESİ

Cukurova Med J 2023;48(4):1275-1281
DOI: 10.17826/cumj.1352439

**RESEARCH**

# Comparison of the effects of lateral decubitus position and traction table on intramedullarynailing in trochanteric femur fractures

## Trokanterik femur kırıklarında lateral dekübit pozisyonu ve traksiyon masasının intramedüller çivilemeye etkisinin karşılaştırılması

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**Abstract**

**Purpose:** The objective of this study is to evaluate the influence of patient positioning on intraoperative outcomes, specifically intraoperative time, fracture reduction, and implant location, in individuals with trochanteric femur fractures undergoing intramedullary nailing. The study compares two patient positions: the lateral decubitus position (LDP group) and the utilization of a traction table (TT group).
**Materials and Methods:** A total of 82 patients with trochanteric femur fractures, who underwent surgery were included. The patients were divided into LDP and TT groups. Various parameters, including age, gender, fracture details, setup time, operation time, anesthesia time, fluoroscopy time, tip-apex distance (TAD), collodiaphyseal angle (CDA), reduction quality, and implant position, were analyzed.
**Result:** Surgical time in the LD group was 33.90 ± 6.05 minutes, whereas in the TT group, it was 33.00 ± 6.64 minutes. Anesthesia time was 50.55 ± 7.46 minutes in the LD group and 55.26 ± 12.49 minutes in the TT group. Fluoroscopy time in the LD group was 45.20 ± 7.18 seconds, while in the TT group, it was 46.23 ± 4.50 seconds. Lateral decubitus position resulted in shorter setup and anesthesia times compared to the traction table.
**Conclusion:** Intramedullary nailing in the lateral decubitus position is a viable and practical choice for fracture reduction, with the potential to decrease morbidity and mortality rates especially in elderly patients.
**Keywords:** Trochanteric femur fractures, intramedullary nailing, lateral decubitus position,traction table

**Öz**

**Amaç:** Bu çalışmanın amacı intramedüller çivileme uygulanan trokanterik femur kırıklarında, intraoperatif hasta pozisyonunun intraoperatif süre, kırık redüksiyonu ve implant yerleşimi gibi intraoperatif sonuçlar üzerindeki etkisini değerlendirmektir. Çalışma iki farklı cerrahi hasta pozisyonunu karşılaştırmaktadır: Lateral dekübit pozisyonu (LDP grubu) ve traksiyon masası kullanımı (TT grubu).
**Gereç ve Yönte**m: Ameliyat edilen trokanterik femur kırığı olan toplam 82 hasta çalışmaya dahil edildi. Hastalar LDP ve TT olarak iki gruba ayrıldı. Yaş, cinsiyet, kırık özellikleri, ameliyat hazırlık süresi, operasyon süresi, anestezi süresi, floroskopi süresi, tip-apeks mesafesi (TAD), kollodiafizer açı (CDA), redüksiyon kalitesi ve implant yerleşimi gibi çeşitli parametreler analiz edildi.
**Bulgular:** Cerrahi süresi, LDP grubunda 33,90 ± 6,05 dakikayken TT grubunda 33,00 ± 6,64 dakikaydı. Anestezi süresi, LDP grubunda 50,55 ± 7,46 dakikayken TT grubunda 55,26 ± 12,49 dakikaydı. Floroskopi süresi, LDP grubunda 45,20 ± 7,18 saniyeyken TT grubunda 46,23 ± 4,50 saniyeydi. Lateral dekübit pozisyonun traksiyon masasına göre dahakısa ameliyat hazırlık ve anestezi süresi sağladığı belirlendi.
**Sonuç:** Bulgular, lateral dekübit pozisyonunda intramedüller çivilemenin kırık redüksiyonu için uygun ve pratik bir seçenek olduğunu, buna bağlı olarak özellikle yaşlı hastalarda morbidite vemortalite oranlarını azaltma potansiyeli olduğunu göstermektedir.

**Anahtar kelimeler**: Trokanterik femur kırıkları, intramedüller çivileme, lateral dekübit pozisyonu, traksiyon masası

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Received: 30.08.2023 Accepted: 24.11.2023

## INTRODUCTION

With the increasing life expectancy, hip fractures resulting from osteoporosis have emerged as a significant concern in geriatric orthopedics[1,2]. The process of osteosynthesis in treating hip fractures is intricate, influenced by a myriad of factors[3-6]. Intramedullary nailing stands out as a commonly employed method for osteosynthesis in the treatment of these fractures. While the use of a traction table in intramedullary nailing offers advantages such as enhanced fracture reduction and intraoperative imaging, it comes with drawbacks, including prolonged preoperative preparation time and complications related to traction. In the absence of a traction table, intramedullary nailing can also be carried out in the lateral decubitus position. The literature contains a limited number of studies comparing the lateral decubitus position and the use of a traction table in intramedullary nailing [7-10]. Our hypothesis posits that the lateral decubitus position can be applied in intramedullary nail surgery for trochanteric femur fractures without significantly affecting intraoperative outcomes when compared to the use of a traction table. This research aims to provide contemporary contributions to the literature on intramedullary nailing for trochanteric fractures, a procedure frequently performed in routine orthopedic practice. The objective of this study is to evaluate the influence of patient positioning on intraoperative outcomes, specifically focusing on intraoperative time, fracture reduction, and implant location in individuals with trochanteric fractures undergoing intramedullary nailing.

## MATERIALS AND METHODS

### Study design

The study received approval from the Necmettin Erbakan University Ethics Committee on May 22, 2023, with decision number 2023/4345. Patients who underwent surgery for trochanteric femur fractures between January 1, 2021, and January 1, 2023, by four surgeons with a minimum of five years of clinical experience in orthopedics at a single center (Konya City Hospital), specializing in advanced trauma operations, were retrospectively analyzed. The patients were categorized into two groups: those operated on the traction table (TT) and those operated in the lateral decubitus position (LDP). Age, gender, fracture side, fracture type, setup time, operation time, total anesthesia time, tip-apex distance (TAD), reduction quality, implant placement (according to Cleveland-Bosworth classification), collodiaphyseal angle (CAD), and fluoroscopy time data were examined and compared. Setup time was defined as the duration between the initiation of patient anesthesia and the skin incision. Surgical time was measured from the commencement of the skin incision until skin integrity was restored. Anesthesia time encompassed the period from the initial anesthesia procedure to the final additional anesthesia required to prevent patient discomfort in the operating room. All patients included in the study received the same implant (Aries, Koç Ortopedi Medikal ve Sağlık Ürünleri İth. İhr. Tic. Ltd. Şti., Ankara/Turkey) with a CAD of 125°.

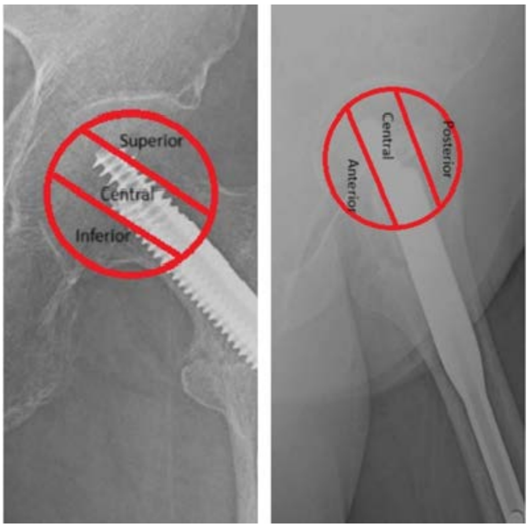


**Figure 1. Dividing the femoral head into three equal parts on anteroposterior (AP) and lateral radiographs, following the Cleveland-Bosworth classification.**

The study incorporated inclusion criteria based on adherence to the Arbeitsgemeinschaft für Osteosynthesefragen (AO) 31A2-3 classification (unstable trochanteric fractures), fractures resulting from simple falls without additional pathological conditions in the trauma history, and the administration of the operation under spinal anesthesia. Exclusion criteria encompassed pathological fractures, bilateral femur fractures, a secondary fracture in another location of the ipsilateral femur, multitrauma or high-energy trauma, and hip dysplasia.

## Evaluation of radiological images

The criteria set by Baumgaertner et al. were applied to determine the quality of fracturereduction [11]. The first criterion mandates a neck angle between 120° and 135°, and the angulation angle should be below 20° in the anteroposterior (AP) hip radiography view. The second criterion emphasizes that any bone fragment should exhibit a displacement of less than 4 mm in AP and lateral views. Using these criteria, reduction quality is evaluated on a three-stage scale. Reductions meeting both criteria are classified as "good," those meeting only one criterion are deemed "acceptable," and reductions not meeting any criteria are considered "poor." These criteria aim to establish an evaluation framework for clinical practice, providing an objective approach for qualitative bone fracture reduction analysis.

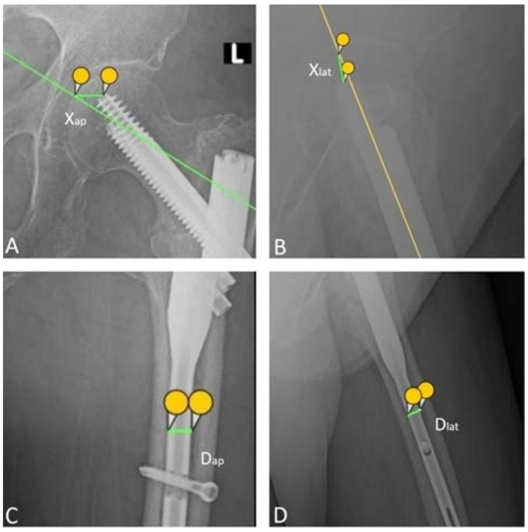


**Figure 2. Tip-apex distance (TAD) measurement; TAD = (Xap x Dtrue/Dap) + (Xlat x Dtrue/Dlat)**

The Cleveland-Bosworth classification was employed to assess the implant's position within the femur. According to this classification, the femoral head is divided into nine quadrants after dividing it into three equal parts in the AP and lateral radiographs, as illustrated in Figure 1. Lag is a system that classifies the screw tip based on its quadrant placement [7,12]. To ensure mechanical stability, it is recommended that the fixation implant's tip be located in the central (AP)-central (lateral) or inferior (AP)-central (lateral) quadrant[13,14]. Patients were categorized into two groups: those in the central-central or inferior-central quadrants and those in the other quadrants.

To measure the TAD, the apex of the femoral head was determined as the point where the line drawn from the middle and parallel to the femoral neck intersects the subchondral bone. Radiographic magnification was determined by comparing the actual width of the implant with its width measured on the radiograph. Subsequently, the distance to the apex in the AP and lateral plane was multiplied by the radiographic magnification to obtain actual values (Figure 2). Summing these values yielded the TAD. CDA measurements were determined by measuring the angle between the line drawn from the center of the femoral head parallel to the femoral neck and the line drawn to center the proximal femoral diaphysis (Figure 3).

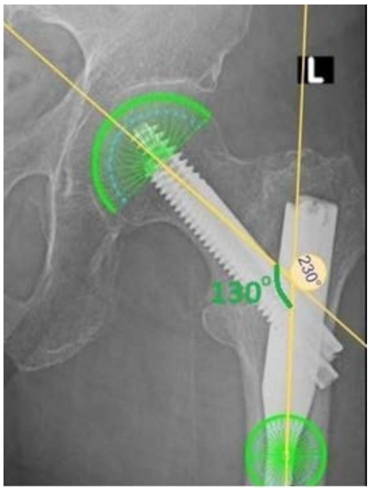


**Fıgure 3. Collodiaphyseal angle (CDA) measurement.**

## Statistical analysis

The data analysis was conducted using SPSS 26.0 (Statistical Package for the Social Sciences) program (Graph Pad Software, Inc., La Jolla, CA). Fisher's exact test and chi-squared test were employed to assess categorical variables (gender, affected side, fracture type, reduction classification, and the position of the implant in the femoral head). The Kolmogorov-Smirnov test was applied to examine whether continuous variables (age, setup time, surgery time, anesthesia time, fluoroscopy time, TAD, and CDA) followed a normal distribution. The 'Student t-test' was utilized for parameters conforming to the normal distribution, while the 'Mann-Whitney U' test was employed for parameters deviating from normal distribution. The minimum (min), maximum (max), median, mean, and standard deviation (SD) values for these parameters were recorded. The level of significance was set at a p-value <0.05 for all tests. In the power analysis, with a predicted type 1 error of 0.05 and an efficacy power of 0.80, a minimum of 30 patients were required in both groups to achieve statistical significance.

## RESULTS

A total of 82 patients meeting the inclusion criteria were retrospectively analyzed. Out of these, 42 patients underwent surgery in the lateral decubitus position (LDP group), and 40 patients were operated on the traction table (TT group). The mean age in the LDP group was 74.88 ± 10.59, and in the TT group, it was 75.13 ± 7.64. No significant age difference was observed between the two groups (p=0.904). The LDP group consisted of 21 females and 21 males, while the TT group comprised 22 females and 18 males. There was no significant gender difference between the two groups (p=0.241). In terms of fractured side, the LDP group had 8 left hip and 34 right hip fractures, and the TT group had 11 left hip and 29 right hip fractures. No significant difference was found between the two groups regarding the fractured side (p=0.628). Among the LDP group patients, 24 had AO 31-A2 type fractures, and 18 had AO 31-A3 type fractures. In the TT group, 24 patients had AO 31-A2 type fractures, and 16 had AO 31-A3 type fractures. There was no significant difference between the two groups in terms of fracture classification (p=0.793).

The mean setup time for patients in the LDP group was 15.38 ± 2.43 minutes, while the mean setup time for patients in the TT group was 17.00 ± 2.12 minutes. A significant difference was observed between the two groups in terms of setup time (p=0.002). The mean surgical time for patients in the LDP group was 33.90 ± 6.05 minutes, and for patients in the TT group, it was 33.00 ± 6.64 minutes. No significant difference was found between the two groups in terms of surgical time (p=0.675). The mean anesthesia time for patients in the LDP group was 50.55 ± 7.46 minutes, whereas for patients in the TT group, it was 55.26 ± 12.49 minutes. There was a significant difference between the two groups in terms of anesthesia time (p=0.043). The mean fluoroscopy time for patients in the LDP group was 45.20 ± 7.18 seconds, and for patients in the TT group, it was 46.23 ± 4.50 seconds. No significant difference was observed between the two groups in terms of fluoroscopy time (p=0.675).

**Table 1. Comparison of parameters between groups**

| Factor | Lateral Decubitus (Mean ± SD) | Traction Table (Mean ± SD) | P Value |
|---|---|---|---|
| Number of patients | 42 | 40 | |
| Age | 74.88 ± 10.59 | 75.13 ± 7,64 | 0.904[a] |
| Gender (Female/Male ratio) | (21/21) | 22/18 | 0.241[c] |
| Side (Left/Right ratio) | (8/34) | 11/29 | 0.628[c] |
| AO fracture classification | | | |
| 31 A2 | 24 (57%) | 24 (40%) | 0.793[c] |
| 31 A3 | 18 (43%) | 16 (60%) | |
| Setup time (mins) | 15.38 ± 2.43 | 17.00 ± 2.12 | 0.002[b] |
| Surgical time (mins) | 33.90 ± 6.05 | 33.00 ± 6.64 | 0.675[a] |
| Anesthesia time (mins) | 50.55 ± 7.46 | 55.26 ± 12.49 | 0.043[a] |
| Fluoroscopy time (secs) | 45.20 ± 7.18 | 46.23 ± 4.50 | 0.47[a] |
| TAD (mm) | 22.20 ± 3.48 | 21.92 ± 1.70 | 0.647[a] |
| CDA (degrees) | 133.67 ± 13.49 | 131.57 ± 21.56 | 0.596[a] |
| Reduction classification | | | |
| Good | 21 | 20 | 0.998[d] |
| Acceptable | 18 | 17 | |
| Poor | 3 | 3 | |
| Cephalic position of the implant | | | |
| At quadrant center/center or inferior/center quadrants | 18 | 19 | 0.673[c] |
| At other quadrants | 24 | 21 | |

[a] Student t test; [b] Mann Whitney U test; [c] Chi-squared test; [d] Fisher's exact test; SD Standard deviation; mins (minutes); secs (seconds); mm (milimetres)

The mean TAD for patients in the LDP group was 22.20 ± 3.48 mm, and for patients in the TT group, it was 21.92 ± 1.70 mm. No significant difference was observed between the two groups in terms of TAD (p=0.647). The mean CDA for patients in the LDP group was 133.67 ± 13.49 degrees, and for patients in the TT group, it was 131.57 ± 21.56 degrees. There was no significant difference between the two groups in terms of CDA (p=0.596). Regarding reduction classification, in the LDP group, it was 'good' in 21 patients, 'acceptable' in 18 patients, and 'poor' in 3 patients. In the TT group, it was 'good' in 20 patients, 'acceptable' in 17 patients, and 'poor' in 3 patients. No significant difference was found between the two groups in terms of reduction classification (p=0.998). In terms of the position of the implant, it was in the recommended quadrants in 18 patients and in other quadrants in 24 patients in the LDP group. In the TT group, it was in the recommended quadrants in 19 patients and in other quadrants in 21 patients. No significant difference was observed between the two groups in terms of the position of the implant (p=0.673). All values are provided in Table 1.

## DISCUSSION

In our study comparing the lateral decubitus position with the use of a traction table in treating trochanteric femur fractures through the intramedullary nailing method, we observed that the lateral decubitus position resulted in a shorter setup time and anesthesia time. The expeditious preparation of the patient for surgery in the lateral decubitus position not only reduces setup time but also facilitates easier access to the nail's entry point, thereby streamlining the implant placement and shortening anesthesia duration. We anticipate that the decreased anesthesia time can contribute to lower morbidity and mortality rates, particularly in elderly patients. Moreover, we posit that preparing the patient for surgery on a traction table and accessing the trochanteric entry point of the nail may pose greater challenges and consume more time, especially for obese patients. Based on clinical experience, we see the lateral decubitus position as having the potential to assist surgeons in managing muscle forces affecting the hip joint and contributing to fracture reduction. Furthermore, the lateral decubitus position appears to offer advantages in scenarios where achieving the desired level of fracture reduction proves challenging or in cases necessitating plate placement, such as distally extending fractures or reductions requiring open surgery.

When reviewing the literature, it is evident that the preparation time for the lateral decubitus position is consistently shorter than that required for the traction table [7,8]. Similarly, in our study, we observed a shorter mean preparation time for surgery in the lateral decubitus position compared to the traction table. In terms of mean operative times, previous studies provide varying results. Dogan et al. reported no significant difference in mean operative times between the two positions [7]. However, Sonmez et al. reported that the mean operative time was shorter in the lateral decubitus position compared to the traction table [8]. In our study, there was no significant difference in the mean operative time between the LDP and TT groups. We attribute this lack of difference to the fact that reduction was performed as part of the preoperative preparation in the TT group, while it was executed intraoperatively in the LDP group. In the LDP group, we think that the surgical duration of both methods is comparable since the closure phase of the patient's subcutaneous and skin tissues is shorter than in the TT group, thus compensating for the time lost during fracture reduction in the LDP group.

In the literature, the recommended TAD value for intramedullary nailing in hip fractures is typically set below 25 mm [15, 16]. In our study, the mean TAD values were 22.2 mm in the LDP group and 21.92 mm in the TT group. Although the mean TAD is slightly higher in the LDP group compared to the TT group, the fact that the mean TAD is below 25 mm suggests that the implant is within the safe range in terms of TAD value in the lateral decubitus position. Previous studies have shown no significant difference in the mean TAD of patients operated in the lateral decubitus position compared to those on a traction table [7-9]. Similarly, in our study, there was no significant difference between the two groups in terms of TAD. From this perspective, we can conclude that patient position or the use of a traction table does not yield a significant difference in terms of TAD.

In their study, Sönmez et al. asserted that, based on the modified Baumgaertner radiological reduction criteria, there was no significant difference between the lateral decubitus position and the traction table position in terms of radiological reduction [8]. Similarly, our study yielded comparable results, demonstrating no significant difference in the radiological reduction of the fracture. Regarding the position of implants in the femoral head, Turgut et al., in their study, reported that the implants were in the recommended femoral head quadrants in 53.5% of the patients [12]. In our study, we observed a similar ratio, with the implants predominantly positioned in the recommended quadrants. The absence of a significant difference between the two groups in terms of implant placement suggests that the lateral decubitus position is a safe choice for implant positioning.

In our study, no significant difference was observed in terms of CDA values between patients undergoing intramedullary nailing in the lateral decubitus position and those on the traction table. Similarly, Dogan et al. noted in their study that there was no significant difference in CDA values[7]. On the other hand, Sonmez et al. reported in their study that CDA was higher in the lateral decubitus position compared to the traction table [8]. However, it's important to note that in the same study, they found higher CDA measurements on the contralateral intact side of the femur in the lateral decubitus position. This discrepancy in anatomical measurements between the femurs in the lateral decubitus position and traction table groups in their study limited the overall findings.

In previous studies, it was reported that fluoroscopy time was shorter in the lateral decubitus position compared to the traction table [8,10]. However, in our study, no significant differencewas observed in terms of fluoroscopy time in both positions. The rationale for this finding is that fracture reduction is carried out preoperatively on the traction table, resulting in relatively less imaging compared to the intraoperative lateral decubitus position. We noted that both fluoroscopy time and operative time did not differ significantly between the two positions, likely due to increased imaging during intraoperative reduction in the lateral decubitus position.

One limitation of our study is that patients who initially underwent intramedullary nailing were operated on by more than one surgeon. Despite each surgeon having a minimum of five years of clinical experience in orthopedics and traumatology, the study's robustness might have been enhanced if conducted by a single surgeon. A second situation that may limit thestudy is that the intramedullary nails used are of different brands. Furthermore, we did not assess the short or long-term clinical findings and complications of the patients; our examination was solely focused on postoperative radiological images.

In conclusion, intramedullary nailing carried out in the lateral decubitus position stands out as more practical choice for fracture reduction compared to using a traction table. This approach has the potential to decrease mortality and morbidity rates by reducing anesthesia time, particularly in the elderly. However, it's crucial to note that this study was retrospective and involved a relatively small patient cohort. Performing prospective randomized studies that compare intraoperative and postoperative long-term outcomes in a larger group of patients requiring intramedullary nailing for trochanteric fractures would provide more definitive guidance.

**Author Contributions:** Concept/Design : AY, NM; Data acquisition: MK; Data analysis and interpretation: AY; Drafting manuscript: AY; Critical revision of manuscript: AY; Final approval and accountability: AY, NM, MK, AY; Technical or material support: NM; Supervision: MK; Securing funding (if available): n/a.
**Ethical Approval:** Ethical approval was obtained from the Necmettin Erbakan University Non-Pharmaceutical and Medical Device Research Ethics Board by its decision dated 22.05.2023 and numbered 176-2023/4345.
**Peer-review:** Externally peer-reviewed.
**Conflict of Interest:** Authors declared no conflict of interest.
**Financial Disclosure:** Authors declared no financial support
**Acknowledgements:** We extend our gratitude to all the contributors to this article.

## REFERENCES

1. Davut S. Effect of distal locking type on radiological results of proximal femoral nails used in the surgical treatment of hip fractures. Cukurova Med J. 2022;47:1350-8.
2. İlker E, Koyuncu D, Gönen E. İntertrokanterik femur kırığı sonrasında proksimal femur çivisi ile başarılı osteosentez elde edilen hastaların fonksiyonel sonuçları. Cukurova Med J. 2019;44:1323-8.
3. Bagır M, Mirioğlu A, Tekin M, Bicer Ö, Özkan C. Comparison of hematoma block and sedoanalgesia for analgesia before reduction of distal radius fractures. Cukurova Med J. 2021;46:1100-7.
4. Çiloğlu O, Dursun M, Kalkan T, Çiçek H, Seyfettinoğlu F, Oğur HU. Distal femur kırıklarında retrograd intramedüller çivi ve perkutan plak osteosentez yöntemlerinin karşılaştırılması. Cukurova Med J. 2017;42:490-8.
5. Yurteri A, Yildirim A, Çelik ZE, Vatansev H, Durmaz MS. The effect of quercetin on bone healing in an experimental rat model. Jt Dis Relat Surg. 2023;34:365-73.
6. Polat A, Misir A, Buyukkuscu MO, Basilgan S, Basar H. Factors associated with femoral neck shortening after closed or open reduction and screw fixation. Indian J Orthop. 2021;56:303-11.
7. Doğan N, Ertürk C, Gülabi D. Is proximal femoral nailing of unstable intertrochanteric fractures in the lateral decubitus position without a traction table as

safe and effective as on a traction table? Injury. 2022;53:555-60.
8. Sonmez MM, Camur S, Erturer E, Ugurlar M, Kara A, Ozturk I. Strategies for proximal femoral nailing of unstable intertrochanteric fractures: lateral decubitus position or traction table. J Am Acad Orthop Surg. 2017;25:e37-e44.
9. de Souza EF, Hungria JOS, Rezende LRS, Bellan DG, Borracini JA. Comparative study between lateral decubitus and traction table for treatment of pertrochanteric fractures with cephalomedullary nails. Rev Bras Ortop. 2017;52:24-8.
10. Xue L, Zha L, Chen Q, Liang Y-j, Li K-r, Zhou Z et al. Randomized controlled trials of proximal femoral nail antirotation in lateral decubitus and supine position on treatment of intertrochanteric fractures. ScientificWorldJournal. 2013; 276015.
11. Mao W, Ni H, Li L, He Y, Chen X, Tang H et al. Comparison of Baumgaertner and Chang reduction quality criteria for the assessment of trochanteric fractures. Bone Joint Res. 2019;8:502-8.
12. Turgut A, Kalenderer Ö, Günaydin B, Önvural B, Karapinar L, Ağuş H. İntertrokanterik femur kırıklarının proksimal femoral çivi antirotasyon (PFNA) ile lateral dekübit pozisyonda tespiti. Acta Orthop Traumatol Turc. 2014;48:513-20.
13. Liu W, Zhou D, Liu F, Weaver MJ, Vrahas MS. Mechanical complications of intertrochanteric hip fractures treated with trochanteric femoral nails. J Trauma Acute Care Surg.2013;75:304-10.
14. Hwang J-H, Oh J-K, Oh C-W, Lee S-J, Myung-Rae C, Kim H et al. A biomechanical evaluation of proximal femoral nail antirotation with respect to helical blade position in femoral head: A cadaveric study. Indian J Orthop. 2012;46:627-32.
15. Kane P, Vopat B, Heard W, Thakur N, Paller D, Koruprolu S et al. Is tip apex distance as important as we think? A biomechanical study examining optimal lag screw placement. Clin Orthop Relat Res. 2014;472:2492-8.
16. Li S, Chang S-M, Jin Y-M, Zhang Y-Q, Niu W-X, Du S-C et al. A mathematical simulation of the tip-apex distance and the calcar-referenced tip-apex distance for intertrochanteric fractures reduced with lag screws. Injury. 2016;47:1302-8.