Knee Pain and Leg-Length Discrepancy After Retrograde Femoral Nailing

Ricardo Reina, MD, Fernando E. Vilella, MD, Norman Ramírez, MD, Richard Valenzuela, MD, Gil Nieves, MD, and Christian A. Foy, MD

ABSTRACT

We retrospectively studied postoperative knee function and leg-length discrepancy (LLD) in 31 patients with femoral diaphyseal fractures treated with retrograde intramedullary nailing (IMN) between October 1998 and April 2000. Mean follow-up was 25 months, mean knee range of motion was 126°, mean Hospital for Special Surgery knee scores were 89.2 (pain) and 78.3 (function), and mean LLD was 1.19 cm. Despite the theoretically higher knee pain and LLD rates associated with retrograde IMN, we believe it may offer a viable treatment option when the antegrade nailing technique is restricted.

Fractures of the femoral shaft are associated with high-energy trauma. Different treatments have had varied results.[1-3] Closed intramedullary nailing (IMN) has been shown to be an effective treatment, with high success rates and minimal complications.[1-8]

The current standard of care for femoral shaft fractures is IMN through an antegrade entry point at the piriformis fossa.[1,2,4,8-12] This technique has several drawbacks, including a difficult starting point at the piriformis fossa, postoperative Trendelenburg gait, iatrogenic fracture of the femoral neck, need for a fracture table with difficult patient positioning, and limitations in use with concomitant surgical procedures.[3,5,6]

Over the past 20 years, retrograde IMN has emerged as an alternative that overcomes the shortcomings of antegrade IMN in treating femoral shaft fractures.[1,3-5,7,8,13,14] The advan-

> **"...indications for retrograde intramedullary nailing have expanded..."**

tages of retrograde IMN include no need for fracture table, ease of entry at the intercondylar notch, and accessibility for performing additional surgical procedures with the patient in a supine position.[5] The original indications for retrograde IMN were femoral shaft fractures with ipsilateral femoral neck fractures, femoral shaft fractures in polytrauma patients, and obese patients.[1,2,7-9,14] With the advantages of this technique, indications for retrograde IMN have expanded. The increasing popularity of the procedure has raised concerns in the orthopedic community about possible complications with respect to knee function, knee pain, and leg-length discrepancy (LLD) secondary to the procedure.[4,6]

In the study reported here, we reviewed postoperative knee function and LLD after retrograde IMN for femoral diaphyseal fractures.

MATERIALS AND METHODS

Between October 1998 and April 2000, a surgeon at University of Puerto Rico District Hospital and Puerto Rico Medical Center used retrograde IMN to treat 46 femoral shaft fractures consecutively. For the purpose of this study, we selected only those fractures located both 5 cm below the lesser trochanter[14] and above the femoral condyles. Patients were contacted by telephone, by mail, or through local government agencies.

Of the 46 patients, 15 (33%) were excluded (4 had passed away, and 11 had insufficient follow-up because of poor patient compliance, or they were unavailable for evaluation at a specific clinic). The remaining 31 patients (67%) had a minimum follow-up of 1 year and were evaluated by the senior authors at a clinic specially set up for this study. In accordance with the approved protocol of our Institutional Review Board, all patients received a complete orientation to the study and signed release and consent forms for participation.

The medical records of these patients were reviewed for variables such as accident type, associated injuries, degree of comminution, open fracture classification, complications, and need for concomitant surgical procedures. For each patient, the Winquist and Hansen classification for comminution of femur fractures was used: 0 (no comminution), 1 (insignificant butterfly fragment),

Dr. Reina is in private practice, San Juan, Puerto Rico.

Dr. Vilella is Third-Year Resident, Dr. Ramírez is Director of Research, Dr. Valenzuela and Dr. Nieves are First-Year Residents, and Dr. Foy is Research Fellow, Department of Orthopaedic Surgery, School of Medicine, University of Puerto Rico, San Juan, Puerto Rico.

Requests for reprints: Norman Ramírez, MD, Department of Orthopaedic Surgery, School of Medicine, University of Puerto Rico, San Juan, PR 00936 (tel, 787-264-2066; fax, 787-264-4483; e-mail, normanpipe@aol.com).
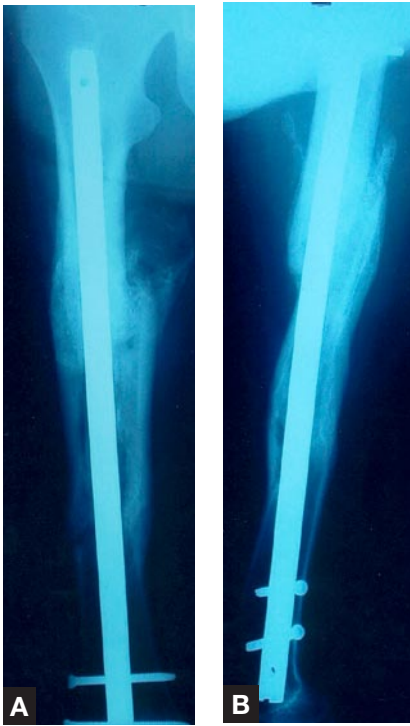
Figure 1. Twenty-year-old man with distal shaft femur fracture sustained in a motor vehicle accident. Anteroposterior **(A)** and lateral **(B)** plain films obtained 24 months after retrograde intramedullary nailing show fracture union.

2 (large butterfly fragment less than 50% the width of the bone), 3 (large butterfly fragment more than 50% the width of the bone), 4 (segmental comminution). Open fractures were classified according to Gustilo and Anderson: type I, low-energy trauma with wound size less than 1 cm; type II, moderate-energy trauma with wound size 10 cm or less; type III, high-energy trauma with wound size more than 10 cm.

Knee pain and function were assessed with Hospital for Special Surgery (HSS) knee scores.[15] Patients were assigned one of the standard clinical categories: excellent (90-100 points), good (80-89 points), fair (70-79 points), poor (<70 points). Plain films of the involved femur and ipsilateral hip and knee were obtained. Radiographic union was defined as presence of a bridging callus across 3 cortices on anteroposterior and lateral plain films. Clinical union was diagnosed when there was no pain with ambulation or single leg stance.[9,14]

In each patient, a scanogram was obtained to objectively determine LLD, defined as more than a 2-cm difference between the legs.[9]

Surgical Technique

Each patient was placed on a radiolucent operating room table in supine position, and the affected lower extremity was prepped and draped in standard surgical fashion.

The knee was positioned in 40° of flexion with a bolster, and a 4-cm skin incision was made just medial to the patellar tendon, from the inferior pole of the patella to the tibial tubercle. The infrapatellar fat pad was partially excised, and then a medial patellar knee arthrotomy was performed.

With the help of the fluoroscope, a guided pin was inserted in the midline just anterior to the intercondylar notch in the anteroposterior view. In the lateral view, the pin should be above the Blumensaat line. A cannulated drill was used to open the distal femur metaphysis. A ball-tipped guide wire was inserted through the entry points just to the distal fracture border. After the fracture was reduced, the guide wire was introduced across the fracture to maintain the alignment of the reduction. Flexible reaming was performed until adequate cortical contact was achieved.

For implants, Russell-Taylor femoral nails (Smith & Nephew Richards, Memphis, Tenn) were used. The intramedullary nail was placed to a level below the lesser trochanter proximally and flush to the chondral surface distally. The length of this nail was selected after using a radiopaque ruler, or by measuring the contralateral femur in case of severe comminution; the selected width was 1 mm less than the largest reamer diameter. Distal locking was done with the insertion handle jig, and proximal locking was performed with the freehand technique.

The rehabilitation protocol was identical for each patient.

RESULTS

Thirty-one patients (25 men, 6 women) with 35 femur fractures were included for evaluation in the study. Minimum follow-up was 1 year, and mean follow-up was 25 months (range, 12-38 months). Mean age was 33.9 years (range, 18-80 years). There were 17 right and 10 left femur fractures, and 4 patients had bilateral femur fractures. The most common fracture mechanism was motor vehicle accident (70%) (Figures 1A, 1B), followed by gunshot wound (17%) (Figures 2A, 2B) and fall from a height (13%). Ten (29%) of the 35 fractures were open: 3 of these were type I, 5 were type II, and 2 were type III. There were 18 Winquist grade 0 fractures, 4 Winquist grade 1 fractures, 6 Winquist grade 2 fractures, 4 Winquist grade 3 fractures, and 3 Winquist grade 4 fractures.

Eleven patients had multiple injuries, and 20 had isolated femur fractures. Associated injuries included head trauma (2 patients), peroneal nerve palsies (2 patients), vascular injuries (2 patients), 1 radioulnar fracture, 1 humeral fracture, 1 pilon fracture, 1 simultaneous talus and calcaneous fracture, 1 acetabular fracture, 1 odontoid fracture, 1 abdominal trauma, 1 pneumothorax, 1 testicular contusion, and 1 urethral injury.

Figure 2. Fifty-five-year-old man with distal shaft femur fracture caused by a gunshot. Anteroposterior **(A)** and lateral **(B)** plain films obtained 18 months after retrograde intramedullary nailing show fracture union.

Mean knee range of motion (ROM) was 126° (range, 85°-130°). At follow-up, 8 (23%) of 35 femur fractures showed loss of knee ROM; of these, 5 had lost more than 10° of ROM, and the remaining patients had less than 10° of limitation. Mean HSS knee score for pain was 89.2 points (range, 52-100 points). Lower scores were seen in patients with concomitant comorbidity, such as extreme age, diabetes mellitus with bilateral below-knee amputations, severe mental retardation, high-degree scoliosis, nonambulators, and juvenile rheumatoid arthritis. Mean HSS knee score

pudendal nerve palsy, and need for a fracture table. Other limitations are hip stiffness, reduced walking distance, Trendelenburg gait, weak hip abductors, difficult entry point, and hip or thigh pain.[1,3,6,10,14]

For many years, different types of IMN have been used through a retrograde extra-articular entry point in attempts to minimize shortcomings of the antegrade technique, but there have been several complications.[3,7,8,16-18] Given the multiple complications associated with an extra-articular entry point, the technique was revised to use the intercondylar

metallurgy, malunion, nonunion, and implant failure.[2,4] Incidence of knee pain after retrograde IMN for femoral shaft fractures has varied from 0% to 60%.[3-5,7-9,14,21] In a comparative study of retrograde versus antegrade nailing, time to union was slightly longer in the retrograde group compared with the antegrade group, and more secondary procedures were needed to obtain union.[1,6,8,9,11,12] The retrograde group had more symptomatic distal screw pain, requiring removal.[1]

In this series, mean HSS knee scores were 89 (pain) and 78 (function). Patients with poor clinical sta-

"...the technique was revised to use the intercondylar entry point..."

for function was 78.3 points (range, 30-100 points). In spite of good mean knee scores for pain, 21 (68%) of the 31 patients complained of occasional knee pain, and 6 of these reported their knee pain was associated with prominent distal screws. Five patients required a second procedure for distal screw removal.

Scanograms were available for all 31 patients. Mean LLD was 1.19 cm. Five patients (16.1%) had more than 2 cm of LLD, 11 (35.5%) had LLD between 1.0 and 1.9 cm, and 15 (48.4%) had less than 1 cm of LLD. All patients with LLD of more than 2 cm had Winquist 3 or Winquist 4 femur fractures. No patient in this study presented with complications associated with retrograde IMN, such as infection, nonunion, or malalignment of more than 10°.

DISCUSSION

Antegrade IMN is an effective treatment for femoral shaft fractures (high-energy injuries), and outcomes have been reliable.[1,2,4,8-12] Although this technique has a high union rate, it also has several drawbacks, such as limited application of this operative method to ipsilateral femoral neck fractures, possibility of heterotopic bone formation around the hip,

entry point, eliminating the potential complications of malreduction in varus and crack propagation at the entry point.[4,5,19,20] With introduction of this technique, current indications for retrograde IMN include ipsilateral femoral shaft and neck fractures, obese and pregnant patients, ipsilateral pelvis and acetabular injuries, and other polytrauma patients requiring concomitant surgery.[1,3,4,9,14] Contraindications are skeletal immaturity, past history of knee joint sepsis, fracture within 5 cm of the lesser trochanter, type III-b open fractures, and severe soft-tissue injury about the knee.[1,5]

The technical advantages of retrograde IMN include minimal dissection, possible use of the standard surgical table, easier and faster setup, less surgical time, and less blood loss.[13] These advantages have motivated orthopedic surgeons to stretch the indications for retrograde IMN to include isolated femoral shaft fractures. Although retrograde IMN is an alternative for managing isolated femoral shaft fractures, this technique is not without disadvantages. With use of these nails, serious complications have been reported, including LLD, knee pain, knee joint stiffness, knee septic arthritis, knee

tus before trauma had the lowest scores. There was no difference in knee pain and LLD between patients with isolated fractures and patients with polytrauma. Mean knee ROM was 126°, comparable to what has been found previously.[1,4,6-8] Clinical assessment of our patients showed that 60% of them were complaining of occasional knee pain in spite of postoperative conservative treatment. It is very interesting that only 5 (16%) of the 31 patients required surgical treatment for knee pain (distal screw removal). The high incidence of knee pain in our series could be attributed to our follow-up being longer than that in previous studies and the possibility that many of our patients were involved in legal issues.

We also evaluated LLD in all our patients by performing scanograms at follow-up. To the best of our knowledge, this study is the first in which LLD was objectively evaluated. Mean LLD was 1.19 cm. As reported in the Results section, 16.1% of our 31 patients had more than 2 cm of LLD, 35.5% had LLD between 1.0 and 1.9 cm, and 48.4% had less than 1 cm of LLD. Patients with higher LLD had a higher degree of comminution.

One third of our patients had insufficient follow-up. Nevertheless, we

believe that retrograde nailing may offer a different treatment option for femoral shaft fractures. Its indications, however, must be limited to specific situations in which the antegrade nailing technique may be restricted, as in cases of concomitant femoral neck fractures, acetabular fractures, multiple injuries, obesity, and pregnancy. Results from recent clinical and experimental studies support use of retrograde nailing in certain situations.

> ## "Our findings preclude recommending its [retrograde intramedullary nailing] routine use for stabilization of isolated femoral shaft fractures."

Clinical studies are still answering questions about the long-term consequences of retrograde IMN in isolated femoral shaft fractures.[1,5,13,14] Our findings preclude recommending its routine use for stabilization of isolated femoral shaft fractures. Antegrade IMN continues to be the standard of care for isolated femoral shaft fractures. However, particular clinical situations would dictate use of the retrograde over the antegrade technique despite theoretically more knee pain and larger LLD associated with retrograde IMN.

REFERENCES

1. Ostrum RF, DiCicco J, Lakatos R, Poka A. Retrograde intramedullary nailing of femoral diaphyseal fractures. *J Orthop Trauma*. 1998;12:464-468.
2. Patterson BM, Routt MLJ, Benirschke SK, Hansen STJ. Retrograde nailing of femoral shaft fractures. *J Trauma*. 1995;38:38-43.
3. Ricci WM, Bellabarba C, Evanoff B, Herscovici D, DiPasquale T, Sanders R. Retrograde versus antegrade nailing of femoral shaft fractures. *J Orthop Trauma*. 2001;15:161-169.
4. Herscovici DJ, Whiteman KW. Retrograde nailing of the femur using an intercondylar approach. *Clin Orthop*. 1996;332:98-104.
5. Moed BR, Watson JT, Cramer KE, Karges DE, Teefey JS. Unreamed retrograde intramedullary nailing of fractures of the femoral shaft. *J Orthop Trauma*. 1998;12:334-342.
6. Ostrum RF, Agarwal A, Lakatos R, Poka A. Prospective comparison of retrograde and antegrade femoral intramedullary nailing. *J Orthop Trauma*. 2000;14:496-501.
7. Sanders R, Koval KJ, DiPasquale T, Helfet DL, Frankle M. Retrograde reamed femoral nailing. *J Orthop Trauma*. 1993;7:293-302.
8. Brumback RJ, Uwagie-Ero S, Lakatos RP, Poka A, Bathon GH, Burgess AR. Intramedullary nailing of femoral shaft fractures. Part II: fracture-healing with static interlocking fixation. *J Bone Joint Surg Am*. 1988;70:1453-1462.
9. Leggon RE, Feldmann DD. Retrograde femoral nailing: a focus on the knee. *Am J Knee Surg*. 2001;14:109-118.
10. Moed BR, Watson JT. Retrograde nailing of the femoral shaft. *J Am Acad Orthop Surg*. 1999;7:209-216.
11. Brumback RJ, Reilly JP, Poka A, Lakatos RP, Bathon GH, Burgess AR. Intramedullary nailing of femoral shaft fractures. Part I: decision-making errors with interlocking fixation. *J Bone Joint Surg Am*. 1988;70:1441-1452.
12. Winquist RA, Hansen STJ, Clawson DK. Closed intramedullary nailing of femoral fractures. A report of five hundred and twenty cases. *J Bone Joint Surg Am*. 1984;66:529-539.
13. Helfet DL, Lorich DG. Retrograde intramedullary nailing of supracondylar femoral fractures. *Clin Orthop*. 1998;350:80-84.
14. DiCicco JD III, Jenkins M, Ostrum RF. Retrograde nailing for subtrochanteric femur fractures. *Am J Orthop*. 2000;29(9 suppl):4-8.
15. Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the Knee Society clinical rating system. *Clin Orthop*. 1989;248:13-14.
16. Rush LV. Dynamic intramedullary fracture-fixation of the femur. Reflections on the use of the round rod after 30 years. *Clin Orthop*. 1968;60:21-27.
17. Casey MJ, Chapman MW. Ipsilateral concomitant fractures of the hip and femoral shaft. *J Bone Joint Surg Am*. 1979;61:503-509.
18. Swiontkowski MF, Hansen STJ, Kellam J. Ipsilateral fractures of the femoral neck and shaft. A treatment protocol. *J Bone Joint Surg Am*. 1984;66:260-268.
19. Iannacone WM, Bennett FS, DeLong WGJ, Born CT, Dalsey RM. Initial experience with the treatment of supracondylar femoral fractures using the supracondylar intramedullary nail: a preliminary report. *J Orthop Trauma*. 1994;8:322-327.
20. Moed BR, Watson JT. Retrograde intramedullary nailing, without reaming, of fractures of the femoral shaft in multiply injured patients. *J Bone Joint Surg Am*. 1995;77:1520-1527.
21. Tornetta PR, Tiburzi D. Antegrade or retrograde reamed femoral nailing. A prospective, randomised trial. *J Bone Joint Surg Br*. 2000;82:652-654.