



Implant breakage, a rare complication with the Gamma nail A review of 843 fractures of the proximal femur treated with a Gamma nail

Diego BERTRAND ÁLVAREZ, José PAZ APARICIO, Esteban LÓPEZ-ANGLADA FERNÁNDEZ, Ignacio GONZÁLEZ-BUSTO MÚGICA, Daniel NÚÑEZ BATALLA, José PAZ JIMÉNEZ

From the University Central Hospital of Asturias, Oviedo, Spain

Internal fixation with a Gamma nail, in its short and long versions, is an excellent surgical technique for intertrochanteric and subtrochanteric fractures of the femur. A stable osteosynthesis is obtained which allows early mobilisation and promotes healing of the fracture. However, it is not free from complications ; many of them are due to poor surgical technique and/or inadequate monitoring. Breakage due to fatigue of the material is an exceptional complication. A review of 843 cases operated in our department between 1990 and 2002 was made. Five cases of implant breakage were found. Non-union of the fracture appears to be the primary cause. The weakest point of the Gamma nail is the opening for the cervical screw. The optimal treatment will depend on each particular case. The possibility of dynamisation of the construct should be considered when delayed healing is suspected.

INTRODUCTION

Fractures in the trochanteric region of the femur are the most frequent involving the hip (18, 21). Their importance is the result of three main factors : the number of intertrochanteric fractures, which is increasing as the mean age of the population increases, and may continue increasing in the next decade ; the high morbidity and mortality that follows these fractures, and the social and economic cost that this represents (5, 17, 22). All this makes the surgical treatment of these fractures a current and

relevant topic as well as the object of numerous reviews and debates among the orthopaedic community. The goal of treatment, for which many devices are available, is to achieve a stable osteosynthesis with a surgery as little aggressive as possible, capable of obtaining a prompt sitting position and weight-bearing (14).

The Gamma nail, (Howmedica, Rutherford, NJ, USA) (12), in its two versions of trochanteric nail and long Gamma nail, is one of the devices most used in the treatment of intertrochanteric and subtrochanteric fractures of the femur. It achieves

-
- Diego Bertrand Álvarez, MD, Registrar.
 - José Paz Aparicio, MD, Orthopaedic Surgeon.
 - Esteban López-Anglada Fernández, Orthopaedic Surgeon.
 - Ignacio González-Busto Múgica, MD, Orthopaedic Surgeon.
 - Daniel Núñez Batalla, MD, Orthopaedic Surgeon.
 - José Paz Jiménez, MD, Professor of Trauma and Orthopaedics, Chairman.

Department of Trauma and Orthopaedic Surgery, University Central Hospital of Asturias, Oviedo, Spain.

Correspondence : Diego Bertrand Álvarez, Av. Pedro Masaveu nº1, 5ªA. 33007. Oviedo. Asturias, Spain.

E-mail : dbertrandalvarez@yahoo.es.

© 2004, Acta Orthopædica Belgica.

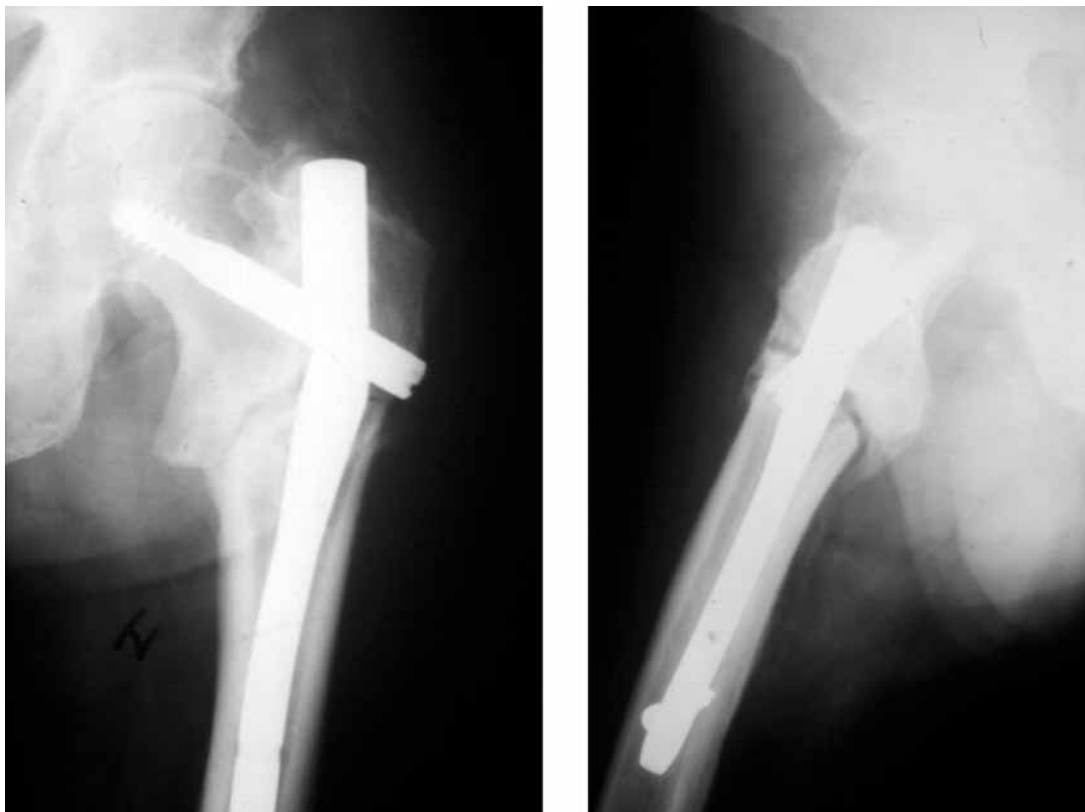


Fig. 1. — Intertrochanteric fracture seven months after implanting a short Gamma nail (case 1). Nonunion at the fracture site may be seen, as well as breakage of the nail at the opening for the cervical screw. To the right, the axial projection.

excellent results in terms of fracture healing, as well as reduced bleeding and infection, as it is implanted through a relatively limited approach. It achieves stable fixation, which allows for early mobilization. Depending on the type of fracture, it is possible to carry out two types of proximal locking : static and dynamic ; the latter permits sliding of the cervical screw over the nail, as well as interfragmentary compression during weight-bearing. In addition there is the option of blocking the nail distally, to prevent rotation.

However Gamma nailing is not free of complications. A rare complication of this type of nail, of which there are very few cases described in the literature (1-4, 6, 10, 15, 16, 20, 23), is implant breakage due to fatigue of the material. Five cases are presented, which occurred over a total of 843 operated in our Department between 1990 and 2002. The purpose of this study is to discuss the causes which

may lead to this complication and the different aspects of its treatment.

MATERIALS AND METHODS

We made a retrospective study of 843 cases which were operated in our institution between 1990 and 2002. The clinical cases of implant breakage that we found are described below.

RESULTS

Case 1

The patient was an 87-year-old male with a good life quality, previously able to walk with a cane, who presented an unstable intertrochanteric fracture of his left femur, Kyle and Gustilo type III (13) following a fall at home. He underwent surgical

fixation of his fracture with a short trochanteric Gamma nail, with a cervicodiaphyseal angle of 130° and a distal diameter of 11 mm. The cephalic screw was 90 mm long ; proximal static locking was performed. Postoperative radiographs showed acceptable reduction of the fracture.

Seven months later, the patient started complaining of permanent pain in his left hip, which became more severe over a few days, resulting in complete disability. He did not recall any trauma or unusual efforts. On physical examination, there was pain on palpation of the left trochanter as well as on mobilisation, particularly in rotation. The surgical wound was unremarkable.

Radiographs showed breakage of the nail, at the opening for the cervical screw (fig 1), resulting in an angulation between the nail and the cephalic screw. The fracture showed no signs of healing ; the fracture line was still visible, with sclerosis of the bone ends, typical for a nonunion.

The broken nail was removed and a long Gamma nail was implanted with proximal dynamic locking and no distal locking. Early weight-bearing was encouraged. Twelve weeks later, radiographs showed healing of the fracture (fig 2).

The patient is presently asymptomatic, walking with a cane.

Case 2

The patient was a 25-year-old male who was injured in a traffic accident. On admission he presented facial trauma with multiple wounds, fracture of the pelvic ring, of the left humeral diaphysis, of the left lateral tibial plateau and a transcervical fracture, as well as a grade II open comminuted diaphyseal fracture of the left femur. A long Gamma nail with a cervicodiaphyseal angle of 130° and a diameter of 11 mm was implanted in the left femur, with two distal screws and static proximal locking (fig 3). Weight-bearing with a walker was allowed only after three months, because of the severity of the fracture. After four and a half months the patient was able to walk with a crutch, and after six months and a half he could walk with full weight bearing. Radiographs at four months showed healing of the cervical fracture, but delayed



Fig. 2. — The patient in case 1 was re-operated, retrieving the broken Gamma nail and replacing it with a long Gamma nail with no distal locking. Three months after surgery, radiological examination shows healing of the fracture.

union of the diaphyseal fracture. Clinically the patient was feeling well and on physical examination, he presented a 1.5 cm shortening of the limb, which he corrected with a heel lift.

Ten months after the surgery, he felt sudden pain in his left thigh while walking. Physical examination revealed severe pain on mobilisation of the left hip and knee. There were no apparent deformities. Radiographs (fig 3) showed nonunion at the fracture site, as well as breakage of the nail. The nail was removed and a new osteosynthesis was made with a 12-hole AO plate and autologous grafts. The patient was allowed to walk non-weight bearing with crutches. Two and a half months after the second surgery, he suddenly felt severe pain in the thigh, and radiographs showed rupture of the plate, and persisting nonunion of the underlying fracture.



Fig. 3. — Radiological findings ten months after implanting a long Gamma nail in case 2. Nonunion of the diaphyseal fracture and breakage of the nail can be seen (left and centre images). The option chosen was to use a Kuntscher nail plus autologous bone graft, achieving consolidation of the fracture (right image).

The broken plate was removed, the medullary canal was reamed, the fracture ends were freshened and the fracture was fixed with a 12 mm Kuntscher nail ; autologous grafts were packed around the fracture site (fig 3). Radiological healing of the fracture was obtained four months later. The patient is currently asymptomatic, walking without a cane, but with a 1 cm heel lift on the left side

Case 3

The patient was a 79-year-old woman with an inter- and subtrochanteric fracture of the right femur, Kyle and Gustilo type IV (13), following a fall. A 130° Gamma nail, 11 mm in diameter, was implanted, distally locked by a 30-mm screw. Surgically this was a high-risk patient because she had high blood pressure, type II diabetes, pachy-

pleuritis with a severe restrictive respiratory syndrome, as well as chronic renal failure, depression and a severe stenosis of the aortic valve. Nonetheless the postoperative period was uneventful. She started walking with a walker on the tenth day and was transferred to the rehabilitation department 17 days after operation, walking with two crutches.

Seven months after surgery, she came to the office, complaining of mid-thigh pain over the past three months, which has worsened in the last few weeks. Radiographs showed breakage of the nail at the proximal opening for the distal locking screws, as well as nonunion of the fracture (fig 4). The nail was removed. ; it was necessary to open de femoral diaphysis to remove the distal fragment. A 130° long Gamma nail, 11 mm in diameter, with dynamic proximal locking, was implanted with autologous grafts at the inter- and subtrochanteric



Fig. 4. — Radiological examination 8 months after implanting a Gamma nail in case 3. The nail is ruptured at one of the openings for the distal locking screws.

fractures. Healing of the fracture was achieved after three months, and the patient recovered her previous functional level.

Case 4

This 75-year-old female patient presented with a very unstable inter- and subtrochanteric fracture with an inverted fracture line. A long Gamma nail was implanted with static proximal and distal locking. She was allowed to sit 3 days after surgery and to bear weight with a walker after 3 weeks. The evolution was favourable and the patient was able to walk with two crutches. Eight months after surgery, she fell once again. She complained of pain and inability to walk and to stand. Radiographs showed breakage of the Gamma nail, at the opening for the cervical screw and the distal blocking screw (fig 5), and nonunion of the fracture. The broken nail was removed (fig 6) and a long Gamma nail was implanted, without distal locking. The fracture healed without any complications in 12 weeks (fig 5). After two years the patient is able to walk on her own with a crutch.

Case 5

The patient was a 60-year-old woman with an inter- and subtrochanteric fracture of her left femur, treated with a short 130° Gamma nail, 11 mm in diameter, with distal and proximal static locking. Weight-bearing with crutches was deferred until the third week. The evolution was favourable until the seventh month, when the patient started complaining of pain and disability in her hip. Radiographs showed breakage of the implant at the opening for

Table I. — Clinical features of five cases of Gamma nail breakage

	Case 1	Case 2	Case 3	Case 4	Case 5
Age	87	25	79	75	60
Sex	male	male	female	female	female
Fracture side	left	left	right	right	left
Fracture type	III*	femoral neck + femoral shaft	IV*	IV*	IV*
Treatment	short nail	long nail	short nail	long nail	short nail
Findings	nonunion	nonunion	nonunion	nonunion	nonunion
Place of failure	proximal Opening	half nail	distal opening	prox opening + distal screw	proximal opening
Failure time	7 months	10 months	7 months	8 months	6 months
New device	long nail	Küntschner nail	long Gamma	long Gamma	THR

* following Kyle and Gustilo classification (13).



Fig. 5. — Case 4. Breakage of a long Gamma nail at the opening for the cervical screw. The distal locking screw is broken as well (left). To the right, consolidation of the fracture twelve weeks after implanting a long Gamma nail with no distal locking.

the cervical screw (fig 7). Nonunion was noted at the fracture site as well as incomplete insertion of the distal locking screw. Due to the young age of the patient, her excellent general condition, and the poor quality of the bone, total hip arthroplasty with cement was done (fig 7). The patient is currently asymptomatic.

DISCUSSION

Breakage of a Gamma nail due to fatigue is an extremely rare complication. The reported incidence of this complication ranges from 0.2% to 5.7% (2, 3, 6, 15). In our experience, the rate is 0.59%. Despite its strength, the Gamma nail only allows several hundred thousand cycles of weight-bearing, following which the implant may break from fatigue of the material if the fracture has not

healed. Very few cases have been described in the literature (1-4, 6, 10, 15, 16, 20, 23). What outstands from our cases is the fact that the breakage of the material occurred at three different points of the nail. None of our cases was a pathological fracture, a situation in which nail breakage has been noted to occur more frequently (16, 20). Only in case 3, was there a previous trauma.

A weak point in the Gamma nail seems to be around the opening for the cephalic screw (case 1 and 5), where the cross section narrows, approximately by 73% (23). This is the critical zone where forces coming from the femoral neck are transmitted to the diaphyseal nail (19, 20). If the guide for the cervical screw is not properly placed, inappropriate drilling of the nail, or off-centre introduction of the cervical screw may cause erosion of the nail in the cervical opening (19).



Fig. 6. — Retrieved broken nail in case 4. Showing breakage of the nail proximally and distally as well as the distal locking screw which was removed with great difficulty.

Another weak point of the Gamma nail structure is the opening for the distal locking screw where the diameter of the nail is also reduced (8). The breakage in cases 3 and 4 was at this level.

All of the cases occurred in unstable fractures with complex fracture lines. The type of fracture in which this complication is most frequent is Kyle and Gustilo type IV (cases 3, 4 and 5). Nonunion at the fracture site (in 100% of the cases) is the trigger factor. It is favoured by the excessive rigidity of the system with a static proximal and distal locking (7, 9-11, 13, 19, 20). The breakage pattern noted in case 2 has not been described in the available literature. The cause may be the outcome of the high mechanical stresses which this complex patient with a double fracture in his left femur was subjected to. As a result of healing of the femoral neck fracture and nonunion of the shaft fracture,

mechanical stresses were shifted towards the diaphyseal area; since, in this case, a long Gamma nail was used, locked distally with two screws, the weak point of the implant was protected, further overloading the part of the nail close to the nonunion.

Table I shows a comparison of the characteristic features of the 5 cases.

This complication usually occurs late, 6 to 10 months after surgery. Thus, the possibility of the implant being broken when there is recurring pain at the operated hip or even more frequently at the thigh, must be taken into consideration. Special attention must be paid to those cases with pathological fractures (16, 20). We recommend taking radiographs of the operated hip in two different projections in the follow-ups, and the option of dynamisation of the device and/or bone grafting must always be considered when delayed union is suspected.

The options for treatment will depend on each particular situation. Retrieving the implant may be very difficult, especially the distal fragment of the broken nail. It may be necessary to open a window in the diaphyseal cortex (case 3). For this reason, we recommend a careful preoperative planning and rigorous technique that will avoid problems with the screws, both proximal and distal; as well as restricting the indications of the distal locking to only very unstable fractures or cases with a subtrochanteric fracture. Regarding nonunion there are many opinions in that respect. In cases 1 and 4 the broken implant was removed and replaced by a long Gamma nail with dynamic proximal locking and no distal locking. The long Gamma nail thus allows for early weight-bearing, and since it is implanted with no distal locking (dynamic device) it submits the fracture to compression when ambulating thus encouraging healing of the fracture. We opted for this solution in case 3, in addition to bone grafting. In case 2, we opted for a dynamic assembly with a Küntscher nail and bone grafts. In case 5, as the patient was relatively young (60 years) and owing to the poor quality of the bone, we opted for a total cemented hip arthroplasty. In all of the cases the clinical and the radiological final results were excellent.



Fig. 7. — Breakage at the opening for the cervical screw in case 5. The distal locking screw is not inside the opening in the nail (left). The patient underwent a cemented total hip arthroplasty (right).

CONCLUSIONS

1. Breakage of the Gamma nail due to fatigue is a very rare complication.
2. It occurs 6 to 10 months after surgery.
3. It is a consequence of nonunion at the fracture site.
4. It occurs more frequently when there is a complex fracture line, Kyle and Gustilo type IV (13).
5. The weakest point of the Gamma nail is the opening for the cervical screw. Breakage occurred at this level in three of our five cases (60%).
6. In the radiological follow-up, films should always be taken with two projections of the hip.
7. The device should be dynamised when delayed healing of the fracture is suspected.
8. The best therapeutic option will depend on each particular situation.
9. In our series, the most frequent treatment after fatigue failure of a Gamma nail was osteosynthesis with a long Gamma nail with no distal locking screws.

BIBLIOGRAPHY

1. Barquet A, Francescoli L, Rienzi D, Lopez L. Intertrochanteric-subtrochanteric fractures : treatment with the long Gamma nail. *J Orthop Trauma* 2000 ; 14 : 24-328.
2. Boriani S, Bettelli G, Zmerly H, et al. Results of the multicentric Italian experience on the Gamma nail : a report on 648 cases. *Orthopedics Int Ed* 1991 ; 14 : 1307-1314.
3. Boriani S, de Iure F, Betteli G. The results of a multicenter Italian study on the use of the Gamma nail for the treatment of pertrochanteric and subtrochanteric fractures : a review of 1181 cases. *Chir Organi Mov* 1994 ; 79 : 193-203.
4. Calero Ferrándiz R, López Viñas F, Vidal Roig E, Mut Oltra T. Clavo de bloqueo Gamma. Experiencia inicial y resultados. *Rev Esp Cir Osteoart* 1997 ; 32 : 120-127.

5. **Cummings SR, Rubin SM, Black D.** The future of the hip fractures in the United States : numbers, costs and potential effects of postmenopausal estrogen. *Clin Orthop* 1990 ; 252 : 163-166.
6. **Docquier PL, Manche E, Autrique JC, Geulette B.** Complications associated with Gamma nailing. A review of 439 cases. *Acta Orthop Belg* 2002 ; 68 : 251-257.
7. **Ferrer Blanco M, Casteleiro González R, Matas Díaz JA.** Tratamiento de las fracturas de la región trocantérea con clavo Gamma. Revisión de 116 casos. *Rev Esp Cir Osteoart* 1994 ; 39 : 99-103.
8. **Gaebler C, Stanzl-Tschegg S, Tschegg EK, et al.** Implant failure of the Gamma nail. *Injury* 1999 ; 30 : 91-99.
9. **Garbayo Marturet AJ, Martínez Mariscal J, Repáraz Padrós J, Rebollo Álvarez E, Muñoz Arribillaga J.** Clavo Gamma. Indicaciones, resultados y complicaciones. *Rev Esp Cir Osteoart* 1997 ; 32 : 49-56.
10. **Goldhagen PR, O'Connor DR, Schwarze E.** A prospective comparative study of the compression hip screw and the Gamma nail. *J Orthop Trauma* 1994 ; 8 : 367-372.
11. **Halder SC.** The Gamma nail for peritrochanteric fractures. *J Bone Joint Surg* 1992 ; 74-B : 340-344.
12. **Kempf I, Grosse A, Beck G.** Closed locked intramedullary nailing. *J Bone Joint Surg* 1985 ; 67-A : 709-719.
13. **Kyle RF, Gustilo RB, Premer RF.** Analysis of six hundred and twenty-two intertrochanteric hip fractures. *J Bone Joint Surg* 1979 ; 61-A : 216-221.
14. **Müller ME, Nazarian S, Koch P, Schatzker J.** *The comprehensive Classification of Fractures of long Bones.* Springer-Verlag, Berlín. Heidelberg. New York, 1990.
15. **Pervez H, Parker MJ.** Results of the long Gamma nail for complex proximal femoral fractures. *Injury* 2001 ; 32 : 704-707.
16. **Randle JA, Meisami-Fard B, McKee MD.** Mechanical failure of a Gamma nail in a patient with an impending pathologic subtrochanteric fracture. *Can J Surg* 1999 ; 42 : 384-386.
17. **Richard F, Kyle MD.** Fracturas de cadera. In : Gustilo RB, Kyle R, Templeman D, coord. *Fracturas y Luxaciones.* 1st ed (esp). Madrid : Mosby/ Doyma libros, 1995 : pp 829-840.
18. **Rubio Suárez JC.** Tratamiento quirúrgico de las fracturas pertrocanterias del fémur mediante tornillo deslizante-placa. In : Munuera L, ed. *Osteoporosis y Fracturas.* 1st ed. Barcelona : Masson, 2000 : 126-142.
19. **Seral B, Albareda J, La Sierra JM, Seral F.** Estudio clínico de la osteosíntesis intra y extramedular en las fracturas trocantéreas de cadera. *Rev Ortop Traumatol* 2001 ; 5 : 374-383.
20. **Van den Brink WA, Janssen MC.** Failure of the Gamma nail a highly unstable proximal femur fracture : Report of four cases encountered in the Netherlands. *J Orthop Trauma* 1995 ; 9 : 53-56.
21. **Vasallo Prieto JL.** Fracturas trocantéreas. In : Sánchez Martín coord. *Traumatología del Aparato Locomotor.* 1st ed. Valladolid : Hergar SL, 1996 : pp 351-370.
22. **Vicario Espinosa C, Marco Martínez F, Domínguez Esteban I, López Durán L.** Tratamiento en el anciano de las fracturas de la región trocantérea femoral con clavo intramedular Gamma. *Rev Ortop Traumatol* 2000 ; 44 : 434-438.
23. **Zafiroopoulos G, Pratt DJ.** Fractured Gamma nail. *Injury* 1994 ; 25 : 331-336.