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# Radiographic and functional results of osteosynthesis with locked intramedulary nailing of subtrochanteric fractures of the femur

## *Subtrokanterik femur kırıklarında kilitli intramedüller çivileme ile osteosentezin radyografik ve fonksiyonel sonuçları*

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**Amaç:** Kilitli intramedüller çivi uyguladığımız subtrokanterik femur kırıklı olgularda radyografik ve fonksiyonel sonuçlar değerlendirildi.

**Çalışma planı:** Subtrokanterik femur kırığı nedeniyle 19 hasta (14 erkek, 5 kadın; ort. yaş 51.8; dağılım 20-87) kilitli intramedüller çivi ile tedavi edildi. Kırıklar dokuz hastada sağ, 10 hastada sol tarafta idi. Kırık nedeni 12 hastada basit düşme, dördünde trafik kazası, ikisinde yüksekten düşme, birinde ateşli silah yaralanması idi. Altı hastada travmaya bağlı ek kırıklar; dokuz hastada travma öncesinde dahili sorunlar vardı. Kırıklar Russel-Taylor sistemine göre sınıflandırıldı. Sonuçlar Harris skorlama sistemine göre değerlendirildi. Hastalar ortalama 25 ay (dağılım 12-58 ay) süreyle izlendi.

**Sonuçlar:** Ameliyat süresi ortalama 40 dakika, kanama miktarı ortalama 150 ml bulundu. Tüm hastalarda tam kaynama sağlandı. Dört olguda kaynama dinamizasyon sonrasında elde edildi. Harris skorlamasına göre 10 olguda (%52.6) mükemmel, altı olguda (%31.6) iyi, iki olguda (%10.5) orta, bir olguda (%5.3) kötü sonuç alındı. Tedavi sonucunun başka kemik kırıkları ve dahili sorunlardan etkilendiği görüldü. Hastaların tümü ortalama 12 haftada eski aktivitelerine dönebildi. İki hastada ameliyat sırasında distal kısımda fissür oluştu; üç hastada ise ameliyat sonrasında distal vida yerinde yüzeysel enfeksiyon gelişti.

**Çıkarımlar:** Subtrokanterik femur kırıklarının cerrahi tedavisinde intramedüller çivileme, yüksek kaynama oranı, erken dönemde mobilizasyona izin vermesi, ameliyat süresinin kısa ve kanama miktarının düşük olması nedeniyle tercih edilebilir bir yöntemdir.

**Anahtar sözcükler:** Kemik çivisi; femur kırıkları/cerrahi/radyografi; kırık fiksasyonu, internal/yöntem; kırık fiksasyonu, intramedüller/yöntem; kalça kırıkları/cerrahi/radyografi.

**Objectives:** We evaluated the radiographic and functional results of locked intramedullary nailing in the treatment of subtrochanteric fractures of the femur.

**Methods:** Nineteen patients (14 men, 5 women; mean age 51.8 years; range 20 to 87 years) underwent locked intramedullary nailing for subtrochanteric fractures of the femur. The fractures were on the right in nine patients and on the left in 10 patients. The injuries were caused by a simple fall (n=12), motor vehicle accident (n=4), falling from a height (n=2), and gun shot (n=1). Six patients had associated fractures and nine patients had preexisting medical problems. The fractures were classified according to the Russel-Taylor system. The results were evaluated according to the Harris scoring system. The mean follow-up was 25 months (range 12 to 58 months).

**Results:** The mean operation time was 40 minutes and the mean amount of bleeding was 150 ml. Union was obtained in all the patients, occurring after dynamization in four. According to the Harris system, the results were excellent in 10 patients (52.6%), good in six patients (31.6%), moderate in two patients (10.5%), and poor in one patient (5.3%). Outcomes were adversely affected by associated fractures and preexisting medical problems. All the patients returned to daily activities in a mean of 12 weeks. At surgery, a distal fissure occurred in two patients and, postoperatively, three patients developed superficial infections at the site of distal screws.

**Conclusion:** Intramedullary nailing may be the preferred method in the treatment of subtrochanteric fractures of the femur due to high rates of union, early mobilization of the patient, short operation time, and less perioperative bleeding.

**Key words:** Bone nails; femoral fractures/surgery/radiography; fracture fixation, internal/methods; fracture fixation, intramedullary/methods; hip fractures/surgery/radiography.

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Fractures of the subtrochanteric region comprise 10-34% of all hip fractures (1). The blood supply to the subtrochanteric region, where the spongious bone ends and cortical bone starts, is weaker than trochanteric region and this is closely related with the vascularization and healing of the fracture fragments. The anatomical structure and biomechanical characteristics of the region make the treatment difficult and increase the complication rates. [1-5]

Angle plates, sliding hip screw-plate systems, intramedullary nails, external fixators and arthroplasty are the methods that are used in the surgical treatment of the fractures. Additional bone fractures due to the high-energy traumas that are frequently reported in the etiology of younger adults and internal health problems of the elderly are among the factors that affect the selection of the treatment method. [1,2,4,6,7,8,9]

## Patients and Methods

In the years 1998-2002, 19 patients treated with locked IM nail osteosynthesis (14 mail, 5 female; mean age 51.8, range 20-87) were evaluated. Fourteen of the patients were male, 5 were female and the mean age was 51.8 (range, 20-87). In 9 patients the fracture was in the right extremity and in 10 patients in the left extremity. The cause of fractures were determined as simple fall in 12 patients, automobile accident in 4 patients, high fall in 2, and firearm injury in 1. Surgical operation was carried out after 7-day antibiotic prophylaxis in the open fracture resulting from firearm injury. Six patients had additional fractures due to trauma (Table 1). Nine patients had 1 or more internal problems before the trauma (Table 1). Fractures were classified according to Russel-Taylor system (Figure 1). Ten patients (52.6%) had type IA, 7 patients (36.8%) had type IB and 2 patients (10.5%) had type IIB fractures.

An average of 4.2 (2-8) days passed until the surgery. All patients were performed unreamed closed antegrade IM nail osteosynthesis using traction table under general anesthesia. In 13 patients (Type IA and type IB) standard femoral nails were used, while reconstruction nails were preferred in 6 patients (Type IB and type IIB). In standard femoral nails 1 piece and in reconstructive nails 2 pieces of proximal locking screws were placed with the help of original implant set, while the distal locking screws were inserted freely. All of the patients were given 2-day antibiotic prophylaxis postoperatively and low-molecular weight heparin prophylaxis during hospitalization period.

Operation time and preoperative bleeding amount were determined. The patients were followed up for an average of 25 months (range 12-58) and the time for the patients to regain their former activity levels were investigated. Results were evaluated according to Harris' scoring system which considers pain, function, being free of deformity, and mobility. [10]

## Results

In all of the patients, complete union of the fractures was achieved. The average union time was determined as 15 weeks clinically and radiographically. In 4 patients, dinamisation from the distal part was performed since no sign of union was observed radiologically at month 4. These patients demonstrated union of the fractures in average 26 weeks. No patients resulted with shortness or rotational deformity. According to Harris' scoring, the results achieved were excellent in 10 patients (52.6%), good in 6 patients (31.5%), moderate in 2 patients (10.6%), and bad in 1 patient (5.3%). Additional fractures and internal health problems affected the result of the treatment. Of the 3 patients with moderate or bad results, 2 patients were politraumatised and 1 had severe internal problems. It was suggested that the rehabilitation difficulties caused by these additional pathologies in these patients affected the results in a negative

**Table 1.** Additional fractures and of internal problems the patients

| Type of the fracture | Number of the patients |
|---|---|
| Fracture of the diaphysis of the humerus | 1 |
| Double fractures of the bones of the crus | 1 |
| Fracture of the acetabulum | 1 |
| Fracture of the forearm | 2 |
| Fracture of the calcaneus bone | 2 |
| Intercondylar fracture of the femur | 1 |
| Internal problem | |
| Hypertension | 3 |
| Cardiac insufficiency | 2 |
| Diabetes mellitus | 2 |
| COPD | 2 |
| Colon carcinoma | 1 |
| Thyroid carcinoma | 1 |

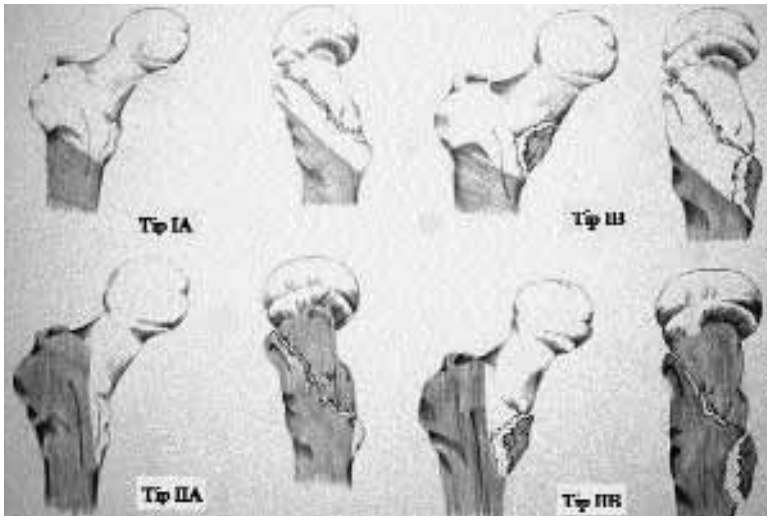


**Figure 1.** Russel – Taylor clasification.

way. Of the patients with excellent results, none had accompanying bone fracture or internal problem except 2 patients. Operation time was average 40 minutes (range, 25-90) and bleeding amount was average 1500 cc (range, 100-225). Hip and knee movements were started on the first postoperative day and mobilization was permitted with tolerable weight-bearing. Time for the patients to return their former activity was average 12 weeks (range, 8-24). Complications included fissure formation distal to the fracture line during insertion of the nail in 2 patients, and postoperative superficial infection at the distal screw site in 3 patients. In patients with the complication of fissure formation at the distal part, mobilization with full weight bearing was delayed beyond the 6th week. Patients with infection at the screw site were treated with oral antibiotic therapy.

## Discussion

Subtrochanteric region covers the area between the lesser trochanter and the isthmus of the diaphysis of the femur. Since it is the transition zone between the spongious bone and cortical bone and its vascu-


**Figure 2.** **a)** Pre-operative roentgenography of the patient aged 61 years. **b)** Anteroposterior roentgenography of the patient during the early postoperative period. **c)** Anteroposterior roentgenography of the patient at 12th post operative month showing union of the fracture.

larization is less than trochanteric region, union of the fractures of this site is different than the trochanteric region.[1,2,3]

In the affected extremity, varus position is seen on the femoral head and neck besides shortening. Functional insufficiency of the abductor muscle group is the cause of this condition and if this deformity is not corrected, limping gait results due to the shortening in the functioning distance of the abductor muscles. For this reason, the treatment of subtrochanteric fractures should include the repair of the shortening in the femoral neck and rotational deformity as well as correction of the angulation of the femoral head and femoral neck. Thus, our aim should be to ensure sufficient abductor muscle tension. [1,2,4,5]

The cause of the fractures of the subtrochanteric region is usually high-energy traumas in younger adults (i.e, automobile accidents, high-fall or firearm injuries) and low-energy traumas (simple fall) in elderly.[2,4,6] In our study the mean age of the patients was 51.8 and high-energy traumas were reported in the etiology of all of the patients under age 50.

High-energy traumas frequently show up with accompanying fractures or organ injuries. [2,6] In the treatment selection of these politraumatised patients and in elderly patients with internal problems, we should be aware of the need of early mobilization.

Methods that can be used in the surgical treatment of the fractures of the subtrochanteric region include angle plates (95° AO plates), sliding screw-plate systems (Richards etc.), intramedullary nails (Ender, Zickel, Gamma, Russel-Taylor, etc.), external fixators, and arthroplasty. [1,2,4,5,6,7,8,9]

In laterally placed implants, the biomechanical analysis of the fractures of the subtrochanteric region showed insufficiency due to high bending forces and increased risk of nonunion.[3] In subtrochanteric region, femur is surrounded with highly vascularized muscle groups. In the surgical treatment with plate-screw systems, damaging the perforating branches of the profunda femoris artery increases bleeding and may cause the avasculization of the fracture fragments. Likewise, damaging the muscle structure may lead to partial function insufficiency in postoperative period. The comperative studies showed that bleeding and complication risk are lower and operation time is shorter in surgical treatment with intramedullary nails. [2,11,12]

The torsional effect of the forces influencing the bone in subtrochanteric region is an important factor causing implant insufficiency. Intramedullary nails ensure maximum torsional stability as well as being durable under axial loads up to 500% of the body weight.[1] Many studies performed agree that intramedullary nails provide a more durable fixation and are a less invasive stabilization method compared to plate-screw systems. [2,4,6,11,12,13,14,15]

Since mechanical properties are particularly poor in instable fractures, flexible intramedullary nails (Ender nails) can not be used. It can be considered as an alternative method especially in elderly patients and patients with internal problems when there is no other treatment choice. [1,15] Zickel nail is a rigid intramedullary nail and does not completely ensure axial and rotational stability. However, successful clinical results are reported. [7,11,16,17]

Sliding screw-plate systems are stabilization methods recommended to be used in type IIA and type IIB fractures extending to the piriformis fossa.[1] In case that intramedullary nails are used in these fracture types, because entry site of the nail is in the fracture line the nail may increase the risk of displacement or extension of the fracture. In 2 patients with type IIB farctures in our series, using reconstructive type nail and reaming the insertion site of the nail during the operation prevented complication formation.

One of the most current methods used in management of the fractures of this region is locking intramedullary nails. These nails show sufficient durability to rotational and axial loads with their improved technical properties. One of the most important properties of locking intramedullary nails is that weight bearing is possible immediately after the operation so complications due to immobilization are avoided. [2,22] Reconstructive intramedullary nails are designed for complex fractures and proximal locking screws are inserted into the femoral neck. In Russel-Taylor type IA fractures standard intramedullary nails and in type IB fractures reconstructive nails are recommended. In literature, treatment choice is controversial in type II fractures.[1,2,4,11,12,14,18,19,20,21] In our series, we used standard

intramedullary nails in 3 patients with type IA, or with type IB with minimum separation of the trochanter minor and we used reconstructive intramedullary nails in patients with type IB and IIB fractures.

In the case of short intramedullary nails (Gamma nail, Proximal femoral nail), the bending forces are focused on the distal tip of the nail. In long intramedullary nails (Russel-Taylor, Unku, Long Gamma nail, etc.) these forces are distributed along the femur. Shaft fractures distal to the end of the nail are reported for short intramedullary nails.[1,18,19] Kelam defined the indications of proximal intramedullary nails as intertrochanteric fractures, high subtrochanteric fractures and fractures that are combination of these.[23]

In literature, delayed union, insufficient fixations or implants, nonunion, wound infection, functional loss of the knees and hip are reported as complications of the intramedullary nails. [1,2,5,8,11,12] There were no other complications in our series except the fissure formation distal to the fracture line in 2 patients and superficial wound infection at the insertion site of the distal screw.

In our study, we concluded that intramedullary nailing which ensures a stable fixation with a minimum invasive operation particularly in management of Russel-Taylor type IA and IB subtrochanteric fractures is the method of choice owing to its high union rates, low complication risk and excellent functional results.

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