

# YAŞLI ERİŞKİNLERDE İNTRAMEDÜLLER KİLİTLİ ÇİVİLER KULLANILARAK FEMUR DİYAFİZ KIRIKLARININ TEDAVİSİ

## Treatment of Femur Diaphysis Fractures in Elderly Adults By Using Intramedullary Locked Nails

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### ÖZET

**Amaç:** Bu çalışma, intramedüller kilitleti çivi ile opere edilmiş 34 yaşlı hastada orta vadeli femoral diafiz kırıklarının sonuçlarını bildirmek amacıyla yapılmıştır.

**Metod:** Çalışmaya, evde düşme (n: 30), trafik kazası (n: 3) veya yüksek enerjili düşme (n : 1) nedeniyle femoral diyafiz kırığı şikayeti ile gelen ve yaş ortalaması 71,2 yıl olan, 19 kadın ile 15 erkek dahil edilmiştir. Kırıklar AO / OTA sınıflandırmasına göre derecelendirilmiştir. Hastaların 9'u A1, 12'si A2, 6'sı A 3, 4' ü B1, 2'si B2 ve 1'i C2 olarak sınıflandırılmıştır. Osteopeniyi belirlemek için Singh indeksi kullanılmıştır. Ortalama takip 29,12 aydır (8-41 ay). Ameliyat için gecikme ortalama 1. 9 gündür.

**Bulgular:** Üç olguda flebit mevcuttu ve 5 olguda ise yüzeysel deri enfeksiyonu gelişti. Bir olguda implant başarısızlığı görüldü. Kemik bütünlüğü 1,4-6,06 ayda sağlandı (ortalama 3 ay). 12. ayda 32 yaşayan hasta için klinik sonuçlar elde edildi. Beş hasta yardım almadan yürümeyi başardı, 17 hasta baston kullandı, 11 hasta koltuk değneğine gerek duydu ve 1 hasta ise yatağa bağımlı kaldı. Hastanede kalma süresi ortalama 5 gündü (3ila 8 gün arası). 34 hastadan 18'i preoperatif ambulasyon haline döndü.

**Sonuç:** Kilitleme çivisi; küçülme, eşlik eden hastalıklar, düşük kemik kalitesi, osteoporoz ve özellikle normal boyuta göre genişlemiş medulla gibi zorluklar olmasına rağmen yaşlı hastalarda femoral shaft kırıklarının yönetiminde etkili bir metod olarak gözükmektedir.

**Anahtar Sözcükler:** Femur diyafiz; Kırık; Yaşlı erişkinler

### ABSTRACT

**Aim:** To report the outcome of midterm femoral diaphysis fractures operated with intramedullary locked nail in elderly 34 patients.

**Methods:** This study included 19 women and 15 men, mean age 71,2 years, who suffered a fracture of the femoral diaphysis due to a fall at home (n:30 ), a traffic accident (n:3) or a high-energy fall (n:1).The fractures were graded according to the AO/OTA classification. A 1 was present in 9, A 2 in 12, A 3 in 6, B 1 in 4, B2 in 2 and C2 in 1 patient. The Singh index was used to determine the osteopenia. Mean follow up was 29,12 months (8-41 Month). Mean delay to surgery was 1. 9 days (interval 1-5).

**Results:** Three cases had phlebitis and superficial skin infection occurred in 5 cases. One implant failure was seen. Bone union was achieved in 1,4-6,06 month (mean 3 month). Clinical outcome in 12th month was available for 32 living patients: Five were able to walk without assistance, 17 used a cane, 11 required crutches and 1 was bedridden. Mean hospitalisation was 5 days (interval 3-8 day). Eighteen of the 34 patients returned to their preoperative level of ambulation.

**Conclusions:** The locking nail appears to be a more effective method of managing femoral shaft fractures in the elderly patient despite the difficulty in reduction, comorbidity, poor bone quality, osteoporosis and especially enlarged medulla according to normal size.

**Keywords:** Femur diaphysis; Fracture; Elderly

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Geliş tarihi/Received: 13.07.2018  
Kabul tarihi/Accepted: 04.10.2018  
DOI: 10.16919/bozoktip.443731

Bozok Tıp Derg 2019;9(1):28-34  
Bozok Med J 2019;9(1):28-34

## INTRODUCTION

Kuntscher was the first to introduced nailing in World War II, which led to decrease in mortality and morbidity rates (1-3). Femur shaft fractures occur in all age groups by various mechanisms (4-8). Proximal and distal femur fractures are often seen in geriatric patients whereas diaphysis fractures rarely occur. However, in recent years there is an increase in the proportion of geriatric femoral diaphysis fractures due to biphosphonate use or other reasons. Aging is a complex process that involves all irreversible structural and functional changes in organisms, from cells to organs, with a gradually decrease in all functions. Aging can lead to changes in the anatomy of the geriatric femur, especially enlargement of the femur medullary, decrease of the cortex thickness and increase of the anterolateral bowing. These factors make the treatment of femur diaphysis fractures difficult. In addition to the changes in the anatomical shape of the femur, decrease in bone density is also noted. This causes serious changes in the biomechanics of the femur and leads to a major problem in fracture stabilization. When the aging femur has enlarged medulla, increase bowing and changes in anatomical axis, and IM nail stabilization can form serious technically problems. On the other hand, the change in the femur histology causes problems in the fixation of the plate screw as it causes reduction in screw torque. Despite these changes in the elderly femur, we still think that intramedullary nail is the best option in elderly patients. In this paper, we present data that shows mid-term results of patients that underwent intramedullary nailing.

## METHODS

The study enrolled 34 patients older than 65 with femoral diaphysis that were admitted to our center between 2008 and 2013. Ethical approval was obtained prior to the conduct of the study. In our study, the femoral shaft was defined as the segment of the femur lying 5 cm distal to the lesser trochanter and 8 cm proximal to the adductor tubercle. The femoral diaphysis fracture in our study occurred by a fall at home (n=30), a traffic accident (n=3) or a high-energy fall (n=1). Exclusion criteria were as follow: pathological fractures, a fracture around prosthesis or implant and sub trochanteric and supracondylar fractures.

The injury severity score (ISS) was determined for all patients. Most patients had an ISS score between 10 and 20 (n=26) whereas 8 patients had a score lower than 10. Medulla diameters were measured best in the isthmus and mostly from the lateral view. The fracture location of our patients were in the proximal shaft (n=8), the middle shaft (n=19) and the distal shaft (n=7). Fractures were graded according to the AO/OTA classification. A1 was present in 9 patients, A2 in 2 patients, A3 in 6 patients, B1 in 4 patients, B2 in 2 patients and C2 in 1 patient. The Singh index was used to determine the osteopenia (Singh index (n): Grade VI, n=0; grade V, n=1; grade IV, n=14; grade III, n=12 and grade II n=7). Anterior-posterior pelvis image and knee images were taken by a standardized protocol. If severe complications were noted, contralateral femur image was taken. Since the curve of the nails is more than the curve of the femur, lateral images were taken in order to evaluate the femur's anterolateral bowing in detail. The roentgenography was performed to evaluated co-morbidities such as tumors metastases, infections, malunion, etc. while the fractured side femur was in traction and the femur length could be taken. The femur length was measured by taking opposite side femur graphics in severely fragmented fractures. Distal femoral traction was applied until the operation time. Preoperative prophylactic antibiotic, cephaolsporin, was given. Only additional antibiotics were given if crush injury of the foot was present. Only 15 patients had an ASA score of two, and 19 patients had an ASA score of three. Most surgeries occurred within 1.9 days of injury (interval 1-5). All patients were operated in the supine position and on the traction table (Figure 1-2). Mean operative time was 60 min. The incision was extended towards the proximal starting from the trochanter major. After the entry of the priformis, a reamer was made through the guide. Closed reduction was achieved in all patients by using Scopi. The fracture line was not opened and bone graft was not used in any of the patients. In all patients, distal locking was performed with at least two screws. The diameters of the nails were 15 mm in 5 patients, 14 mm in 17 patients, 13 mm in 11 patients and 12 mm in 1 patient. Blood transfusion was needed for almost all patients. Mean hospital stay was 5 days (interval 3-8 day). In-bed exercises were initiated one day after

operation. Patients were mobilized with crutches on 6th and 7th day. Dressing was recommended once in every 3 days. Sutures were removed between 15th-25th days. Active rehabilitation was started after 1st month. Follow up visits were preferred every month for 6 months and then every 3 months. Datasets used in this study are not suitable for statistical hypothesis because of unattainable randomization of the sample and certain problems in conducting a designed representative control experiment. However, the study assesses the performance of intramedullary nailing for elderly patients via descriptive statistics and certain quantities/measurements for those who are given in the results section.

### RESULTS

Table 1 summarizes the preoperative and postoperative status of our femur diaphyseal fracture patients. The mean age of the patients at enrollment was 71.2 years (range 65 years to 89 years). Mean follow up was 29.12 months (8-41 Months). Complications occurred in 8 patients with 3 patients having phlebitis and 5 patients having superficial skin infection. No significant wound problem was noted. Chopart amputation was performed in one patient due to crush injury of foot. One other patient required a forearm fracture surgery and one patient, in addition to diaphysis fracture had an ipsilateral subtrochanteric femur fracture.

Three deaths occurred during a 1.5 years follow up (2 patients between 6 and 12 months and 1 patient at the 18th month after surgery), leading to 9.09 % mortality rate. Nineteen patients did not have any comorbidities, whereas some patients had a history of cardiovascular disease (n=11), diabetes mellitus (n=15), light dementia (n=7), muskuloskeletal disease (n=15), urological disease (n=7), pulmonary disease (n=11) Parkinsonian syndromes (n=2). Mean hospital stay was 5 days (interval 3-8 days). Patients were gradually mobilized with crutches on the 6th and 7th day. Particular attention was given to survival rate, healing rate, the amount of knee motion, and the level of ambulation which was attained. Seven cases had delayed union. Bone union was achieved in 5 months (mean 3 months). One patient had an implant failure due to screw fracture which required reoperation. All patients were able to walk independently or with support before they had fracture. The one-year outcome for all survival patients (n=32) was as followed: 5 patients were able to walk without assistance, 12 used a cane, 14 required crutches and 1 was bedridden. The average waiting period for surgery was 3 days and 15 patients returned to their preoperative level of ambulation. No implant was removed from patients. Knee flexion was 90 degrees in two patients, 90 degree in one patient and at least 100 degrees in all other patients.

**Table 1:** Summary of preoperative and postoperative status of elderly patients with femur diaphyseal fracture .

Comorbidity/additional pathology	Gender//Mean age/ Follow up	Classification/location of fractures	Clinical outcome	Uniontime/Frx. etiology	Complications
CVS diseases 32 %	Women,19	AO/OTA classification A1 9, A 2 in 12, A 3 in 6, B 1 in 4, B2 in 2 and C2 in 1 patient	Preoperative level of ambulation,18	Union time- 1,4-6,06 month (mean 3 month)	One implant failure
DM 44%, urological diseases 20%	Men,15	The upper third 8 case	17 used a cane	Fall at home (n:30),	Phlebitis occurred in 5 cases.
pulmonary diseases 32%, musculoskeletal diseases 45%	Mean age 71,2(int.65-89)	The middle third in 19	11 required crutches	high-energy fall (n:1)	Infection occurred in 5 cases.
light Demantia 20%,parkinsonian diseases 4%	F-Up-29,12 months(8-41 Month)	The lower third in 7.	1was bedridden	traffic accident (n:3)	7 Delayed union and 3 dead in 1.5 year



**Figure 1** a,b,c,d,e: A 65 year old femur diaphyseal fracture patient preoperative, early postoperative and late period images (union achieved).



**Figure 2** a,b,c,d,e: Late stage images showing a segmental femur fracture in 69-year-old male patient followed by union.

## DISCUSSION

In older patients, identifying and treating pre-existing medical problems is very important. In a cohort study of 102 patients with geriatric femur fractures, Sartoretti et al. identified that the most common comorbid conditions were cardiovascular diseases (80%), musculoskeletal diseases (75%), gastrointestinal diseases (67%), psychiatric diseases (61%), urological diseases (55%), and pulmonary diseases (41%). In our study we found cardiovascular diseases (32%), Diabetes Mellitus (44%), light dementia (20%), parkinsonian diseases (4%), urological diseases (20%), pulmonary diseases (32%) and musculoskeletal diseases (45%). Ostrum et al. (9) reported hemodynamic changes but no hypotension in femoral diaphyseal patients. In older patients, the fractures are more often caused by low energy. However, even the smallest wound needs attention and treated with suspicion. Due to the potential blood loss of femur diaphyseal fractures, it has more hemodynamic impairment effect especially in elderly patients. As a result, if hypotensive shock

is detected in isolated femur closed fractures, other causes of blood loss should be investigated. Almost all of our patients needed blood transfusion but none of our patients showed shock table despite amputation. All these additional injuries make initial evaluation and treatment quite difficult.

The femur lateral and AP images must be carefully examined preoperatively because of the increase width of the medulla and bowing of anterolateral femur and decreased bone density. The kind of medullary implant used in elderly patients is based on these preoperative examinations. After blunt traumas, ipsilateral femur neck fractures (10-12), pelvis and acetabulum fractures (13), hip protrusion (14), knee injuries, intercondylar distal femur fractures (15, 16) can be seen. Studies have shown that neck fractures and diaphysis fractures are ignored by 20-50% of the time. When standard protocols are applied, this rate decreases to 5% (17, 18). The advantage of our study is that most patients did not have additional health problems and the average age was not that high.

This study showed that functional restoration early in postoperative elderly fractures depends on solid internal fixation, correct management and treatment of additional problems, rapid rehabilitation, strong patient compliance, and mentalities. We believe that prolonged immobilization due to inadequate internal fixation and non-surgical treatment may lead to an irreversible process owing to thromboembolic disease, pulmonary complications, decubitus ulcers and widespread musculoskeletal system disorders.

Although the femur bone is the strongest against compression, it is the weakest against tension. A torsional force can cause spiral fracture in elderly patients. As the applied force increases, fragmentation increases. Due to the fact that the femur is in tubular structure, biomechanical studies and practical applications made nailing an ideal option. The nail can support all strengths being exposed in all axis owing to its resistance to axial and bending forces, symmetrical design and cross-sectional central placement. Important features of the nail are the presence of the open part or slot, wall thickness, cross-sectional shape, and locking screws that can be applied (19). The resistance of the fracture and the implant against the axial loads depends on the contact between the fracture ends and whether locking occurs. There are many factors that determine the resistance, thus selecting nails is very important. Studies have shown the effects of cross-sectional form and the wall thicknesses of intramedullary nails on circular and torsional strengths. There is an incompatibility between the radius of the nail bowing and the radius of the femur bowing (20, 21). Calculation of bowing on 948 femurs showed that the radius of the femur inclination was 120 cm (20). Interestingly the femur bowing was not related to age of femur length but by race. Although fixation with intramedullary nails has difficulties in a changed axis, a wide medullary canal, increased bowing, deteriorated micromineralization and a low-density elderly femur, these disadvantages can be overcome by technically enriched nails.

We believe that nails have unique benefits because of their load-sharing feature. Low bone quality seen in elderly patients, distal diaphyseal fractures,

widespread fracture and early weighting expectation are conditions requiring placement of two or more screws in distal femur. In elderly adults, the screw–bone interface usually represents the weakest point, whereas in younger patients, the interlocking screw itself is the point of weakness. The unit of bone–locking screw–nail is now the main antagonist against axial loads and rotation. If locking screws are exposed to a severe compressive load during loading, the use of two or more screws is needed for more resistant to loading. While intramedullary nail application in fracture of femur diaphysis has the advantage of preserving fractured hematoma and periosteum, bone reaming has osteo-inductive and osteo-conductive effects on fracture healing as well as stimulating of periosteal response and blood flow enhancing effects in relation to this. As a result, sufficient callus formation and fracture healing are expected with the use of nails in femur diaphysis fractures in elderly patients. In this study, even though delay occurred due to comorbidity and other age-related problems, no significant union problem was found as the nail allows early mobilization. An external fixator can be applied quickly and safely in critical patients with head trauma, accompanied thorax and severe limb injury, patients with high injury severity scores and arterial injuries on the same side (22, 23). The fixator can be converted to another stabilization form by providing a temporary stabilization of the extremity (24). As a result, every external fixation attempt should be made to facilitate the subsequent intramedullary nail intervention, to ensure extremity alignment, and to protect the length of the femur. Recently, minimally invasive plaque techniques are preferred since they do not harm endosteal and periosteal blood flow (24). However, these techniques have increase rates of malrotation (25) and are declined as a primary treatment option. There are indications of plaque screw use in significant medullary narrowness, fracture around malunion fractures, pertrochanteric and metaphyseal fractures, ipsilateral femoral neck fractures, peri-implant and periprosthetic fractures, and in the presence of skeletal immaturity. Riemer et al. (26) published a study with 141 femoral shaft fracture treated with emergency plate screws. They found that one third are open fractures. Autografts were used in 98% of the cases. Plaque insufficiency

was observed in 10 patients, and the majority of the patients recovered after the treatment. In a patient with an open fracture, infection was observed and the average duration of union was 17 weeks. The increase in popularity of intramedullary nail has reduced the use of routine plaque. The most disadvantage is the need for major surgical intervention, blood loss, infection, soft tissue damage, limited knee motion, and weakness of the quadriceps muscle. While the nail is load sharing, the plate is a load bearing implant. If union is not achieved, plaque insufficiency can occur. When an intramedullary nail is used as a load-sharing implant, it tends to last longer than the plaque.

In elderly patients, especially in women, bone mineral density decreases and the cortex gets thinner. The change in the femur histology leads to serious problems in the fixation of the plate screw as it causes decrease in the screw torque. This eventually makes fracture detection particularly difficult. In geriatric patients, intramedullary nailing is associated with high union rates, although they have high incidence complications including mortality. A study conducted with 138 patients older than 65 with femoral diaphyseal fractures showed that complications occurred in 46% with 20% of mortality rate (27). The mental status of patients was an important parameter in terms of survival time, and the development of a new medical problem after injury was associated with poor outcomes (28). In surviving patients operated with intramedullary nails, a significant fracture union can be expected. It is necessary to look at some specific technical features of the intramedullary nailing in elderly patients. Due to the relatively weak cortex, it is useful to have the first access portal correctly detected. A mismatch between the femur's and the nail's sagittal slope when a long antegrade nail is used can lead to unwanted distal femoral fractures. Older patients have often an enlarged medullar canal and therefore a larger diameter nail may be needed. We believe that more problems in the fixation of the implant to the bone occur than the fatigue fracture of the implant with the treatment of osteoporotic fractures. The intramedullary nails are important implants as they reduce the stress by doing controlled fracture impaction in the bone implant interface. It is important to notice that the first surgical treatment may be the only and last chance in most

elderly adults with femur diaphysis fractures. Thus, intramedullary nailing may be preferred as a fixation method allowing controlled impaction, stability and load sharing. As a general rule, load-sharing materials are preferred over load bearing materials in elderly patients. Unfortunately, no currently available load sharing materials are suitable for optimal levels in geriatric femur diaphysis fractures. In this respect, the development of specially designed intramedullary nails may be a very important development in the success of such fractures. However, larger randomized control trials are required to confirm the results.

## CONCLUSIONS

Although several types of osteosynthesis have been proposed for fixation of femoral shaft fractures, the locking nail appears to be an effective and viable method of managing femoral shaft fractures in the elderly patient despite the difficulty in reduction, comorbidity, poor bone quality, osteoporosis and especially enlarged medulla according to normal size.

## Acknowledgement

No conflict of interest.

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