

# Femoral Retrograde Nailing, an Excellent Choice for Femoral Shaft Fracture with Scarce Complications: Educational Corner

Sadula Sharifpour<sup>1</sup>, Seyed Peyman Mirghaderi<sup>2</sup>, Maryam Salimi<sup>3</sup>, Seyed Hadi Kalantar<sup>4\*</sup>

<sup>1</sup> Resident, Joint Reconstruction Research Center, Tehran University of Medical Sciences, Tehran, Iran

<sup>2</sup> Medical Student, Joint Reconstruction Research Center, Tehran University of Medical Sciences, Tehran, Iran

<sup>3</sup> Medical Student, Student Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran

<sup>4</sup> Assistant Professor, Joint Reconstruction Research Center, Tehran University of Medical Sciences, Tehran, Iran

\*Corresponding author: Seyed Hadi Kalantar; Joint Reconstruction Research Center, Tehran University of Medical Sciences, Tehran, Iran. Tel: +98-2166581586, Email: hadikalantar4@gmail.com

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## Background

Femoral shaft fractures contribute to 1% of all fractures and 7% of femoral fractures (1, 2). It peaks in young men (median age = 27 years) due to mainly high-energy forces sustained in motor vehicle accidents and in older women (median age = 80 years) because of osteopenia (2-4). Because the femur is the longest and strongest bone in the body (5, 6), mainly high-energy forces might cause femoral shaft fracture. Therefore, femoral shaft fractures commonly coincide with multiple concurrent trauma and other skeletal fractures or organ injuries (5, 6). The Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) classification categorized this type of the fracture into three subtypes: type A represents simple fracture, type B shows fractures with more than two fragments, but the bone continuity is maintained, and type C displays the complex fractures with the disjoined bone cortex (2, 7).

In the 1970s, the developed countries shifted to surgical fixation of the femoral shaft fracture (8). Currently, fracture fixation with intramedullary nail (IM nail) is the gold standard of treating femoral shaft fracture with a satisfactory outcome and scarce complications (9-16). However, the detail of this technique - such as entry site, reaming magnitude, and nail structure - is still under debate (17-19). Due to the paramount importance of appropriate IM nail's entry site, two approaches exist for applying IM nail in these described patients: anterograde or retrograde nailing (AN or RN) of the femoral shaft fracture (17).

AN encountered some complications, including injury to the hip abductors or pudendal nerve (10-15 percent) (20, 21), moderate to severe heterotopic ossification (HO) of the hip (20%) (22, 23), and hip pain associated with the implant (10%) (12). To this end, RN emerged as an alternative approach (24, 25).

To minimize the mentioned complications, the RN emerged (25). RN indicates for the patients with a fracture at the distal metaphysis, multiple trauma, morbid obesity, pregnancy, ipsilateral tibial, femoral neck, pelvic, acetabular fractures, coexistence of spine fracture, and bilateral femur fractures (18). Nevertheless, RN faces serious challenges regarding morbidity and pain up to

70% at the knee joint that may even lead to reoperation (24, 26-28). Furthermore, RN may impose detrimental effects on knee joint cartilage that may cause osteoarthritis (OA), septic arthritis, or restriction in range of motion (ROM) of knee joint (18, 27). Besides, quadriceps atrophy and patellar ligament injury are other complications which surgeons confront in RN (28, 29). Therefore, there is a fear of unsatisfactory recovery of the knee function when applying IM nail retrogradely; thus, caution should be taken.

Multiple studies compared the two preceding techniques (10-12, 27, 30-39). In terms of either long-term and short-term outcomes, studies suggest that both AN and RN have a comparable healing capacity for the fracture when assessing structural, functional, and pain-related outcomes (10, 12, 27, 37). Hussain et al., in their meta-analysis, conclude that there is no preference in selecting any of these techniques (27). In sum, AN has shown more complications regarding the hip joint, but RN will cause more serious complications in the knee site.

This educational corner article aims to describe a traumatic femoral shaft fracture treated by the RN fixation method and represented with a dramatic outcome - to the extent that the patient does high-demanding bodybuilding exercises. The purpose of the current study is to clarify the cons of the RN, especially in cases with distinct indications, and not to be over-conservative about the possible complications of the knee joint.

## Case Presentation

A 30-year-old obese man [weight: 108 kg, body mass index (BMI): 34 kg/m<sup>2</sup>], who was a professional bodybuilder (heavy lifter) and otherwise healthy, was referred to our center (Imam Khomeini Hospital, Tehran, Iran - a level I trauma center) with a history of high-energy traffic accident causing a closed femoral shaft fracture at the left side. The patient had complained of pain, deformity, swelling, and tenderness at the middle third of the left thigh with movement disability and weight-bearing intolerance. He mentioned the application of traction, which had been held in another center. A proximal tibial skeletal traction had been applied for the patient. However, after two weeks, the fracture had severe shortening due to inefficient skeletal traction.



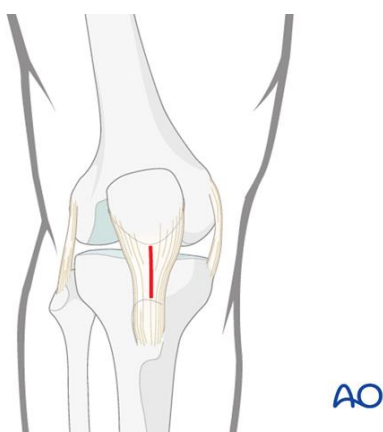
Radiography was ordered after initial assessment, ensuring the patient's homeostasis stability and ruling out associated injuries.

Radiography of the left thigh displayed a transverse displaced mid-shaft femoral fracture of AO/OTA type 32.A3 in this patient (Figure 1) (7).



**Figure 1.** Anteroposterior (AP) view of injury presenting femoral mid-shaft fracture

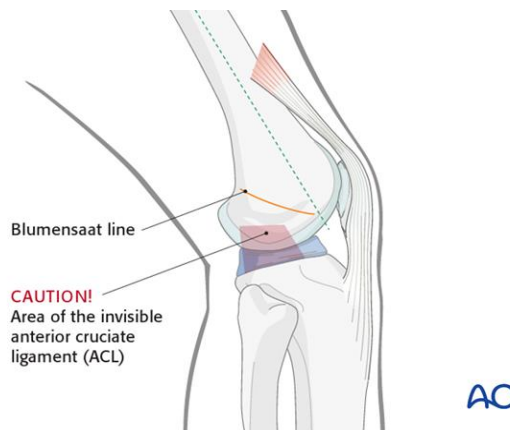
Because the patient was obese (BMI = 34 kg/m<sup>2</sup>) - one of the indications for utilizing RN - the surgeon preferred to install an IM nail retrogradely. To this end, after general anesthesia, we were able to perform a close reduction of the fracture with the help of a femoral distraction device and fix the fracture using the femoral nail retrogradely. Using a trans-patellar approach, we put the nail in the supine knee flexed 30° position (Figure 2). A 2-cm incision was made vertically which started from the inferior patellar pole and continued over the midline. Then, after splitting the patellar tendon and arthrotomy, we chose the entry point carefully under the fluoroscopy guide using the anteroposterior (AP) and lateral views. The entry point was penetrated with a guidewire for 4-cm, while the knee was in 30° flexion.



**Figure 2.** Trans-patellar approach for retrograde nailing [image is from Arbeitsgemeinschaft für Osteosynthesefragen (AO) foundation, <https://surgeryreference.aofoundation.org>]

Regarding the possible injuries to several anatomical entities, including anterior cruciate ligament, weight-bearing zone's cartilage, etc., care must be taken. Thus, we

checked that 1) the guidewire was accurately placed into the middle of the intercondylar notch, on the AP view, 2) placed on the Blumensaat's line (Figure 3), on the lateral view, and 3) the entry point was aligned with the medullary canal's axis. With this orientation, we could protect ligaments and cartilage from injury (40).



**Figure 3.** Blumensaat's line (orange line), an anatomical landmark for retrograde nail insertion [image is from Arbeitsgemeinschaft für Osteosynthesefragen (AO) foundation, <https://surgeryreference.aofoundation.org>]

After opening the medullary canal to a depth of 3 cm and reaming, the IM nail was inserted, while the lower extremity was in the traction. The ultimate result of RN after surgery is shown in figure 4.



**Figure 4.** Early postoperative radiography [anteroposterior (AP) and lateral views]

After the nailing surgery, the patient was recovered without any complications. He was hospitalized for two days, and rehabilitation and knee ROM was started as soon as possible. He was prescribed to do physiotherapy and full weight-bearing right after his surgery's recovery.

The patient's follow-up sessions were at 2, 6, 12, and 24 weeks, postoperatively. As early as three months, the patient was represented with complete radiological and clinical healing. He did not represent residual pain, restricted ROM, or muscle atrophy at that point or until the end of his follow-up sessions. He did not complain about his knee function, and we did not find any signs and symptoms of degenerative joint disease. He was able to return to his sports activities as early as three months (Figure 5).



Figure 5. Patient returned to bodybuilding and heavyweight lifting after nine months

The patient had a full ROM and normal muscle strength. The radiograph demonstrated a complete fracture union with the appropriate alignment of the femur (Figure 6).



Figure 6. 3-month radiological follow-up

## Discussion

We have represented a satisfactory result of a femoral RN due to the femoral shaft fracture. The patient returned to the heavy-lifting without any limitation, and

radiological evaluation confirmed appropriate bone healing. Therefore, it seems that we can trust RN if either facility or skillful staff are available. Besides, it is expected for professional athletes to return to sport within one year or even sooner (41).

When comparing RN with AN in terms of pain, we should distinguish the site of the pain. Regarding pain at the hip and thigh site, Ostrum et al. (11) and Ricci et al. (12) deduced that those patients who underwent AN showed a more significant pain. Hussain et al., in their meta-analysis, computed the relative risk = 4.3 with 95% confidence interval (CI) = 1.66-11.10 (27). However, if we consider knee pain, this situation will reverse. Ricci et al. (32) and Tornetta and Tiburzi (43) found more severe pain in the knee site when applying IM NAIL retrogradely. Nevertheless, some studies reported comparable knee pain in both approaches (11, 30, 42). A hypothesis that notes the more severe pain felt in patients who underwent RN is related to concomitant patellar injuries or ligaments stemming from initial trauma (27). The knee pain subsided by the time consumed to the presence of bone union (approximately three months) (43).

Benefits regarding the RN approach are discussed in many studies when comparing with AN. In obese patients, RN consumes significantly lower surgery time (30% less), and patients are exposed to lower radiation exposure (225% less) (44). RN has a similar rate of union, appropriate alignment, and functional scores (27). RN is preferred when comparing HO as a post-operative complication of nailing (22, 23, 27). At the discharge time, RN patients functioned better in terms of Harris Hip Score (HHS) (42).

Murray et al. claimed inferior knee function and ROM by following two groups of patients (n = 32) who underwent AN and RN of the femur (45). Moreover, Toluse et al. study confirmed that knee ROM recovered more rapidly in the AN group. In comparison, no difference was observed between the two groups regarding hip joint motion (46). However, there are some controversies in other investigations. In the randomized clinical trial of Daglar et al., after mean follow-up of 44 months of 71 patients, they did not find any superiority between AN or RN regarding knee functional scores and ROM (33). Andrzejewski et al. study also represented similar knee function and ROM in terms of AN or RN of the femur (30). Based on previous studies, we can conclude that RN in indicated patient and carrying out with caution could be a gold standard treatment for femoral shaft fracture.

## Conclusion

Femoral retrograde nailing has promising outcomes, and is the choice of treatment for specific femoral fractures. Surgeons should not avoid this approach while choosing the right patient and well-performing the procedure. In this situation, satisfactory outcomes are expected.

## Conflict of Interest

The authors declare no conflict of interest in this study.

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