

# Antegrade Versus Retrograde Locked Intramedullary Nailing for Femoral Fractures: Which Is Better?

Chan K. Yu<sup>1</sup>, Vivek A. Singh<sup>1</sup>, Sureisen Mariapan<sup>1</sup>, Se T.B. Chong<sup>2</sup>

## Abstract

**Background:** Locked intramedullary nailing or interlocking nailing (ILN) is a proven mode of treatment for femoral shaft fractures. It can be inserted via the antegrade or retrograde approach. Retrograde approach is technically less demanding especially if the patient is overweight. But there are concerns with regard to the violation of the knee and its effect on subsequent knee function.

**Methods:** We studied consecutive cases of femoral shaft fractures treated with locked intramedullary nailing at the Penang General Hospital, from 1st June 2004 to 1st June 2005. We looked at radiological and clinical union rates, union of fractures, alignment of the operated limb, and the knee function, using the Thoresen scoring system.

**Results:** There were a total of 77 cases of femoral interlocking nails during the study period. Forty-two cases were antegrade nails and 35 cases were retrograde nails. Both groups of patients eventually achieved union of the fracture and retrograde nailing group showed significantly earlier union rate ( $p = 0.032$ ). There is no significant difference between both groups, in regards to knee pain, swelling, and range of motion as well as postnailing femoral alignment.

**Conclusions:** Both methods of nailing achieved excellent union rates with good alignment of the limb. Contrary to popular belief, we found that retrograde nailing does not give rise to a higher rate of knee complications. Therefore, we strongly recommend this approach of nailing as it is technically less demanding.

## Key Words

Antegrade · Retrograde · Interlocking nail · Knee function

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## Introduction

Locked intramedullary nailing (ILN) is routinely used for the stabilization of femoral fractures. Many centers now advocate the use of interlocking nailing as the gold standard for the treatment of femoral shaft fractures [1–4]. Interlocking nails can be inserted via two approaches. The antegrade method involves insertion of the nail into the femoral canal from the proximal femur, through the piriformis fossa. On the other hand, retrograde nailing involves insertion of the nail through the intercondylar notch of the femur, just above the insertion of the anterior cruciate ligament. Both approaches yield high union rates. Antegrade nailing is associated with recognized complications such as the Trendelenburg gait [1] due to injury to the hip abductors or its nerve supply and implant-related pain [1]. Furthermore, surgical insertion of the nail via the antegrade approach is often complicated by difficulty in finding the entry point at the piriformis fossa, especially in obese individuals [1]. On the other hand, the retrograde approach by virtue of the fact that it involves an entry point through the knee is fraught with potential complications to the knee. In retrograde

<sup>1</sup>Department of Orthopaedic Surgery, University Malaya Medical Center, Kuala Lumpur, Malaysia,

<sup>2</sup>Department of Orthopaedics and Traumatology, Penang General Hospital, Penang, Malaysia.

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nailing, if precautions are not taken, the articular cartilage around the intercondylar notch as well as the articular surface of the patella is at risk of damage, giving to posttraumatic patellofemoral osteoarthritis [5].

As to date, only two papers have been published comparing both retrograde and antegrade nailing for femoral fractures. We carried out this study with the aim of comparing the both methods, looking at outcome and complications.

**Materials and Methods**

We reviewed all cases of femoral fractures, which were treated with interlocking femoral nail from 1st June 2004 till 1st June 2005. Fractures were divided according to the location along the femoral shaft; proximal, middle, or distal third. Metaphyseal fractures such as supracondylar, pertrochanteric, and subtrochanteric were excluded. Those with associated injuries around the knee, e.g. patella fractures, tibial plateau, and femoral condylar fractures as well as ligamentous avulsion fractures were excluded. The patients were identified from our implant record book and their records were traced from our record office. All the patients in this study had at least 6 months of follow-up.

All the patients were interviewed by telephone and also called back to the clinic for physical evaluation. Their follow-up radiographs were traced and assessed by an independent reviewer from the radiology department. A standard approach was used for both the antegrade and retrograde nailing. Retrograde nails were inserted through the knee via the intercondylar notch, with a soft tissue protection sleeve in order to protect the articular surface of the patella from damage by the guide wire and reamers. We used the image intensifier to ensure that the distal end of the nail was situated proximal to the intercondylar notch so that it did not protrude into the knee joint space. Antegrade nails were inserted via the piriformis fossa. There were no strict criteria set for choosing the approach for the nailing. It was entirely at the discretion of the operating surgeon. The same kind of nails was used in all the cases, which was the Stryker T2 Universal femoral nail. It can be inserted via both the retrograde and antegrade approach. All the nails were reamed nails. Antegrade nails were locked with two proximal screws and two distal screws. All screws were inserted from the lateral side. Retrograde nails were locked with two distal screws (from lateral side) and one proximal screw, in the anterior posterior direction.

Radiological union was defined as the presence of bridging callus across three cortices and fractures were

considered healed when the patients had radiological union and were able to bear weight without experiencing thigh pain [6]. We define delayed union as radiological union which took longer than 6 months while nonunion as not having any gross callus visible on radiographs 6 months after the surgery.

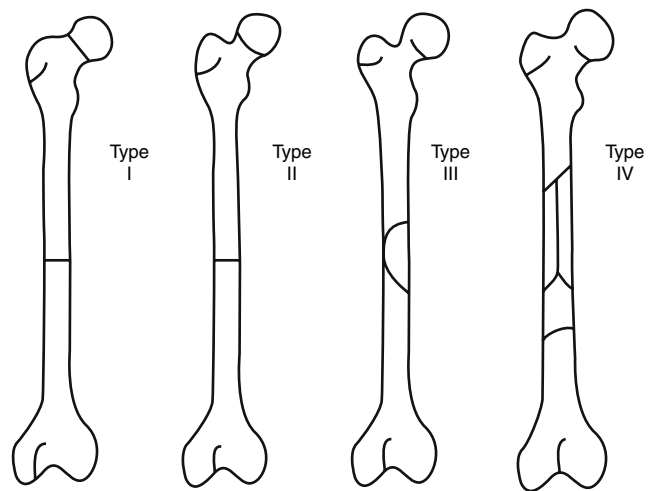
Fractures were graded as open or closed fractures. Open fractures were further classified according to the Gustilo classification [7]. The degree of comminution of the fracture was graded with the Winquist system [8] as shown in Figure 1.

The Thoresen scoring system [9] was used to evaluate the eventual alignment of the fracture after the nailing, regards to the valgus or varus, procurvatum or recurvatum, shortening and rotational (internal or external) alignment, as shown in Table 1. The former two were determined by examining the radiographs in both anterior–posterior and lateral views. While rotation was determined clinically by physical examination, by observing the position of the patella and second toe in regards to the anterior superior spine on the same side. Shortening was determined by measuring the limb length. This same scoring system also enabled us to assess the patients’ knee function clinically in terms of flexion, extension deficit, pain, and swelling. We analyzed patients’ demographics and outcomes in terms of union, healing, alignment, and knee function.

Statistical analysis was carried out with the unpaired t-test, Fisher’s exact test, and Chi-square test.

**Results**

There were a total of 76 consecutive cases of femoral fractures treated with interlocking nails at the Penang



**Figure 1.** Winquist classification of femoral shaft fractures.

**Table 1.** Thoresen scoring system.

Variables	Result			
	Excellent	Good	Fair	Poor
<b>Malalignment</b>				
Varus/valgus	5	5	10	> 10
Procurvatum/recurvatum	5	10	15	> 15
Internal rotation	5	10	15	> 15
External rotation	10	15	20	> 20
Shortening (in cm)	1	2	3	> 3
<b>Range of motion (knee)</b>				
Flexion	> 120	120	90	< 90
Extension deficit	5	10	15	> 15
Pain or swelling	None	Sporadic, minor	Significant	Severe

General Hospital during the period of the study. There were 35 cases of retrograde nailing and 42 cases of antegrade nailing. All cases were related to trauma except one, which was a case of a corrective supracondylar osteotomy of the femur, done for a patient with genu valgus deformity.

With respect to age, gender, and the number of open and closed fractures, there were no statistical differences between both groups of patients (Table 2). As for the degree of comminution, the retrograde group had a greater proportion (60.0%) of simple fractures (Winqvist 1) compared to the antegrade group (38.1%). The antegrade group, on the other

**Table 2.** Demographic table.

	Retrograde	Antegrade	p-value
<b>Number of fractures</b>	35	42	
<b>Mean age (years)</b>	37.4 (13–73)	31.4 (15–84)	p = 0.1564
<b>Gender</b>			
Male	28	36	p = 0.5532
Female	7	6	
Nonfracture	1 <sup>a</sup>	0	p = 0.5648
Closed fractures	30	36	
Open fracture grades 1 and 2	4	5	
Open fracture grade 3	0	1	
<b>Comminution</b>			
Winqvist 1	21	16	p = 0.0138
Winqvist 2	7	6	
Winqvist 3	5	7	
Winqvist 4	1	13	
Not classified (nonfracture case)	1 <sup>a</sup>	0	

<sup>a</sup> Represents the patient with genu valgus treated by supracondylar osteotomy and retrograde nailing

hand, had a significantly higher proportion (47.6%) of severely comminuted or segmental fractures (Winqvist 3 and 4) compared to the retrograde group (17.1%). In the antegrade group, 25 fractures were at the middle third of the femur, 13 at the proximal third, and 4 at the distal third. In the retrograde group, 24 fractures were at the distal third of the femur whilst 10 were at the middle third. We did not use retrograde nails for proximal third fractures.

None of the fractures fixed by retrograde nailing had any protrusion of the distal end of the nail into the knee joint. This was confirmed by both the image intensifier intraoperatively and postoperative plain radiographs. Anterior and posterior drawer tests were performed on the knees of the patients whose fractures were fixed with retrograde nails after the nails were inserted and locked. None of the patients showed any cruciate ligament laxity postnailing.

All 35 cases (100%) of the retrograde nailing and 85.7% cases of antegrade nailing finally achieved union. There was no statistical difference between both the groups of patients, in regards to union (p = 0.0665). In the antegrade group of patients, the delayed union and nonunion rate was 9.5% and 4.8% respectively. In analysis of the postnailing fracture alignment, the patient treated for the valgus knee with supracondylar osteotomy was excluded as his surgery was done to restore normal alignment of the knee. We found that in all the parameters of the Thoresen system for fracture alignment were similar in both groups (Table 3).

However, it is important to note that the retrograde group of patients showed 100% excellent results in terms of valgus or varus, procurvatum or recurvatum, rotation and shortening. Excellent results for each of the parameters meant valgus or varus angulation less than 5°, procurvatum or recurvatum less than 5°, internal rotation less than 5°, external rotation less than 5°, and shortening of 1 cm and below.

The antegrade group did in fact yield a number of cases with malunion, especially in valgus or varus and procurvatum or recurvatum angulation, though these numbers are not statistically significant (Table 3). As for the knee function, both groups did not differ significantly in regards to the presence of knee pain or swelling (p = 0.2379), knee extension deficit (p = 0.5100), and knee flexion (p = 0.7215). About 91.4% of the patients in the retrograde group and 88.1% of the patients in the antegrade group showed good to excellent knee flexion based on the Thoresen scoring system. The proportion of patients in both groups who reported significant knee pain was also small (9.5% in the antegrade group and 2.9% in the

**Table 3.** Postnailing fracture alignment of both retrograde and antegrade groups, using the Thoresen scoring system.

	Antegrade	Retrograde	p-value
<b>Valgus/varus</b>			
Excellent	34	34	p = 0.0769
Good	3	0	
Fair	3	0	
Poor	2	0	
Not applicable	0	1 <sup>a</sup>	
<b>Procurvatum/recurvatum</b>			
Excellent	39	34	p = 0.2913
Good	0	0	
Fair	1	0	
Poor	2	0	
Not applicable	0	1 <sup>a</sup>	
<b>Internal rotation</b>			
Excellent	41	34	p = 0.3617
Good	1	0	
Fair	0	0	
Poor	0	0	
Not applicable	0	1 <sup>a</sup>	
<b>External rotation</b>			
Excellent	40	34	p = 0.2377
Good	2	0	
Fair	0	0	
Poor	0	0	
Not applicable	0	1 <sup>a</sup>	
<b>Shortening</b>			
Excellent	38	34	p = 0.2015
Good	3	0	
Fair	1	0	
Poor	0	0	
Not applicable	0	1 <sup>a</sup>	

<sup>a</sup> Represents the patient with genu valgus treated by supracondylar osteotomy and retrograde nailing

retrograde group). As for knee extension, 85.7% of the patients in the antegrade group and 94.3% of the patients in the retrograde group had excellent results (less than 5° extension deficit). None of the patients in either groups had any hip pain or impairment of hip motion. None of the antegrade nail patients showed any radiographic evidence of heterotopic ossification.

Implant infection was virtually nil in both groups of patients. The antegrade group had only one case of superficial wound infection at the entry point of one of the locking screws, which resolved with antibiotics and removal of the screw. The fracture went on to heal without any complications. In this entire series, only three cases, all from the antegrade group had failure of implant. One case of nail bending, which was treated with exchange nailing and went on to heal successfully

and two cases of broken screws (one case of broken, both the proximal screws and one case of broken, one distal screws). They eventually achieved fracture union.

**Discussion**

Interlocking nailing currently is considered to be the treatment of choice for most femoral shaft fractures [10]. In the reduction and fixation of femoral fractures, the following principles are agreed upon: (1) restoration of alignment, rotation, and length, (2) preservation of the blood supply to aid union and prevent infection, and (3) rehabilitation of the extremity and thereby the patient [10]. The interlocking nail is an ideal implant as it can fulfill all the above principles. Fixation of femoral fractures can also be achieved by plating. But it is an open method of surgery and involves extensive soft tissue stripping. This causes devascularization of the fracture ends with subsequent higher rates of nonunion, implant failure, and infection [10].

Rüedi [11] in 1979 reported a 6% infection rate and a 14% nonunion rate with plating as opposed to an infection rate of 0.5% and a nonunion rate of 0.8% reported for closed nailing by Winquist et al. [8]. Interlocking nailing has an advantage as the fracture site is not exposed during the procedure. Thus, the introduction of ILN brought about great breakthrough in the treatment of major long bone fractures [12]. Retrograde nails were first developed for the stabilization of supracondylar fractures of the femur. Since then, its scope has been widened to include other situations where one would consider retrograde nailing more favorable [5, 10, 13]. Such as:

1. Ipsilateral proximal hip implant, e.g., a total hip prosthesis blocking the medullary canal with fracture in the femoral shaft.
2. Pregnant women (especially first trimester) with a femoral fracture. The lower abdomen can be shielded by a lead cover, protecting the fetus from radiation.
3. Femoral shaft fracture with ipsilateral acetabular fracture, displaced femoral neck fracture or hip dislocation. Retrograde nailing enables stabilization of the shaft fracture, so that one can subsequently perform closed reduction of the femoral neck fracture or the hip dislocation.
4. Floating knee (ipsilateral femoral and tibial fracture). Both fractures can be stabilized from the same knee incision, thus speeding up the surgery. In

such a case, the femoral nail has to be inserted retrograde.

5. Bilateral femoral shaft fracture. In patients with polytrauma, where patients may have other concomitant injuries and require fast stabilization of the fractures, retrograde nailing is faster and thus the preferred mode.
6. A fracture of the femoral shaft above a total knee prosthesis is best treated by retrograde nailing.
7. Obese patients with femoral shaft fractures, where we expect difficulty in obtaining an entry point for antegrade nailing.

The retrograde approach, by virtue of the fact that it involves an entry point through the knee, is therefore fraught with potential complications to the knee. During the procedure, the articular cartilage around the intercondylar notch as well as the patella is at risk of damage while reaming and insertion of the nail. Posttraumatic patello-femoral osteoarthritis is therefore a legitimate fear [5]. Retrograde nailing is contraindicated in cases where the fracture is too distal, involving the supracondylar region, where the distal locking will be inadequate to provide stability or if it is an intraarticular fracture involving the knee joint, where there is difficulty in restoring the articular surface and in cases where there is stiffness of the knee, preventing at least 90° of flexion, making the insertion of the nail virtually impossible. The relative contraindication to retrograde nailing would be the presence of wounds around the knee joint area, which would increase the risk of postoperative infection.

In our literature review, we have only come across two published papers, which compare antegrade versus retrograde nailing methods. There are a number of papers looking into the outcome of retrograde femoral nailing without comparing with it to antegrade nailing, such as the following. Khare & Mehra [12] in 2002 studied 35 cases of retrograde nailing of the femur. Thirty-one cases (88%) regained full knee movement. Two out of the four remaining cases had regained up to 90° of knee motion. The authors reported that these four patients had old fractures and were uncooperative. As such, they concluded in their study that retrograde nailing has no adverse effect on knee function. Leggon & Feldmann [13] in 2001 reported that 90% of their series of 23 consecutive patients who underwent retrograde nailing had good to excellent results in terms of their knee scores, but with 55% having mild knee pain. The papers that compared antegrade versus retrograde nailing gave conflicting results when it came

to knee function. Ricci et al. [14] retrospectively studied 293 femoral fractures, of which 140 were nailed retrograde while the other 153 were fixed with antegrade nails. They found that the incidence of knee pain was significantly higher in the retrograde group (36%) compared to the antegrade group (9%). They also found that in the antegrade nail group of patients, 10% had hip pain and 26% had heterotrophic ossification. On the other hand, Ostrum et al. [15] in a prospective study of 100 consecutive femoral interlocking nails (54 retrograde and 46 antegrade), reported that knee pain was equal in both groups of patients. But hip and thigh pain predominated significantly in the antegrade group. Knee motion was not much different in both groups (98.1% of the retrograde group had knee flexion more than 120° compared to 97.8% in the antegrade group).

This is consistent with our findings. We found that retrograde nailing did not result in significantly higher knee complications compared to antegrade nailing. In fact, the results actually show that the outcome of knee pain, swelling, knee flexion, and extension deficit in both groups are similar. Both methods of nailing achieved excellent union rates with good alignment of the limb. The observed increase in malunion cases in the antegrade group could be attributed to the fact that this group had a higher number of comminuted fractures compared to the retrograde group. Contrary to popular belief, we found that retrograde nailing did not result in higher rates of knee complications. Therefore, we recommend this approach of nailing as it is technically less demanding. However, we do advice one to take certain precautions to protect the knee joint during the procedure. The use a soft tissue protection sleeve during reaming is essential.

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**Address for Correspondence**

Vivek Ajit Singh, MS, FRCS  
Department of Orthopaedic Surgery  
University Malaya Medical Center  
Kuala Lumpur  
Malaysia  
Phone (+60/1) 2494-0600  
e-mail: drvivek69@gmail.com

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