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A comparative study of trochanteric fractures treated with the Gamma nail or the proximal femoral nail

Accepted: 13 June 2002 / Published online: 31 July 2002
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Abstract The aim of the present paper is to compare the results obtained using two osteosynthesis systems developed for the surgical treatment of fractures of the trochanteric region of the femur, based on the principles of closed intramedullary nailing: the Gamma nail and the proximal femoral nail (PFN). A prospective study is presented of 125 trochanteric fractures of the femur treated with PFN and 125 treated with the Gamma nail in our service between the years 1997 and 2000, with the prerequisite of a minimum follow-up of 1 year. Fractures were classified according to the AO system, the most commonly recorded subtype encountered being the A2. Clinical and radiographic controls were performed upon admission and in the post-operative follow-up at 1, 3, 6, and 12 months, the corresponding assessment protocol being completed on each occasion. Of the 250 patients, 179 were women and the rest men. The average age was 78.9 years. Both systems enabled early mobilisation and walking in most of our patients. There were no significant differences in the use of either nail in terms of the recovery of previous functional capacity, nor in terms of the time required for fracture healing (12 weeks on average). With regard to the more significant technical complications recorded, shaft fractures and the cutting-out phenomenon were more common with the use of the Gamma nail, while secondary varus occurred at a greater rate when using the PFN.

Résumé Nous comparons les résultats obtenus avec deux systèmes d'ostéosynthèse des fractures de la région trochantérienne du fémur, basés sur le principe de l'encolage médullaire à foyer fermé: le clou Gamma et le P.F.N (Proximal Femoral Nail). Une étude prospective est présentée de 125 fractures trochantériennes traitées

avec P.F.N. et 125 avec le clou Gamma dans notre service entre les années 1997 et 2000, avec un suivi minimum de une année. Les fractures ont été classées d'après le système AO, la plus fréquemment rencontrée étant la sous-classe A2. Des contrôles cliniques et radiologiques ont été fait à l'admission et dans les suites opératoires à 1, 3, 6, et 12 mois. 179 des 250 cas étaient des femmes et l'âge moyen était 78.9 années. Les deux systèmes ont permis une mobilisation précoce et la marche pour la plupart de nos patients. Il n'y avait pas de différences notables dans l'usage de l'un et l'autre clou quant à la récupération de la capacité fonctionnelle antérieure, ni quant au temps nécessaire pour la consolidation de la fracture (12 semaines sur moyenne). Quant aux complications techniques enregistrées, les fractures diaphysaires ont été plus fréquentes avec l'usage du clou Gamma, tandis que les varisations secondaires se sont produits à un plus grand taux avec le P.F.N.

Introduction

In unstable trochanteric femoral fractures we find – in common with most authors [3, 7, 10, 12] – the intramedullary nailing systems to be ideal due to their biomechanical and technical advantages. The aim of this paper was to study two different intramedullary nailing systems and compare the results and complications in homogeneous patient groups.

Materials and methods

A prospective randomised study is presented of 125 peritrochanteric fractures of the femur treated with proximal femoral nail (PFN) (Synthes) and 125 the Gamma nail (Howmedica) in our service between 1997 and 2000, with a requirement of a minimum follow-up of 1 year. The fractures were classified using the AO system. Clinical and radiographic controls were performed upon admission and during the post-operative follow-up period at 1, 3, 6 and 12 months, the appropriate assessment protocol being completed on each occasion.

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The documentation protocol of each case included data concerning the basic status of each patient (age, gender, pre-existing illness, previous ambulatory ability), along with the main features of the fracture, details of the surgery and of the immediate post-operative radiological controls. Early and late intra- and post-operative complications were also recorded, as well as the final outcome – both clinical and radiological – with a follow-up period of 1 year.

In the post-operative period, in each case we reviewed the transfusional requirements, length of hospital stay, the point at which weight bearing was initiated and the time to fracture healing. With regard to the results, we studied final walking ability, leg-length discrepancy and axes of the affected limb, along with changes in mental function compared to pre-fracture state. A database was created from the information obtained, and statistical analysis of the results was carried out.

The surgical procedure was carried out with the patient in the supine decubitus position on the orthopaedic traction table and with the injured extremity slightly adducted to facilitate insertion of the nail. In all cases, thromboprophylaxis was administered in the form of enoxaparine, and antibiotic prophylaxis was provided with cefonicid – except in allergic patients, who received teicoplanin.

Results

Average age of patients was 78.9 years; 179 were women. Individual patients were assigned to two groups according to the system of osteosynthesis used in their treatment (Gamma nail or PFN). Previous pathological conditions, types of fracture according to AO classification and American Society of Anesthesiology (ASA) risk in both groups are shown in Table 1. The most common sub-type in the both groups was A2, followed by A1 and A3. Surgical procedures were performed between 1997 and 2000.

Average pre-surgical stay was 2.9 days. General anesthesia was administered to 191 patients and intradural in the remainder. Length of the surgical procedure averaged 49 min for the PFN and 68 min for the Gamma nail – a statistically significant difference ($P < 0.05$).

In the PFN group, patients presented an average haematocrit of 38.1, which dropped to 29.1, 48 h after the operation. Transfusion of packed erythrocytes was necessary in 65 cases, with an average requirement of 1.89 units. In the Gamma nail group, the pre-operative haematocrit of 38.7 dropped to 26.9 post-operatively, with transfusion needed in 47 cases. Statistical comparison of these figures showed transfusional needs to be significantly higher where the Gamma nail was used.

Average healing time was 12 weeks for both groups. Two cases of non-union were recorded in the fractures treated with PFN and one in those treated with the Gamma nail. All cases of non-union coincided with pathological fractures.

The most commonly used PFN implant was of stainless steel, with a diameter of 10 mm and a neck-shaft angle of 130° (Fig. 1). The most frequently implanted Gamma nail had a diameter of 11 mm and a neck-shaft angle of 130° (Fig. 2). In the PFN cases, distal locking was performed with two screws in 26 patients and a single screw in the remaining. The Gamma nail was distally



Fig. 1 AP view of a trochanteric fracture treated with a proximal femoral nail (PFN). Radiological control at 1 month. Correct reduction was achieved and the two lag screws and a dynamic distal lock were placed correctly

Table 1 Previous pathological conditions, types of fracture according to AO classification, and ASA risk in the proximal femoral nail (PFN) and Gamma nail groups (*n* number of patients)

	PFN group (<i>n</i>)	Gamma group (<i>n</i>)
Cardiopathy	39	30
Diabetes	11	15
Chronic obstructive pulmonary disease	16	19
Neoplasia	7	6
Hypertension	48	41
A1 fractures	13	19
A2 fractures	83	79
A3 fractures	28	30
III or IV ASA risk	71	60

locked with two screws in 30 patients, one screw in 92, and left unlocked in the remaining three.

Fracture reduction achieved in the operating theatre was judged to be correct in 221 patients (less than 100 of varus/valgus compared to the opposite femur). There was no significant difference between the groups.



Fig. 2 AP view of a trochanteric fracture treated with a Gamma nail. Radiological control at 3 months

Complications encountered in the post-operative period are listed in Table 2. The most common in both groups were seromas and haematomas of the surgical wound, which resolved satisfactorily in all cases. The cases of superficial or deep infections also evolved favourably once antibiotic treatment was instituted. Overall, in 15 patients a second operation was necessary for technical reasons – six from the PFN group and nine from the Gamma nail group. All presented unstable fractures of A2 and A3. Specifically, they were two cases of poor reduction in the immediate radiological control, three of malrotation of the limb, six of intra-articular protrusion of screws, and four shaft fractures below the tail of the implant due to further trauma. One case with poor reduction is shown in Fig. 3 in which the lag screws were incorrectly placed. The implant was removed and a new reduction was performed followed by insertion of a PFN. The subsequent progress of the patient was good. In the cases with malrotation, replacement of the distal screws was sufficient to solve the problem. The cases with cut-out were re-operated using new implants. The shaft fractures were treated using long Gamma nails.

No failures or breakages due to fatigue were seen in the implants. Other complications reported, such as frac-

Table 2 Overall complications in the proximal femoral nail (PFN) and Gamma nail groups

	PFN group	Gamma group
Decubitus ulcers	11	9
Acute post-operative mental confusion	15	20
Digestive haemorrhage	0	1
Urinary infection	8	6
Pulmonary embolism	2	1
Acute kidney failure	1	2
Early local complications:		
Seroma	19	21
Haematoma	17	13
Superficial infection	3	4
Deep infection	1	0
Greater trochanter fracture at nail insertion	5	*19
Re-operation for poor reduction	2	0
Re-operation for rotational defect of the leg	2	1
Late local complications:		
Cutting-out	1	*5
Secondary varus (>10%)	*9	2
Muscle pain (due to point effect)	4	7
Calcifications on apex of trochanter	6	8
Fracture site collapse due to screw migration	*10	4
Diaphyseal fractures (beneath the nail)	0	*4

* Statistically significant difference ($P < 0.05$)

tures of the greater trochanter upon insertion of the nail or secondary varus, were all treated conservatively. Four patients in the PFN group and seven in the Gamma nail group presented pain in the thigh due to the point effect.

Attempts were systematically made to have all patients adopt a sitting position within the first 48 h after surgery, and this was achieved with good tolerance after an average of 4 days. Patients remained hospitalised for an average of 14.1 days. They were encouraged to try weight bearing with the aid of crutches or a frame during the first post-operative week, and 100 patients achieved this. By the second week, 160 achieved it, and in the course of the third week, 188 were successful. Recovery following fracture and surgery was also evaluated. Sixty-two of the patients treated with the PFN and 64 treated with the Gamma nail completely recovered their previous walking ability, while the remainder suffered some deterioration in this ability, usually going from unassisted walking to the use of one stick in the majority of cases. There were no significant differences between the two groups either in their pre-operative situation or in the recovery of their previous functional ability.

Death occurred in 53 patients during the total follow-up period; 24 had been treated with Gamma nails and 29 with PFN. In 11 cases, death occurred during the immediate post-operative period and in 42 during the first post-operative year due to causes unrelated to the fracture. The differences in terms of mortality between the groups of patients treated with one or the other osteosynthesis systems were not significant.



Fig. 3 AP view showing poor reduction with a proximal femoral nail (PFN). The patient was re-operated

Discussion

Both systems showed themselves to be effective for the treatment of this type of fracture. Results in terms of the time required to achieve fracture repair were similar. Nor were any significant differences noted with regard to overall complications and recovery of previous functional ability. These features essentially depend on the prior comorbidity and pre-operative functional status of the individuals and not on the osteosynthesis system used [5, 10].

Operating times and peri-operative blood loss were lower in the PFN group, and we attribute this to the fact that reaming is not necessary for the placement of this nail. In both systems, a similar tendency was observed by the surgeons – being attributed to the use of nails of a progressively smaller diameter and more dynamic constructs, as Boriani [1] recommends.

With regard to early local complications associated with the osteosynthesis system used, fractures of the trochanter are more frequent with the Gamma nail, which, in our opinion, is explained by the need to ream, and by the insertion point of the nail required by the greater valgus axis.

Among late local complications there was a higher incidence of the cutting-out phenomenon with the Gamma nail, which we believe to be due to the greater rigidity of the femoral neck screw-nail assembly, due to the effect of the proximal locking screw. The type of distal locking might also have an influence, by not permitting the dynamization of the fracture site. However, in the case of the PFN group, a higher incidence of external migration of the femoral neck screw and anti-rotational screws was noted, with collapse of the fracture site. This would explain why, with this nail, a discrete loss of reduction is more common, giving rise to a higher rate of secondary varus, even though this phenomenon did not present subsequent clinical problems in any of our cases.

By the same token, cases of pain in the thigh due to the point effect, and the incidence of fractures below the nail, were greater in the Gamma nail and statistically significant, while also related to the greater valgus and rigidity of the construct [8, 11]. The percentage of diaphyseal fractures recorded when using the Gamma nail was 3.2%, similar to the findings of most authors [2, 4, 6] and there were no diaphyseal fractures when using PFN.

The PFN seems to us to be a more dynamic system with a lower incidence of local and late complications [5, 9, 12]. However, it does have – at least from what we observed in our patients – the technical difficulty of correctly placing the two screws in the femoral neck, particularly since most of our patients were short women with a small femoral neck. This necessitated adjustments when tracing the position of the femoral neck screw in order to place the anti-rotational one. This circumstance, on certain occasions, obliged us to reposition the nail during surgery (advancing it into or withdrawing it slightly from the shaft), with the occasional loss of a certain amount of the initial reduction in the course of these manoeuvres.

The problems detected in the Gamma nail due to the need for reaming and its somewhat excessively valgus design (a 10° angle compared to 6° of the PFN) have led the manufacturers to change the design of the system, with the appearance of the new trochanteric range nails, which do not require reaming before insertion and have a valgus angle of only 4°. At present, this trochanteric range nail has substituted the regular Gamma nail in our service, and the preliminary results are very satisfactory.

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