Clinical and Radiological Results of Patients Treated with Talon Distalfix Femoral Intramedullary Nail for Femoral Shaft Fractures

Femur Cisim Kırıkları İçin Talon Distalfix Femoral İntramedüller Çivi ile Tedavi Edilen Hastaların Klinik ve Radyolojik Sonuçları

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Atıf/Cite As: Dundar A et al. Clinical and Radiological Results of Patients Treated with Talon Distalfix Femoral Intramedullary Nail for Femoral Shaft Fractures. Hitit Med J 2023;5(2): 99-103. https://doi.org/10.52827/hititmedj.1272032

Abstract

Objective: Talon distalfix intramedullary nails have been developed as a solution to the technical difficulties experienced during the placement of locking screws. We aimed to evaluate the radiological and clinical results of retractable talon distal fix for the treatment of femoral shaft fractures.

Material and Method: Between January 2017 and January 2022, 28 patients with femoral shaft AO type 32-A and B fractures were treated with Talon distalfix nails. AO Type 32-A and B fractures were included in the study. Demographic characteristics, follow-up times, ASA of Anesthesiologists classification and fracture type were recorded. The duration of the operation, intraoperative blood loss, fluoroscopy time (in min), and time to bone union were recorded. General and technical complications (nonunion, malunion, malrotation, and shortening) were evaluated. Clinical functional outcomes were evaluated using the Knee Injury and the Osteoarthritis Outcome Score Physical Function Shortform (KOOS-PS), Hip Injury and Osteoarthritis Outcome Score Physical Function Shortform (HOOS-PS) and Thoresen criteria.

Results: A total of 28 patients (11 female and 17 male) were included in the study. The mean age was 46.8 years and the mean follow-up was 23.7 months. The mean time to bone union was 22.6 weeks. No nonunion was observed in any of the patients. The mean hospital stay was 3.4 days and the mean Body Mass Index was 24.2. The mean operation time was 40.3±3.4 minutes and the mean scope time was 26.9 seconds. The mean KOOS-PS score and HOOS-PS were 83.4 and 85.6, respectively.

Conclusion: Talon distalfix nails can be safely used in AO type A-B fractures of the midshaft femur. Talon distalfix nail application provides advantages including shorter operation times, less radiation exposure, fewer surgical incisions, and less blood loss. In addition, it should be emphasized that the union time is prolonged compared with that of conventional nails.

Keywords: Clinical result; Distal locking; Femoral shaft fracture; Malrotation; Malunion; Talon distal fix

Özet

Amaç: Talon distalfix intramedüller çiviler, distal kilitleme vidalarının yerleştirilmesi sırasında yaşanan teknik zorluklara çözüm olarak geliştirilmiştir. Femur şaft kırıklarının tedavisinde geri çekilebilir Talon distalfix çivisinin radyolojik ve klinik sonuçlarını değerlendirmeyi amaçladık.

Gereç ve Yöntem: Ocak 2017-Ocak 2022 tarihleri arasında femur şaft AO tip 32-A, B kırığı olan 28 hasta Talon distalfix çivileri ile tedavi edildi. AO Tip 32-A, B kırıkları çalışmaya dahil edildi. Demografik özellikler, takip süreleri, ASA sınıflaması ve kırık tipleri kaydedildi. Ameliyat süresi, intraoperatif kan kaybı, floroskopi süresi (dakika cinsinden) ve kemik kaynamasına kadar geçen süre kaydedildi. Genel ve teknik (kaynamama, yanlış kaynama, malrotasyon ve kısalık) komplikasyonlar değerlendirildi. Klinik fonksiyonel sonuçlar Diz Yaralanması ve Osteoartrit Sonuç Skoru Fiziksel Fonksiyon Kısa Skoru (KOOS-PS), Kalça Yaralanması ve Osteoartrit Sonuç Puanı Fiziksel Fonksiyon Kısa Skoru (HOOS-PS) ve Thoresen kriterleri kullanılarak değerlendirildi.

Bulgular: Çalışmaya toplam 28 hasta (11 kadın, 17 erkek) dahil edildi. Ortalama yaş 46,8 yıl, ortalama takip süresi 23,7 ay idi. Ortalama kemik kaynama süresi 22,6 hafta idi. Hiçbir hastada kaynamama gözlenmedi. Ortalama hastanede kalış süresi 3,4 gün, ortalama Body Mass Index 24,2 idi. Ortalama ameliyat süresi 40,3±3,4 dakika, ortalama skopi süresi ise 26,9 saniye idi. Ortalama KOOS-PS skoru ve HOOS-PS skoru sırasıyla 83,4 ve 85,6 idi.

Sonuç: Talon distalfix çiviler femur orta şaft AO tip A-B kırıklarında güvenle kullanılabilir. Talon distal fiks çivi uygulaması daha kısa ameliyat süreleri, daha az radyasyona maruz kalma, daha az cerrahi kesi ve daha az kan kaybı gibi avantajlar sağlar. Bununla birlikte kaynama süresinin geleneksel çivilere göre daha uzun olduğu akılda tutulmalıdır.

Anahtar Sözcükler: Klinik sonuç; Distal kilitleme; Femur şaft kırığı; Malrotasyon; Yanlış kaynama; Talon distal fiks

Geliş Tarihi/Date of Submission: 27.03.2023
Kabul Tarihi/Date of Acceptance: 02.05.2023
Yayım Tarihi/Date of Publication: 30.06.2023

Peer Review: Evaluated by independent reviewers working in the at least two different institutions appointed by the field editor.
Ethical Statement: Ethics committee approval was received from Hitit University Clinical Research Ethics Committee on 10.03.2021 with decision number 425.
Plagiarism Checks: Yes - iThenticate
Conflict of Interest: No conflict of interest was declared by the authors.
Complaints: hmj@hitit.edu.tr
Authorship Contribution: Idea/Hypothesis: DA, ID, KS, ZS Design: DA, ID, KS, ZS Data collection/Data processing: DA, KS Data Analysis: DA, KS Preparation of the article: DA, ID, KS, ZS
Informed Consent: Consents were obtained from the patients.
Financial Disclosure: No financial support.

Introduction

Femoral shaft fractures are significant fractures that are frequently observed in the young adult population, occur with high-energy trauma, and may be associated with concomitant organ injuries. These fractures can lead to serious morbidity and mortality. The aim of treatment is to achieve union and previous functionality in the shortest possible time with the fewest possible complications (1). Surgery is almost always the treatment of choice for adults femoral diaphyseal fractures. Currently, closed reduction and intramedullary nailing are the most commonly used and appropriate treatment methods. Alternatively, open reduction and intramedullary nailing, plate-screw fixation, intramedullary nailing with flexible nails, and dynamic fixators can be used (2). In addition, a number of alternative nails are used in femoral shaft fractures (carved and non-carved, flexible and rigid, trochanteric, piriformis-entry nails, etc.). With the development of interlocking nails, intramedullary fixation of the ends of long bones and comminuted fractures has also been practiced (3). Recently, talon distalfix (TDF) intramedullary nails have been developed as a solution to the technical difficulties experienced during the placement of locking screws. Talon distalfix nails offer the advantages of multiplanar stability in femoral shaft fractures by providing distal locking with retractable hooks that can be attached to the distal fracture, less exposure to fluoroscopy, a shorter operation time, less blood loss, a smaller surgical incision, and easy and effective use. To the best of our knowledge, there is no study on talon distalfix femoral nails in the literature. Therefore, in this study, we aimed to evaluate the radiological and clinical results of femoral shaft AO Type 32-A and B fractures treated with a talon distal fix intramedullary nail.

Material and Method

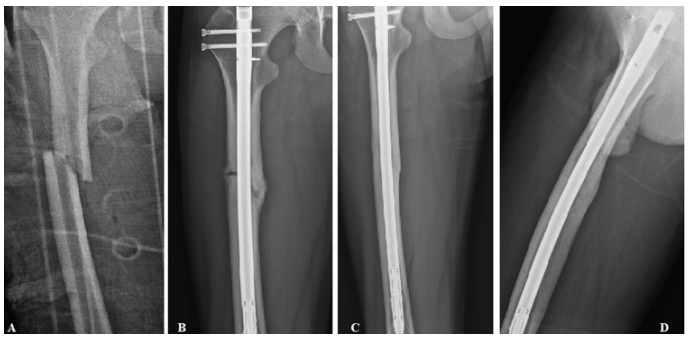
Between January 2017 and January 2022, 28 patients with femoral shaft AO type 32-A and B fractures were treated using TDF intramedullary nails. The research protocol was approved by the Hitit University Ethics Committee (10.03.2021-425) and informed consent was obtained from all patients. The clinical and radiological records of patients treated with TDF were retrospectively analyzed. Patients older than 18 years with AO Type 32-A and B femur fractures with a minimum follow-up of 1 year were included in the study. Patients with polytrauma, history of previous surgery on the same extremity, osteoarthritis of the hip and knee, and open fractures were excluded. The average time from fracture to surgery was 4 days. Fracture types were evaluated according to AO classification. AO Type 32-A and B fractures were included in the study, while other fracture types were excluded. The appearance of calluses in the three cortices and the patient's ability to walk without pain or support were considered as unions. Patients were followed up every two weeks until union for a mean of 26 months (range 9-38 months).

Surgical technique

Operations were performed on the fracture table using traction and fluoroscopy. The piriformis fossa was used as the TDF entry site. After a closed reduction was achieved, the medullary canal was reamed and the nail was advanced intramedullary antegrade distally. The distal talon was expanded using a talon driver. In fractures in which adequate reduction could not be achieved, open reduction was achieved with a 6 cm limited second incision lateral to the fracture line without much intervention to the soft tissue cover and periosteum. Femur length was assessed using a metal ruler with reference to contralateral femur length. Rotational malalignment was determined by examining the profile of the trochanter minor on radiography (Fig1) (Fig2).

Figure I. Retractable Talon DistalFix Femoral Nail System (Orthopedic Designs North America Inc., FL, USA)

Figure II. Talon DistalFix Femoral Nail System (Orthopedic Designs North America Inc., FL, USA)



(A) Preoperative anteroposterior (AP) view of a femoral shaft fracture (37-year-old–men). (B) Postoperative AP view after 2 months (C, D) Post-operative 1st-year AP and L views show good union and with no shortening and malunion.

Postoperative follow-up

On postoperative day 1, isometric muscle strengthening exercises and range-of-motion rehabilitation were started in all patients. Patients were allowed to mobilize with a walker support as much as possible, and a partial load was applied. All the patients underwent the same postoperative rehabilitation program.

In the postoperative period, the patients were followed up at 4-week intervals until bone healing was achieved and clinically and radiologically at 3, 6, 9, and 12 months after union was achieved. Fracture union was assessed radiologically. Sufficient callus tissue in the anterior, posterior, and lateral cortices radiographs was considered union. Nonunion was defined as inadequate fracture healing at

nine months postoperatively. All patients were followed for a minimum of one year.

Data Assessment

Demographic characteristics (i.e., age, gender, and BMI), anesthesia types, follow-up times, ASA classification and fracture types were recorded. The duration of the surgery, intraoperative blood loss, complications, scope time (in minutes), and time to bone union were recorded. Complications were classified into two groups: general and technical complications. Technical complications included as nonunion, malunion, malrotation, and shortening. A angulation of > 5o was considered angular malunion, and a difference of >5 mm between the contralateral femur lengths was considered shortening. A difference of >10° between the contralateral hip and the affected hip in the hip rotation test was considered malrotation (4).

At the last follow-up, clinical functional outcomes were evaluated using the Knee Injury and Osteoarthritis Outcome Score Physical Function Shortform (KOOS-PS), Hip Injury and the Osteoarthritis Outcome Score Physical Function Shortform (HOOS-PS), and the Thoresen criteria. The KOOS-PS and HOOS-PS are scoring systems that determine knee and hip functions based on 7- and 5-item criteria, respectively. According to Thoresen's evaluation criteria, the patients were rated as excellent, good, fair, or poor.

Statistical Analysis

SPSS version 23.0 (SPSS, IBM Corp., Armonk, New York, USA) was used for the statistical analysis. Descriptive statistical analyses were used to describe the patient population and surgical procedure.

Results

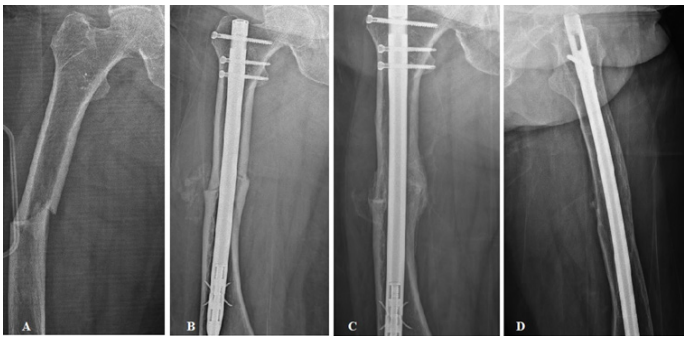
A total of 28 patients (11 female and 17 male) were included in the study. The mean age was 46.8 years and the mean follow-up was 23.7 months. Demographic data, length of hospital stay, fracture type, ASA score, BMI (kg/m^2), and surgical data (bone union time, intraoperative blood loss, and fluoroscopy time) are shown in Table 1. The mean time to bone union was 22.6 weeks. No nonunion was observed in any of the patients (fig 3). The mean hospital stay was 3.4 days and the mean BMI was 24.2. The mean operation time was 40.3±3.4 minutes and the mean scope time was 26.9 seconds. According to the AO classification system, 12 fractures were AO type 32-A and 16 fractures were AO type 32-B. The KOOS-PS, HOOS-PS score, and Thoresen scoring systems (Table 2) (5), and the general and technical complications are shown in Table 3. The mean KOOS-PS and HOOS-PS score were 83.4 and 85.6, respectively. When we evaluated the patient results according to the Thoresen criteria, we found excellent results in 18 patients, good results in 6 patients, fair results in 2 patients, and poor results in 2 patients. General complications: Deep infection was seen in one patient. The nail was removed and an antibiotic spacer was applied. We did not experience any complications or difficulties when the nail was removed. The nail was easily removed after the distal anchors were retracted using talon driver. After eradication of the infection, fracture union was achieved with conventional nail application. A superficial infection was observed in one patient and was treated with appropriate antibiotic therapy. Technical complications included 15-degree malrotation in one patient, 2 cm shortening in one patient, 1 cm shortening in one patient, and delayed union in one patient. No angular malunion was observed in any of the patients.

Table I. Demographic and Operative Data

Variable	Data
Patient (n)	28
Age (years)	46±22.3
Side, n (%)	
Right	13(46.4)
Left	15(53.5)
Sex, n (%)	
Male	17 (60.8)
Female	11 (39.2)
BMI (kg/m^2)	24.2±2.8
ASA score	3.05 (2-4)
AO/OTA fracture classification, n (%)	
32A	12 (42.8)
32B	16 (57.2)
Follow-up time (months)	23.7±24 (12-28)
Mean operation time (min)	40.3 ± 3.4 (28-48)
Mean fluoroscopy time (s)	6.9±4.2
Hospitalization time (days)	3.4±2.4
Mean intraoperative blood loss (ml)	112.4±4.1
Mean union time (weeks)	22.61±3.1

Values are presented as number, mean ±SD, (range), or number (%).
ASA, American Society of Anesthesiologists.

Figure III. Talon DistalFix Femoral Nail System (Orthopedic Designs North America Inc., FL, USA).



(A) Preoperative anteroposterior (AP) view of a femoral shaft fracture (78-year-old–woman). (B) Postoperative AP view at 2 months (C, D) Post-operative 1st-year AP and L views.

Table II. Thoresen scoring system

Variable	Excellent	Good	Fair	Poor
Malalignment of femur (degree)				
Varus or Valgus	5	5	10	>10
Antecurvatum or recurvatum	5	10	15	>15
Internal rotation	5	10	15	>15
External rotation	10	15	20	>20
Shortening of femur (cm)	1	2	3	>3
Range of motion of the knee (degree)				
Flexion	>120	120	90	<90
Extension deficit	5	10	15	>15
Pain or swelling	None	Minimal	Significant	Severe

Table III. Demographic and Operative Data

Radiologic parameter	Data
Angular malunion, n (%)	0
Axial malunion, n (%)	
Shortening	2 (7.14)
Malrotation	1 (3.57)
Nonunion, n (%)	1 (3.57)
Deep infection, n (%)	1 (3.57)
Superficial infection, n (%)	2 (7.14)
Reoperation, n (%)	1(3.57)
Mean KOOS-PS Score	83.42.1±32.2
Mean HOOS-PS Score	85.61.2±24.4
Mean Thoresen score. n (%)	
Excellent	18 (64.2)
Good	6 (21.4)
Fair	2 (7.1)
Poor	2 (7.1)

Values are presented as number (%) or mean (range) n or mean ±standard deviation.

Discussion

The aim of treatment of femoral shaft fractures is to preserve the normal length and axis of the bone, achieve bone union that will allow patients to walk in the early period, and maintain the functional range of motion of the knee and hip joints (6). In recent years, significant advances have been made in the treatment of long bone fractures, such as those of the femur, using minimally invasive intramedullary nail methods. Along with the increase in minimally invasive surgical techniques, the use of fluoroscopy has also increased. Increased fluoroscopy exposure occurs, especially when distal locking of interlocking intramedullary nails is performed. The main disadvantage of traditional interlocking intramedullary nails is the difficulty in distal locking. This leads to a prolonged operation time, increased radiation exposure, and increased blood loss. TDF nails were developed to address these problems. The TDF intramedullary nailing method is used in similar indications with interlocking nails and provides some advantages over these systems. The main advantage is the absence of distal locking difficulties, experienced with interlocking nails, as locking screws are not required. This results in a shorter operation time and reduced radiation exposure (7). In different publications, the mean operative time in operations performed with interlocking intramedullary nails is 50- 60 minutes (8, 9). We found the mean operative time to be 40.1 minutes in our study, which is lower than the results found in the literature.

In different publications, the mean time to union after intramedullary nailing of femoral shaft fractures has been reported to be 4-6 months. Wiss et al. treated femoral shaft fractures using intramedullary nailing and reported a mean union time of 20 weeks in a study of 112 patients (10). Kempf treated patients with femoral shaft fractures with interlocking intramedullary nailing in a study of 52 patients and found the mean union time to be 18 weeks (11). Reynders and Broos reported 4.6 months; Giannoudis et al. reported 4.8 months (12). In our study, the mean union time was found to be 5.2 months (22.6 weeks), which is longer than that found in the literature with interlocking intramedullary nails (13). In previous studies, malunion rates have been reported to be as high as 37% (14,15). In our study, no patient developed angular malunion (0%), shortening was found in two patients with AO 32-B fractures, and delayed union was found in two patients with AO 32-A fractures (7.1%). This result is consistent with those reported in the literature. Yapici et al. compared two groups that underwent talon nail and distal locking nail in the treatment of patients with femoral shaft fracture, showing statistically significant differences between the groups in terms of mean operation time, mean fluoroscopy time, and mean intraoperative blood loss (16). These results are similar to those of the present study.

In the two cases of axial malunion, we believe that the distal hooks of the TDF were inadequate against rotational and compressive forces as they did not adhere well to the distal bone. The common point in these three patients was that the fractures were located below the femoral isthmus in the distal metaphyseal diaphyseal region. In fractures distal to the isthmus, talon hooks do not provide sufficient attachment to the distal cortex, and shortening may develop. Retrograde nail application can solve this problem in this type of fracture. In our study, none of the patients had shortening or angulation that would cause walking problems, which did not affect the functional results.

Our study had some limitations. First, it was a retrospective study. Second, the number of patients in our study could have been larger because of the limited number of TDF nails that we accessed.

Conclusion

TDF nail application provides advantages, including shorter operation times, less radiation exposure, fewer surgical incisions, and less blood loss. In addition, it should be emphasized that the union time is prolonged compared with that of conventional nails. According to the results of our study, TDF nails can be safely used in AO type A-B fractures of the mid-femur. However, we believe that it is not safe for type A and B fractures in the distal 1/3 and type C fractures in terms of rotation and shortening. Further prospective randomized controlled studies with larger populations are needed to develop a new system of TDF nails and compare them with conventional nails for distal-located fractures.

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