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ARAŞTIRMA YAZISI / RESEARCH ARTICLE

RETROGRAD İNTRAMEDÜLLER ÇİVİLEME İLE TEDAVİ EDİLEN FEMUR KIRIKLARININ ORTA-UZUN DÖNEM SONUÇLARININ DEĞERLENDİRİLMESİ

EVALUATION OF MID-LONG TERM RESULTS OF RETROGRADE INTRAMEDULLARY NAILING IN FEMORAL FRACTURES

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ÖZET

AMAÇ: Femur kırıkları dikkatli tedavi edilmesi gereken yaralanmalardır. Bu kırıklarda retrograd intramedüller çivileme ile kırığın minimal invaziv bir şekilde tedavi edildiği ve periosteal kan akımının daha iyi korunduğu düşünülmektedir. Bu çalışmada, retrograd intramedüller çivileme ile tedavi edilen femur kırığı hastalarının orta ve uzun dönem sonuçlarının değerlendirilmesi amaçlanmıştır.

GEREÇ VE YÖNTEM: Bu retrospektif çalışmada femur kırığı nedeniyle retrograd çivileme yapılan ve minimum 2 yıllık takipleri olan 86 hasta incelendi. Hastaların demografik verileri, takip süreleri, kırıklarının karakteri, çekilen röntgenleri, kırık kaynama oranları ve komplikasyonlar incelendi. Hastaların son takiplerinde alınan karşı tarafa göre hareket açıklığı kayıpları ve son grafilerinde gözlenen koronal ve sagital açılanmaları ve bacak uzunluk farkları incelendi. Son kontrol muayenelerinde ağrı ve fonksiyonel değerlendirmeler adına visual analog scale (VAS), Lower Extremity Functional Scale (LEFS) ve Tegner Lysholm Knee Score (TLKS) skorlamaları uygulandı.

BULGULAR: Karşı tarafa göre diz ekleminde olan ortalama fleksiyon kaybı 7 ± 9 derece, ekstansiyon kaybı ise 3 ± 5 derece olarak bulundu. Bacak uzunluk farkı ortalama 0,8 ± 1.1 cm idi. Hastalarda ortalama 4 ± 4 derece koronal ve 4 ± 3 derece sagital deformiteler gözlendi. LEFS skoru 69 ± 10, TLKS skoru ise 82 ± 19 olarak bulundu. Hastaların preoperatif VAS skoru 9 iken postoperatif VAS skoru 2'ye geriledi (p<0,0005). Hastaların %92'sinde kaynama elde edildi. Çok parçalı kırıklarda kaynama süresi daha uzun bulundu (p=0,044). Açık ve kapalı kırıklar arasında ise kaynama süresi açısından fark gözlenmedi (p=0,86).

SONUÇ: Retrograd intramedüller çivileme ile femur kırıklarının tedavisinde fonksiyonel sonuçlar tatmin edicidir. Ancak çok parçalı kırıkların kaynama süresi uzamaktadır ayrıca deformiteler ve bacak uzunluk farkları ise fonksiyonel sonuçları olumsuz etkilemektedir. Geniş hasta gruplarıyla yapılacak ileri çalışmalar, retrograd çivilemenin uzun dönem sonuçlarını daha iyi anlamak için gereklidir.

ANAHTAR KELİMELER: Çivi, Femur, İntamedüller, Retrograd.

ABSTRACT

OBJECTIVE: Femoral fractures require careful treatment, with retrograde intramedullary nailing being a minimally invasive method that preserves periosteal blood flow. This study evaluates the mid-to-long term outcomes of femoral fracture patients treated with retrograde intramedullary nailing.

MATERIAL AND METHODS: In this retrospective study, 86 patients who underwent retrograde nailing for femoral fractures and had at least 2 years of follow-up were analyzed. Data on demographics, fracture characteristics, radiographs, union rates, and complications were examined. The range of motion (ROM) deficits in the contralateral limb, as well as coronal and sagittal malalignments and leg length discrepancies from final radiographs, were assessed. Pain and functional evaluations were done using the visual analog scale (VAS), Lower Extremity Functional Scale (LEFS), and Tegner Lysholm Knee Score (TLKS) during the final follow-up.

RESULTS: The average loss of flexion in the knee joint was 7 ± 9 degrees, and the loss of extension was 3 ± 5 degrees. The average leg length discrepancy was 0.8 ± 1.1 cm. Coronal deformity averaged 4 ± 4 degrees, and sagittal deformity averaged 4 ± 3 degrees. The LEFS score was 69 ± 10, and the TLKS score was 82 ± 19. The preoperative VAS score was 9, which decreased to 2 postoperatively (p<0.0005). Union occurred in 92% of patients. Healing time was longer in multi-part fractures (p=0.044), with no significant difference in healing time between open and closed fractures (p=0.86).

CONCLUSIONS: Retrograde intramedullary nailing provides satisfactory functional outcomes for femoral fractures. However, multi-part fractures result in prolonged healing times, and deformities and leg length discrepancies affect functional outcomes. Larger studies are needed to further assess the long-term results of retrograde nailing.ee replacement surgery performed under spinal anesthesia.

KEYWORDS: Nail, Femur, Intramedullary, Retrograde.

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INTRODUCTION

Femoral fractures in young individuals typically occur due to high-energy traumas such as traffic accidents, whereas in elderly individuals, they usually result from low-energy traumas such as falls from standing height (1). If not treated properly, complications such as non-union, malunion, stiffness, and shortening may develop (2). Surgical options come to the forefront in treatment. The muscular structures and neurovascular formations around the femur are critical considerations during surgical interventions in this area. Injuries, particularly close to the distal femur, defined as the area distal to the femoral isthmus, can lead to potential movement limitations and reduced functional recovery due to their proximity to the knee joint.

Commonly used surgical methods include plating with internal fixation and intramedullary nailing. Plating can be performed as an open reduction with a large incision or minimally invasively with small incisions. Compared to plating, intramedullary nailing is thought to better preserve periosteal blood flow due to less soft tissue dissection (3). Intramedullary nailing, with its load-sharing characteristics, allows for early mobilization and generally yields highly successful healing outcomes. Although antegrade nailing is a commonly used method for femoral fractures, difficulties may arise in achieving reduction in fractures located in the distal femur. Therefore, the retrograde nailing technique emerges as a preferred option for managing distal femoral fractures (4).

This study aims to evaluate the mid-to-long term treatment outcomes of femoral fracture patients treated with retrograde intramedullary nailing at a university hospital where trauma patients are referred.

MATERIALS AND METHODS

This study was conducted at a university hospital, with necessary approvals obtained from the local ethics committee. The data for the study were retrospectively collected from the hospital and clinic archives. A total of 154 patients, aged 16-65, who underwent retrograde nailing for femoral fractures between 2009 and 2023, were identified from the hospital records. Thirty-five patients with bilateral femoral fractures or multiple fractures in the lower extremity were excluded. Additionally, 10 patients who had previously undergone surgeries such as arthroplasty or arthroscopy on the knee and 12 patients with pre-fracture knee osteoarthritis were excluded from the study. Eleven patients with a follow-up period of less than 24 months were also excluded. The remaining 86 patients were included in the analysis **(Figure 1)**. Of these, 54 were male, and 32 were female, with a mean age of 38.1 ± 15.5 months. The mean follow-up duration was 53.4 ± 27.9 months. Among the fractures, 53 were comminuted, and 33 were non-comminuted. Additionally, 14 patients had open fractures, while 72 had closed fractures.

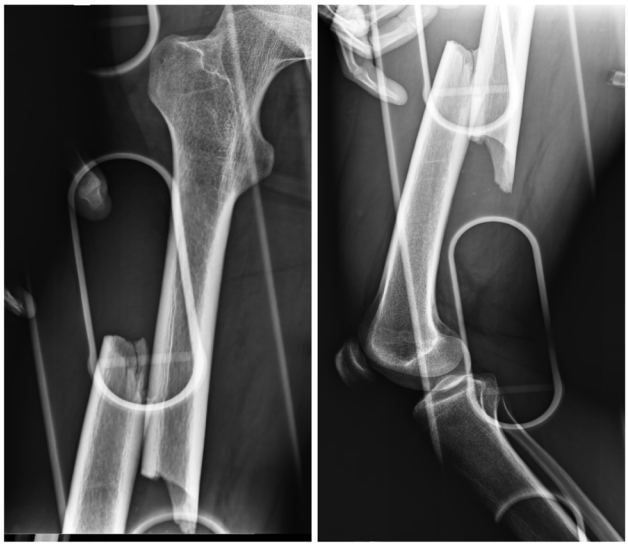

Figure 1: Fracture of femur

Sixty-one patients were operated on under general anesthesia, while 25 underwent the procedure with spinal or epidural anesthesia. All patients were positioned supine, with the knee flexed at 30-40°, during the surgery. A 2-4 cm skin incision was made on the anterior aspect of the knee, and the patellar tendon was split to access the knee joint. No medial or lateral parapatellar approaches were used in any case. The entire procedure was performed under fluoroscopic guidance.The guidewire entry point was determined as the exact center of the intercondylar notch on anteroposterior imaging and the most anterior aspect of Blumensaat's line on lateral imaging. Following entry point reaming, a longer guidewire was advanced from the distal to the proximal segment across the

fracture line. If the wire could not be passed through the fracture line, a 2 cm mini incision was made, and the wire was manipulated manually to complete the procedure. All fractures were reduced using traction and manual techniques.

The appropriate nail size was calculated over the guidewire, and intramedullary reaming was performed. Reaming was gradually expanded in 0.5 mm increments, and the intramedullary canal diameter was determined by comparing the reamer size with the cortical contact observed under fluoroscopy. The nail diameter was set 1 mm smaller than the final reamer used. Intramedullary nailing was then performed over the guidewire. Distal locking screws, numbering 2 to 3 (minimum of 2), were positioned along the trajectories permitted by the nail design using a guided insertion technique. Proximally, 1 to 2 screws (minimum of 1) were placed freehand under fluoroscopic guidance. The mean distance between the most distal point of the fracture line and the knee joint femoral surface line was measured as 11.2 ± 2.6 cm.

Poller screws were applied in 12 patients, and temporary blocking with K-wires was performed in 10 patients. The use of poller screws or temporary K-wires, and the choice between the two, varied based on the surgeon's preference. These techniques were generally applied in cases where reduction was deemed insufficient. The K-wires were removed after locking the screws. No blocking procedures were applied in 64 patients. Rotational alignment was assessed in all patients by comparing the injured extremity with the contralateral side. Symmetrical fluoroscopic imaging of the lesser trochanters was ensured while both feet and patellae were positioned superiorly, and cortical thickness continuity at the fracture site was verified. Postoperative mobilization with crutches was initiated on the first postoperative day, and range of motion (ROM) exercises began on the second day. Weight-bearing was introduced progressively, starting with toe-touch walking in the first week and gradually increasing as healing progressed. Full weight-bearing was delayed until radiological healing was confirmed. Patients were encouraged to participate in rehabilitation programs focusing on improving ROM and strengthening muscles. Follow-up visits were scheduled at 2, 4, and 6 weeks post-fracture, followed by monthly intervals within the first year. Subsequent follow-ups were conducted annually.

Fracture healing was assessed as the continuity of at least 3 out of 4 cortices **(Figure 2)**. Nonunion was defined as the absence of radiological evidence of healing progression at the fracture site despite a 9-month follow-up period after fracture surgery. Nonunion was observed in 7 patients (8%), and healing was achieved in these cases through secondary procedures, including exchange nailing, grafting, and vascularized bone surgeries. In the remaining patients, the average time to healing was 4.4 ± 1.9 months. At the final follow-ups, assessments included flexion-extension ROM angles deficits compared to the contralateral side, coronal and sagittal angulations observed on the latest radiographs, and leg length discrepancies. Quantitative measurements for rotational assessment were not performed on the patients; instead, their gait was evaluated during follow-up examinations, and they were assessed for any complaints related to rotational malalignment.

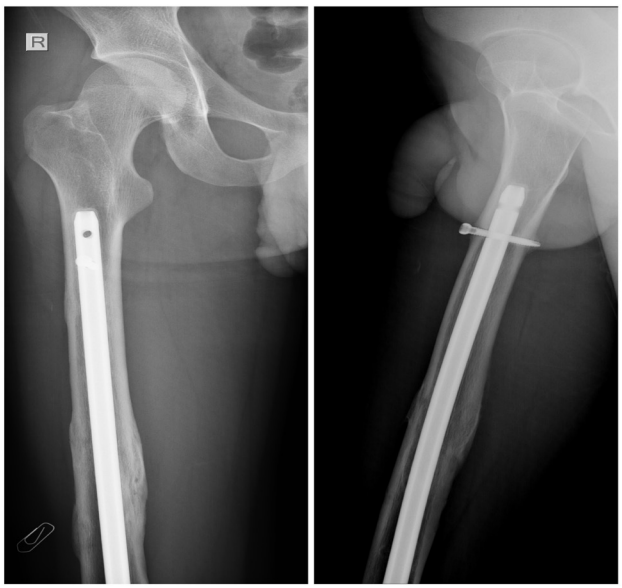

Figure 2: Femoral fracture treated with retrograde femoral nailing and showing union

Ethical Committee

Ethical approval was obtained from the Selçuk University Local Ethics Committee. Date: 19.11.2024, Number: 2024/583. Informed consent is not applicable.

Statistical Analysis

Assumptions of normality were checked with Kolmogorov-Smirnov and Levene tests, for the cases in which these assumptions were violated non-parametric tests were applied. Group comparisons were conducted by using Mann-Whitney U test, pre and post-operation scores were compared with Wilcoxon Signed-Rank Test. Correlations between the variables were evaluated with Spearman's rho.

RESULTS

Patients demonstrated an average coronal deformity of 4 ± 4 degrees and a sagittal deformity of 4 ± 3 degrees. No clinically important rotational abnormalities were detected in any patient. The mean loss of flexion in the knee joint, compared to the contralateral side, was 7 ± 9 degrees, while the mean loss of extension was 3 ± 5 degrees. The average leg length discrepancy was 0.8 ± 1.1 cm. The mean Lower Extremity Functional Scale (LEFS) score was 69 ± 10, and the Tegner Lysholm Knee Score (TLKS) was 82 ± 19. Preoperative Visual Analog Scale (VAS) scores averaged 9 ± 1, while postoperative scores averaged 2 ± 1, showing a significant improvement in VAS scores ($Z=-8.08$, $p<0.0005$).

It was observed that the type of fracture, whether open or closed, had no effect on the healing time ($U=333.00$, $p=0.86$). Healing time was longer in comminuted fractures compared to non-comminuted fractures ($U=548.00$, $p=0.044$). As the leg length discrepancy increased, both the LEFS ($rs(84)=-0.437$, $p<0.0005$) and TLKS ($rs(84)=-0.382$, $p<0.0005$) scores decreased, while the VAS score increased ($rs(84)=0.421$, $p<0.0005$). It was observed that as the coronal angulation increased, the sagittal angulation also increased, indicating a correlation between these two deformities ($rs(84)=0.422$, $p<0.0005$). As the coronal angle increased, both LEFS ($rs(84)=-0.286$, $p=0.008$) and TLKS ($rs(84)=-0.256$, $p=0.017$) scores decreased, while the VAS score increased ($rs(84)=0.233$, $p=0.031$). No difference was observed in sagittal ($U=646.00$, $p=0.56$) and coronal ($U=700.00$, $p=0.97$) angulation between patients who underwent blocking with poller screws or K-wires and those who did not. In the postoperative period, deep vein thrombosis (DVT) was observed in 5 patients, with pulmonary thromboembolism (PTE) occurring in 2 of them. Debridement was performed in 3 patients due to wound infections. Serous discharge was noted in 5 patients, which were managed with wound care. One patient experienced a distal locking screw fracture; however, fracture healing was later observed. Anterior knee pain was reported in 42 patients during the first year. Of these, 19 patients experienced resolution of knee pain during subsequent follow-ups. In 4 patients, distal locking screws were removed due to discomfort around the knee **(Figure 3)**, and in 3 patients, the entire nail system was removed due to implant-related complaints.

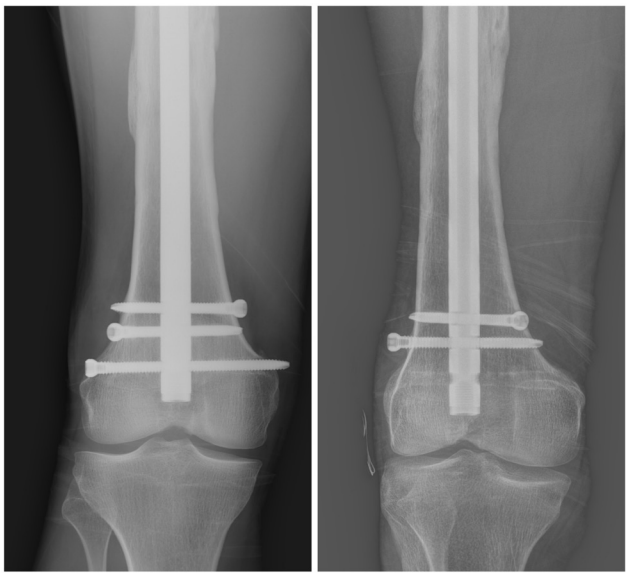

Figure 3: Screw causing knee pain (left) and removal of this screw with a second surgery (right)

DISCUSSION

Femoral fractures are significant injuries that require careful treatment. In their surgical management, locking plate fixation, antegrade nailing, and retrograde nailing are the prominent options. Nailing treatments offer better preservation of soft tissues and allow for a load-sharing approach. The choice of retrograde nailing over antegrade nailing may vary depending on the specific circumstances (5). In obese patients, retrograde nailing may be preferred for femoral shaft fractures, as the anterior fatty tissue around the knee is less abundant compared to the hip region (6). The likelihood of a femoral shaft fracture being accompanied by a femoral neck fracture is as high as 9%. In cases where these fractures occur together, retrograde na-

iling for the femoral shaft can yield successful results. Additionally, in polytrauma patients with multiple fractures, retrograde nailing may be a suitable option, as surgical intervention for femoral fractures requires a supine position (7). Another situation where the supine position can be used is in floating knee injuries. In this type of injury, both tibial and femoral fractures can be treated with two intramedullary nails through a single knee incision. In our study, patients with multiple fractures were excluded. The reason for this exclusion was that additional fractures could have affected the functional outcomes. When assessing the results of retrograde nailing, it would be more effective to evaluate isolated femoral fractures alone to maintain the homogeneity of the study. Retrograde femoral nails may be limited in use for patients with open growth plates as they are technically applied transphyseal. However, there are also views suggesting that the use of these implants in patients with open growth plates does not cause growth arrest (8). Other factors that may limit the use of these implants, such as infections, pathological fractures resulting from primary bone tumors, long-stemmed hip arthroplasties, and lung injuries, were not present in the patients of this study.

One of the main disadvantages of nailing in general is the potential for problems with axial alignment, rotation, and leg length, which can occur compared to plating with open reduction. Moreover, there are opinions that malunion is more commonly observed with retrograde nailing compared to antegrade nailing (9). However, the reason why the likelihood of malunion is higher with retrograde nailing has not been clearly identified (10). The underlying cause of reduction loss is the use of indirect reduction techniques. The tractional forces exerted by the muscles attaching to the proximal and distal ends of the fracture intensify the displacement. Therefore, although closed reductions help preserve the fracture hematoma and reduce soft tissue trauma, there may be situations where successful reduction is not achieved. To improve reduction, towel rolls placed under the knee, percutaneous clamps, long and wide diameter nail choices, and poller screw applications can be used (1,11). In this study, poller screws were used as a blocking method, and temporary blockages were also applied using K-wires. The choice between blocking methods was left to the surgeon's preference, and blocking procedures were typically used when adequate reduction could not be achieved. Hence, the absence of a significant difference in angular deformities between patients with and without blocking further supports this. During surgery, length comparison with the contralateral side and evaluation of the lesser trochanters on fluoroscopy while the patella is facing forward are important techniques for examining malreduction and malrotation (12).

Knee pain is one of the primary drawbacks of retrograde nailing. The incidence of knee pain can reach up to 70% (13,14). However, these rates significantly decreased to 23–24% for retrograde fixation by the final follow-up (15). The potential causes of knee pain include the incisions made at the front of the knee and soft tissue damage due to the distal entry, as well as potential osteochondral defects that may occur as a result of the entry reaming. Additionally, the distal locking screws of the intramedullary nail can also cause pain due to irritation. The distal part of the femur has a trapezoidal shape. Although the locking screws sent from the medial and lateral sides may appear to be the correct length on fluoroscopy, they could end up being longer than intended due to the trapezoidal structure. This is one of the frequent technical causes of irritation (16). Knee pain is more frequently observed in retrograde nailing for shaft fractures compared to distal fractures (17). In our study, 42 patients experienced anterior knee pain within the first year. Over time, pain resolved in 19 of the patients. Due to the pain, distal screws were removed in 4 patients, and all implants were removed in 3 patients. In the remaining patients, the pain was relatively minimal, and since it was not thought to be related to implant irritation, no implant removal was performed. Our findings regarding knee pain are consistent with the previous studies (14,15). As a complication, apart from pulmonary thromboembolism (PTE) observed in 2 patients, no major complications were seen. Complications were generally limited to deep vein thrombosis, serous discharge, and

superficial infections, and were few in number. The main limitations of this study are its retrospective design, being a single-center study, and the relatively small sample size. The lack of a comparative surgical group is another important limitation. Future randomized controlled trials will be crucial for further elucidating this issue.

In conclusion, this study investigated the mid-long term results of retrograde intramedullary nailing for femoral fractures, with a minimum 2-year follow-up, at a university hospital where trauma patients were referred. According to the study results, retrograde nailing for femoral fractures yielded highly satisfactory functional outcomes. Additionally, it was found that while multi-part fractures had a longer healing time, the presence of an open fracture did not affect the healing time. It was also observed that as leg length discrepancy and angular deformities increased, functional outcomes worsened. Further studies with larger patient groups are needed to better understand the long-term results.

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