

L.J. Domingo · D. Cecilia · A. Herrera · C. Resines

## Trochanteric fractures treated with a proximal femoral nail

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**Abstract** We followed prospectively 295 patients with trochanteric fractures treated with the proximal femoral nail. The average age of the patients was 80 years and three out of four were female. The most frequent fracture type was A2 (59%). Clinical and radiographic controls were performed at 1, 3 and 6 months. There were technical complications during the operation in 12% of the cases, complications in the immediate postoperative period in 27% and late complications were detected in 4% of patients. Previous walking ability was recovered by 71%. The surgical technique is not complex, the number of complications recorded was acceptable and the overall results obtained are comparable with other fracture systems.

**Résumé** Nous avons suivi 295 patients avec des fractures trochantérienne traitées avec un Clou Fémoral Proximal. L'âge moyen était 80 ans et 3/4 des patients étaient des femmes. Les fractures ont été classifiées avec le système AO, la plus courante étant du type A2 (59%). Des contrôles cliniques et radiologiques ont été effectués 1, 3 et 6 mois après l'intervention. On a enregistré des complications techniques pendant l'opération dans 12% des cas, des complications postopératoires précoces dans 27% et des complications tardives dans 4% des cas. 71% des patients ont récupéré la déambulation précédente. La technique opératoire n'est pas difficile, le nombre des complications est acceptable et les résultats globaux obtenus sont comparables à ceux obtenus avec d'autres matériels pour le traitement de ce type de fractures.

L.J. Domingo (✉) · A. Herrera  
Orthopaedic Surgery and Traumatology Service,  
'Miguel Servet' University Hospital, Zaragoza, Spain  
e-mail: ljdomingo@jazzfree.com  
Tel.: +34-976-553175

D. Cecilia · C. Resines  
Orthopaedic Surgery and Traumatology Service, '12 de Octubre'  
University Hospital, Madrid, Spain

L.J. Domingo  
C/ Menéndez Pidal, no. 3, 8° dcha., 50009 Zaragoza, Spain

### Introduction

A new system of intramedullary nailing that does not require full reaming has recently been introduced by AO/ASIF. The proximal femoral nail (PFN) presents biomechanical modifications compared to existing systems, in an attempt to minimise the technical complications. This study presents our experience in the treatment of peri- and intertrochanteric fractures of the femur.

### Materials and methods

Between 1996 and 1998 we studied prospectively 295 hip fractures treated with PFN in the Orthopaedic Surgery and Traumatology Services of the Miguel Servet University Hospital (Zaragoza) and the 12 de Octubre University Hospital (Madrid) with a mandatory follow-up period of at least 6 months. The fractures were classified according to the AO system. Clinical and radiographic controls were performed at the time of hospital admission and at 1, 3 and 6 months postoperatively, the corresponding protocol being completed at the same time.

In the documentation for each case, characteristics of the patient were noted (age, sex, concomitant illnesses, previous walking ability), along with the characteristics of the fracture, details of the surgical procedure and of the immediate postoperative radiological controls. Early and late intra- and postoperative complications were also recorded, as were the final clinical and radiographic results achieved after a follow-up of 6 months. Antithrombotic prophylaxis was given, using low molecular weight heparin (Enoxaparina) and antibiotic prophylaxis was provided with second-generation cephalosporin (Cefonicid). There were nine pathological fractures. The operation was performed with the patient on a traction table – under imaging control, which followed the general instructions of the manufacturer.

### Results

The average age of the patients was 80.1 years (76% of the cases were female). Fractures were classified according to the AO system [11], the most frequent type encountered being the A2 (59%), followed by A1 (26%) and A3 (15%). The degree of osteoporosis was recorded, using the scale of Singh et al. [13], with 70% of the cases being in levels III and IV.

**Table 1** General complications encountered during the study

Complications	Cases
Decubitus ulcer	10
Acute postoperative mental confusion	30
Gastro-intestinal haemorrhage	1
Urinary infection	13
Pulmonary embolism	3
Acute renal insufficiency	1
Deep vein thrombosis	3

**Table 2** Local technical complications

Complications	Cases
Early local	
Fracture of greater trochanter at nail insertions	9
Seroma	47
Haematoma	29
Superficial infection	3
Deep infection	1
Late local	
“Cut-out off”	4
Secondary varus (>10°)	12
Muscle pain (due to point effect)	8
Calcifications in apex of trochanter	13
Diaphyseal fractures (beneath the nail)	1

The average perioperative period was 4.5 days, 32% of patients were operated on within the first 48 h and 30% after more than 1 week. The average duration of the operation recorded was 44 min. In all cases closed reduction was achieved and the nail was inserted with no need to ream the femoral diaphysis. The average time required for consolidation was 12 weeks. There were four cases of delayed consolidation but no pseudoarthroses. In 248 fractures (84%) the reduction as achieved in the operating theatre was within 10° of varus/valgus compared to the contralateral femur. In 32 cases (11%) there was an average shortening of the fractured limb of 5 mm.

General complications occurring in the immediate postoperative period are listed in Table 1 and local technical complications are reflected in Table 2. There were technical complications during the operation in 12% of the cases, although it should be noted that the majority arose in the early cases and the frequency diminished with the learning curve and with the improvements in instrumentation.

The most frequent complications were seromas and hematomas of the surgical wound, which resolved satisfactorily in all cases. Superficial or deep infections also evolved favourably, once the appropriate antibiotic treatment had been instituted. No breakages or failures due to implant fatigue were seen. Other complications, such as fracture of the greater trochanter during insertion of the nail, or secondary varus were treated conservatively, since they did not imply clinical consequences for the patients in whom they occurred. Three percent of patients presented with pain in the thigh due to the nail point effect.

**Table 3** Pre- and postoperative physical condition of the patients

Physical condition	%
Preoperative	
Walking unaided	45.7
Walking with one stick	37.1
Walking with two sticks/frame	10.8
Wheelchair-bed	6.28
Preoperative mental state	
Normal	37.1
Memory failures	41.7
Moderate dementia	13.1
Severe dementia	8
Preoperative handling of everyday tasks	
Unaided	37.1
Long interval	20
Short interval	21.1
Critical interval	21.7
Recovery of previous function	
A) Physical state	
Recovery	71
No recovery	29
B) Mental state	
Recovery	82.8
No recovery	17.1
C) Handling of everyday tasks	
Recovery	66
No recovery	34

Reoperation was necessary in 10 patients due to technical complications. Each of them presented with unstable fractures, corresponding to AO groups A2 and A3. Of these, there was one case of poor reduction in the intraoperative radiological control, two cases of rotational defects of the limb, four cases of intra-articular protrusion of the screws, two cases where the material was removed due to pain in the thigh and one diaphyseal fracture beneath the tail of the implant due to new trauma. In the case of poor reduction an incorrect placement of the screws was observed, as a result of which the implant was removed, a new closed reduction was performed and a new PFN was placed, with good subsequent progress of the patient. In the cases of malrotation, removal and replacing of the distal screws was sufficient to solve the problem. The cases of cut-out were reoperated with the removal of the PFN, osteosynthesis being achieved by placement of Gamma nails in two cases, DHS in one and Ender nails in one patient. The patient who suffered the diaphyseal fracture was treated with a long Gamma nail.

Attempts to seat the patient were systematically initiated in the first 48 h after surgery and succeeded with good tolerance on average at 3 days. Patients remained hospitalised for an average of 15.4 days. They were encouraged to initiate assisted weight-bearing with crutches or a frame during the first postoperative week, and 43% of patients managed this.

The preoperative condition of the patients in terms of physical condition and walking ability, psychological

state and ability to cope with everyday activities is shown in Table 3. The patient's recovery after suffering the fracture and the operation was also evaluated and 71% recovered their previous walking ability. The overall mortality was 16% (49 patients) with 7% of the deaths occurring while in hospital.

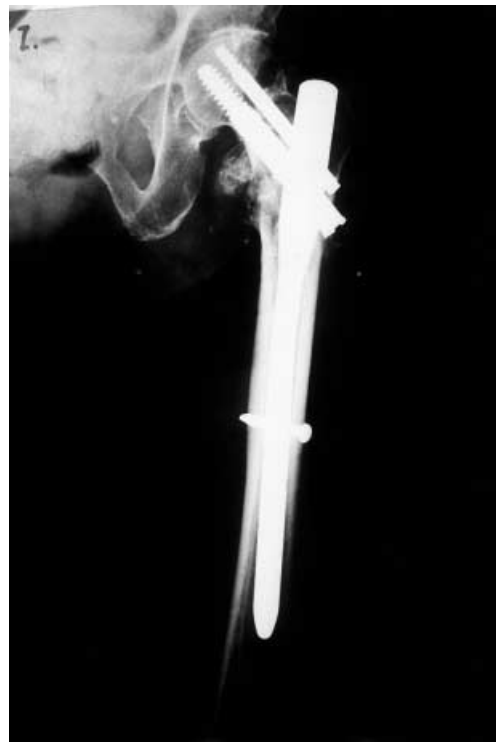
## Discussion

Peri- and intertrochanteric fractures of the femur constitute a common pathology in elderly patients and it was demonstrated several decades ago that surgical treatment reduces morbidity and mortality by permitting early mobilisation and reduction of the risks of prolonged bed rest for the elderly patient [14]. However, the ideal osteosynthesis system for the fixation of these fractures, particularly unstable and comminuted, is still controversial.

The Gamma nail is currently the most widely used intramedullary device, since its biomechanical properties permit early loading in very comminuted and unstable fractures, even at the subtrochanteric level. Other theoretical advantages include the need for a smaller incision, reduced surgical time, less dissection of soft tissue and consequently lower risk of infection [11]. However, peri- and postoperative technical complications are common, ranging from 8 to 15% in the majority of series, in some cases necessitating reoperation [12]. Most of the complications are attributable to shortcomings or lack of attention to detail in surgical technique, but others, in our opinion, can be improved by implant design, particularly those due to excessive rigidity and valgus in the nail, as well as to the lack of an anatomical profile. Fractures around or underneath the distal point of the nail, a complication specific to the intramedullary nailing systems, may be due to the stress-shielding phenomenon, point effect, excessive reaming and errors in distal interlocking. Additionally, the existence of a "learning curve" in the surgical technique for the Gamma nail has been demonstrated, which accounts for the appearance of a higher percentage of complications initially, as Halder [5] has indicated. With regard to the sliding screw-plate systems of the DHS type, these present a level of complications of between 3 and 15% depending on the author [1, 7, 9, 10].

In this respect, Parker and Pryor [9] carried out a meta-analysis of publications comparing the Gamma nail to DHS-type systems, including approximately 1,800 peritrochanteric fractures and did not find statistically significant differences in the incidence of proximal protrusion of the cephalic screw, infection or length of stay in hospital. On the other hand, he did find a higher incidence of femoral fracture around the nail point when the Gamma nail was used, not recommending it for routine use in this type of fracture.

In an attempt to solve or at least minimise the complications that present with the use of intramedullary fixation devices, AO/ASIF has recently introduced the PFN, whose main biomechanical innovations include greater



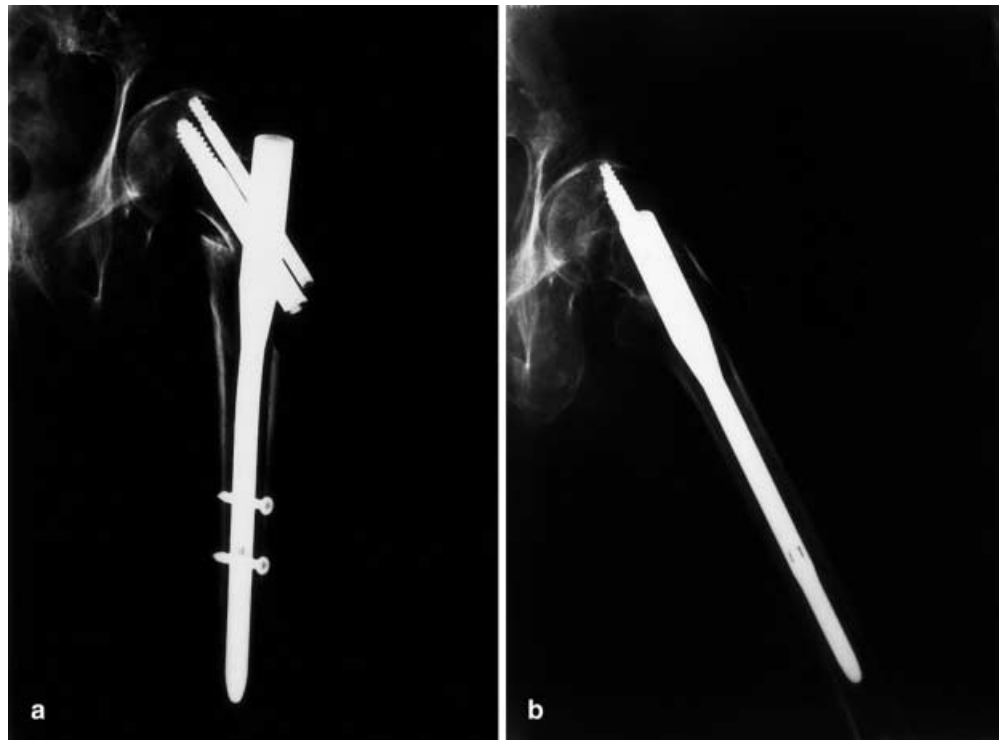
**Fig. 1** Peritrochanteric fracture of the femur satisfactorily treated with PFN. Radiological control at 6 months

implant length (compared to the standard Gamma nail), less valgus in the nail, what angle there is being set at a higher level (11 cm from the proximal end) than in the Gamma nail, the availability of smaller distal diameters and a flexible distal end that reduces the concentration of stresses to a minimum, elimination of the need for diaphyseal reaming in order to introduce it and finally, the possibility of placing an additional antirotational screw in the femoral neck in order to avoid breakdown of the fracture line and rotation of the cervico-cephalic fragment. In this respect it should be borne in mind that during surgery, the cervico-cephalic screw must be adjusted to the calcar, taking into account the need to place the antirotational screw. Fig. 1 shows the radiological control at 6 months of a peritrochanteric fracture treated with PFN with excellent patient progress.

In our study, the overall percentage of complications necessitating reoperation was 3%. Only one diaphyseal fracture was recorded, representing a much lower rate than that published in different studies on the use of the Gamma nail [1, 2, 3, 4, 6, 9], varying between 2 and 12%. The cut-out rate (1.35%) is also lower than that indicated in most of the literature consulted. We believe that the biomechanical improvements introduced with this new implant are the reasons for the reduction in the incidence of technical complications. Fig. 2 show one of the reported cases of cut-out.

With regard to the choice of implants, with increasing experience, we have tended to use progressively smaller diameter nails and to increase the indications for dynam-

**Fig. 2a,b** Cut out, which occurred in a patient with a PFN.  
**a.** AP view. **b.** Axial view



ic set-up. No cases of implant breakage or fatigue fractures have been observed.

We believe, as do other authors [4] that variables such as the duration of hospitalisation, commencement of the sitting posture, early weight-bearing and others are related to the pathology associated with advanced age and the type of fracture, rather than the technique itself. In our study, the percentage of local and systemic complications, mortality rate and the ability to recover previously recorded function are similar to those encountered by other investigators.

In the light of the results obtained from the present study, we believe that the PFN emerges as a valid option for the treatment of femoral fractures of the trochanteric region, because of the simplicity and lack of aggressiveness of the surgical technique and the low level of technical complications encountered, which is particularly important bearing in mind that the large majority of patients who suffer these kinds of fracture are elderly, and their general condition is frequently compromised.

*Statement on conflict of interest* No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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