

Results of Treatment of Subtrochanteric Femoral Fractures with the AO/ASIF Long Trochanteric Fixation Nail (LTFN)

Výsledky léčení subtrochanterických zlomenin femuru pomocí AO/ASIF Long Trochanteric Fixation Nail (LTFN)

E. MUÑOZ-MAHAMUD, G. BORI, J. CUÑÉ, L. FONT, A. DOMINGO, S. SUSO

Department of Orthopaedic and Trauma Surgery, Hospital Clinic of Barcelona, University of Barcelona, Barcelona, Spain

ABSTRACT

PURPOSE OF THE STUDY

This retrospective study reports on the clinical results of a group of 23 patients with subtrochanteric femoral fractures using the Long Trochanteric Fixation Nail (LTFN).

MATERIAL

Between January 2005 and January 2008, 23 patients (20 women, 3 men; average age: 64.8 years old) with subtrochanteric femoral fractures were treated surgically. According to the AO/ASIF Classification, the most frequent fracture type was an 32-A1. They were also classified regarding the Seinsheimer Classification, in which the commonest type was the IIB. Of the 23 fractures, 14 of them had been the result of an unexpected fall, 2 were the result of a high-energy trauma and 7 consisted of pathologic fractures.

METHODS

All the patients were treated using the LTFN device and they all received clinical and radiological follow-ups at least until their fractures were consolidated. The average surgery time, average decrease in haemoglobin in the first 24 hours post-surgery, average need for red blood cell transfusion, postoperative mortality at a 6th month follow-up, time to autonomous deambulation, most frequent destination at the time of discharge, average time for consolidation of the fracture and average follow-up time were reported. Intraoperative and postoperative complications were also recorded.

RESULTS

The average surgery time from cut to stitch was 97.45 minutes with the decrease in haemoglobin averaging 26.45 g/L and, on average, the need for red blood cell transfusion was 1.12 concentrates. In the first postoperative week, 57.1% of the total number patients were capable of deambulation. The time to hospital discharge was 12.9 days. After an average follow-up of 13.9 months, total weightbearing was achieved in the 64.7% of the patients. The average consolidation time was 21.6 weeks and none of the patients developed pseudoarthrosis. Technical failures were seen in 4.3% of the cases: 1 patient suffered a migration of the distal locking screw. There were no cases of deep infection, cut-out, bending/breaking of the implant, malrotation or fracture of the femoral shaft at the tip of the implant.

DISCUSSION

From a mechanical point of view the use of a long intramedullary nail in combination with a blade or a screw seems to be the most appropriate treatment for subtrochanteric fractures of the femur. Despite the improvement of implants and surgical techniques, failures due to complications are still considerable. The low distal shaft diameter of the LTFN, in combination with an extremely precise positioning of the blade in the middle of the femoral head, can prevent mechanical complications. Open reduction and cerclage cabling may be required so as to obtain a correct alignment of the fracture.

CONCLUSION

We conclude that the LTFN is a safe and reliable intramedullary device for the treatment of subtrochanteric fractures of the femur. Deambulation within the first postoperative surgery is possible when positioned properly. Its implantation requires more surgical time than the standard nails.

Key words: subtrochanteric fractures, femur, Long Trochanteric Fixation Nail (LTFN).

INTRODUCTION

It is projected that a dramatic increase in the elderly population will lead to a higher incidence of osteoporosis. As a consequence, the number of subtrochanteric fractures of the femur is expected to rise in the coming years. Subtrochanteric femoral fractures are not easy to treat successfully. Despite the improvement of implants, complication rates account for 10-20% of the total failures (3, 4, 7, 23, 24, 25, 27). Implant failures mainly occur in the first six months after the operation and cut-out of the neck screw has been reported to be the complication most often associated with the failures. It has been shown that the subtrochanteric region is the part of the femur with the highest concentration of biomechanical stress. Fractures in this region mainly affect the cortical bone and consequently they require longer time to heal than those affecting the cancellous bone. Both the concentration of high stress and the affection of the cortical bone might be the reasons for the high complication rates in the treatment of these fractures (7, 22).

Outcomes of treatments using alternative implants [Trochanteric Fixation Nail (TFN, Synthes®), Proximal Femur Nail (PFN, Synthes®), Long Proximal Femur Nail (LPFN, Synthes®), Gamma Nail (Stryker®)] have already been described in the literature (6, 15, 18, 19, 23, 27). The purpose of our study is to evaluate the results for the treatment of subtrochanteric hip fractures with the AO Long Trochanteric Fixation Nail (LTFN).

MATERIAL AND METHODS

The Long Trochanteric Fixation Nail (LTFN)

The LTFN implant is made of titanium alloy combined with niobium (7%) and aluminium (6%). It consists of a cannulated nail with a variable length ranging from 300 to 460mm. The distal part is available in 10, 11 or 12 mm diameters, while its proximal part measures 17 mm in diameter. A 6° angle is formed by both parts and the implant has an anatomical anteversion of 10°. At its proximal end a cannulated helical blade of 11mm is inserted into the femoral neck. The angle between the nail and the blade is available in 125, 130 and 135°. At the distal end of the nail there is a hole for distal locking. The LTFN provides the possibility to choose between using either a round or the oval locking hole, so as to permit static or dynamic locking respectively. It is available for both the left and the right side.

Surgical technique

The patient is placed in a supine position on a radiotransparent fracture table and the fracture is reduced by a combination of traction, rotation and flexion of the hip. Fluoroscopy [anteroposterior (AP) and cross-table projections] verifies the correct reduction and helps in selecting the proper length and angle of the nail before draping. A 5 cm incision is made in the skin proximal to the great trochanter and in line with the femoral shaft. Then the fascia and the muscles are dissected. The entry point is located at the tip of the great trochanter in the

AP view and between the anterior third and the two posterior thirds in the cross-table view. After manually palpating this point, a 2.5 mm diameter guide wire is introduced through the nail into the medullary canal. Fluoroscopy imaging is performed in order to verify the correct location of the guide wire. Initially the proximal part of the canal is reamed using a 17 mm cannulated reamer over the guide wire and using a protective sleeve. The medullary cavity is reamed 0.5 by 0.5 mm until it reaches a diameter 1 mm smaller than the diameter of the chosen nail. The intramedullary nail is introduced manually into the femoral shaft and the image intensifier is used to verify the proper positioning. An aiming arm is attached to the insertion device and a buttress/compression nut is fixed onto it. A 3.2 mm diameter guide wire is introduced through the femoral neck into the femoral head and countersunk approximately 5 mm below the subchondral cancellous. The position is verified using the image intensifier since the guide wire must be centred in the femoral head in both the anteroposterior and cross-table view. The insertion hole for the blade is reamed using an 11 mm reamer and the blade is fully inserted and then locked. Free-hand distal locking is performed using fluoroscopy imaging for verification.

Clinical study

This is a retrospective study of patients who showed a subtrochanteric fracture of the femur and who were treated with the LTFN between January 2005 and January 2008. All the patients of the study were treated in a 3rd level educational hospital. The operations were performed either by consultants or by resident doctors in training under the direct supervision of consultants. All the patients received clinical and radiological follow-ups at least until their fractures were consolidated. Those patients not attending posterior clinical follow-up were contacted via telephone.

The data that was recorded for the patients and the fractures included: gender, age, side, mechanism of fracture and ASA. Fractures were classified using the preoperative radiographs and without any prior knowledge of the results of the treatment. They were both classified using the AO/ASIF classification (16) and the Seinsheimer classification (22) systems. The average surgery time, average decrease in haemoglobin in the first 24 hours post-surgery, average need for red blood cell transfusion, postoperative mortality at a 6th month follow-up, time to autonomous deambulation, most frequent destination at the time of discharge, average time for consolidation of the fracture and average follow-up time were reported. Intraoperative and postoperative complications were also recorded.

RESULTS

A total of 23 patients who met the inclusion criteria were included in the study: 20 women and 3 men. Of the 23 fractures, 14 of them had been the result of an unexpected fall, 2 were the result of a high-energy trau-

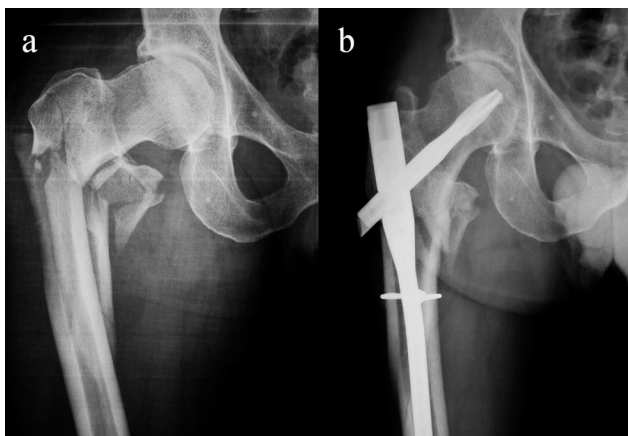


Fig. 1. Radiography showing the frontal view of the right hip of a 58-year-old patient who had suffered a high-energy trauma and presented with a subtrochanteric femoral Seinsheimer type-IV fracture (a); a LTFN device was implanted and open reduction and cerclage cabling prior to nailing were required in order to achieve the correct reduction of the fracture (b); the fracture fully healed after 15 weeks after surgery

ma and 7 consisted of pathologic fractures. The average age was 64.8 years old (range: 25-98 years old). A total of 8 fractures occurred on the right-side and 15 occurred on the left-side. Patients were classified as ASA-I (2 patients), ASA-II (10 patients) and ASA-III (11 patients). Of the 23 fractures, 6 of them were classified as 31-A2, 6 as 31-A3 and 11 as 32-A1 according to the AO/ASIF classification system. They were also classified according to the Seinsheimer classification system as follows: 2 type IIA, 7 type IIB, 6 type IIC, 4 type IIIA, 3 type IV and 1 type V. None of the fractures were classified as type I or IIIB.

Average surgery time was 97.45 minutes (range: 60–210 minutes). Decrease of haemoglobin in the first 24 hours post-surgery averaged 26.45 g/L (range: 15–53 g/L) and the average need for red blood cell transfusion was 1.12 concentrates (range: 0–3 concentrates). The follow-up time averaged 13.9 months (range: 6–38 months).

Weightbearing was permitted after 48 hours post-intervention according to patient's tolerance level. In the first postoperative week 12 patients (57.1%) were able to walk with the help of crutches or another person. A total of 13 patients (56.5%) went directly to their own homes and 7 patients (30.4%) went to a rehabilitation centre. Three patients (13%) passed away in the hospital: 2 patients died within the first postoperative month due to the natural progression of their cancer and 1 patient died due to an acute renal failure. Time to hospital discharge averaged 12.9 days (range: 7-26 days).

During the intervention a total of 4 patients (17.4%) required open reduction and cerclage cabling prior to nailing so as to achieve correct reduction of the fracture (Fig. 1). No intraoperative complications were found. At the 6th month follow-up no complications were found as a result of cutting out of the helical blade. A techni-

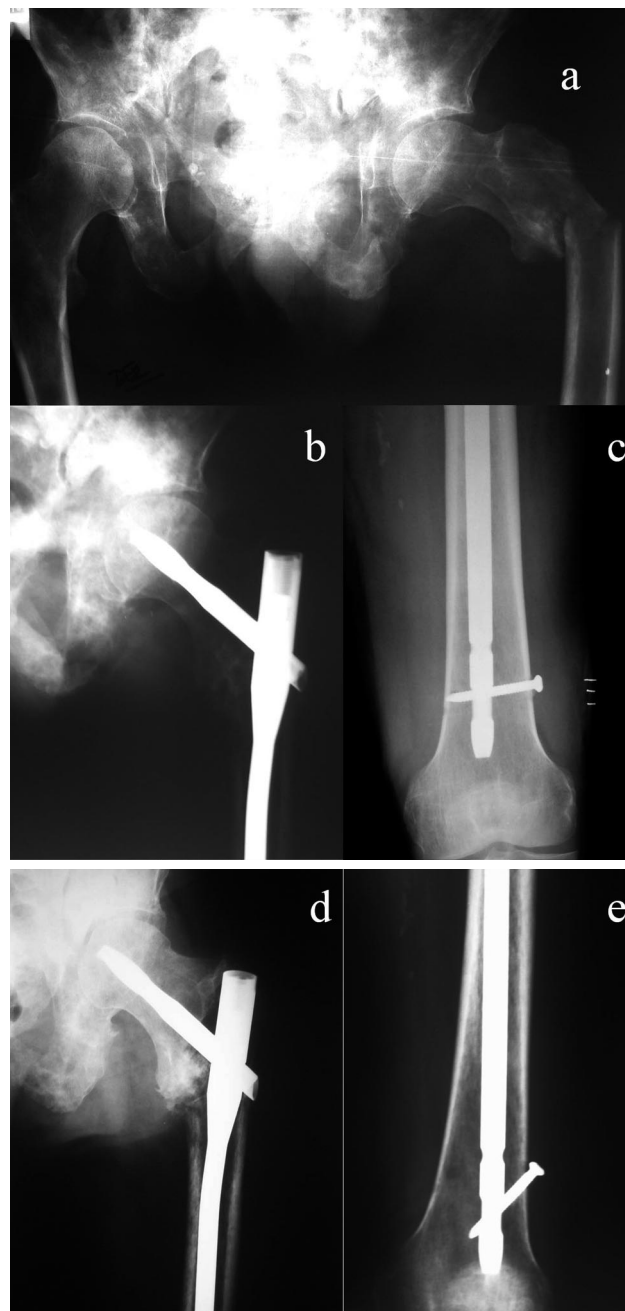


Fig. 2a–c Anteroposterior radiography of the left hip of a 66-year-old man presenting with a Seinsheimer type-IIA fracture (a); post-operative x-ray imaging radiography after stabilizing the fracture with the LTFN (b) shows the selection of a too short distal screw (c); after 6 months, both complete consolidation of the fracture (d) and autonomous deambulation had been achieved, even though the x-ray imaging control showed a migration of the distal screw (e)

cal failure occurred in 1 patient who showed a migration of the distal locking screw, but consolidation of the fracture and autonomous deambulation were achieved. No case of infection was reported and none of the implants needed to be removed.

A total of 6 patients (26.1%) died within 6 postoperative months, but they had all shown signs of consolidation before passing away. No patient died of causes

directly related to the surgery. At the 6-month follow-up, total weightbearing was achieved in the 64.7% of the remaining patients. The average consolidation time was 21.6 weeks (range: 8-60 weeks) and none of the patients developed pseudoarthrosis.

DISCUSSION

From a mechanical point of view the use of a long intramedullary nail in combination with a blade or a screw seems to be the most appropriate treatment for subtrochanteric fractures of the femur (12, 17). However, because of the wide variety of implants and high complication rates the definitive type of implant may have not been designed yet.

The current failure rates of the most frequently used intramedullary nails vary from 10 to 20% (3, 8, 9, 15, 23). The most commonly described failures are due to cut-out of the neck screw, migration of the distal screw, fracture of the femoral shaft at the tip of the implant, malrotation and deep infection (15, 23). After 6 months, only 1 of our patients (complication rate: 4.3%) had a complication and it was caused by the migration of the distal screw, probably due to the selection of a screw that was, in fact, too short (Fig. 2). Patients were followed up on for an average time of 13.9 months (range: 6-38 months) and no further major complications were reported. All the fractures that were included in the study consolidated and no cases of pseudoarthrosis were found. It is important to mention the complete absence of fractures at the tip of the implant, which corroborates with the other outcomes reported in studies about intertrochanteric fractures treated with the Trochanteric Femoral Nail (Synthes®) (23). Just like the TFN the LTFN features a helical blade for stabilising the head and neck fragment as well as a locking mechanism in the cannulated nail to prevent the rotation of both fragments. Lenich demonstrated the importance of an extremely precise positioning of the blade in the middle of the femoral head (14). A low distal shaft diameter results in a minor stress concentration at the tip (23). As seen in our study, all these technical features can prevent mechanical complications from occurring when the implant is correctly inserted by a surgeon who is highly familiar with the use of intramedullary nails.

Seinsheimer reported that the type-IIIa fractures (a three-part spiral subtrochanteric fracture in which the lesser trochanter is part of the third fragment), according to his own classification system, are the most unstable subtrochanteric fractures (22). There were 4 out of the 23 patients (17.4%) of our study who showed this type of fracture: 2 of them achieved autonomous deambulation within the first postoperative week, 1 was capable of deambulation within the first 3 postoperative months and 1 was unable to walk without assistance at the 6 month follow-up.

It has been reported that the need for open reduction and cerclage cabling is usually required in order to obtain a correct alignment of unstable subtrochanteric frac-

tures of the femur. Compared to recent studies, the outcomes of this study are pretty much the same (5, 20). In 4 cases (17.4%) open reduction and cerclage were reported, 3 of which achieved deambulation within the first 10 postoperative days. The 4th case showed consolidation signs in the x-ray but the patient was still not capable of autonomous deambulation at the 6 month follow-up. Open reduction and cerclage has not been reported to be detrimental to fracture healing and should be considered a useful surgical manoeuvre when satisfactory alignment of the fracture cannot be achieved by close reduction.

In our study, 57.1% of the total number of patients were capable of deambulation within the first postoperative week and this percentage increases to 64.7% in the sixth month after surgery. It has been reported that immediate deambulation after surgery is possible when the implant is properly introduced and positioned correctly (2).

The number of subtrochanteric fractures of the femur increases as the population becomes older. In this study, the average age of the patients was 64.8 years old, which contrasts with higher figures reported by similar studies (1, 8, 10, 11, 15, 21, 23, 26). This may be a result of the high number of fractures produced by a pathologic mechanism (30.4%). According to similar reports on other implants for proximal femoral fractures, there is a higher rate of these types of fractures in females (13, 15, 23). In our study we report an even higher rate in females, since 20 of our 23 patients were females (86.9%). The average time to hospital discharge in our study (12.9 days) is lower than those reported in similar studies (1, 13, 15).

The average surgery time in our study (97.45 minutes) shows a slightly higher result than those reported by similar studies. It must be taken into account that most of the fractures included in the study might be more complex than the reported intertrochanteric fractures healed using the standard TFN (15). Moreover, the use of a long intramedullary nail requires more time than the standard nails since they require reaming the medullary cavity. The need for free-hand locking of the distal screw, instead of using the aiming arm, is an additional reason for a longer surgery time.

This study has several inherent limitations. Most importantly, because of its retrospective nature, certain biases might have influenced the results. However, much of the data analyzed is unlikely to be affected by this fact. Another negative factor might be that different surgeons participated in the study and there may be significant differences in their intraoperative management. However, all the surgeons used the same surgical procedure. Also the fact that clinical follow-up of some patients occurred via telephone may generate a possible recall bias. All these limitations may affect the extent to which our findings can be generalized beyond the specific cases studied. Thus, it can be assumed that further evaluations are needed to replicate the findings in different contexts and surroundings.

CONCLUSION

We conclude that the LTFN is a safe and reliable intramedullary device for the treatment of subtrochanteric fractures of the femur. The complication rates are rare when used properly. Deambulation within the first postoperative surgery is possible when positioned properly. Open reduction and cerclage cabling may be required so as to obtain a correct alignment of the fracture. Its implantation requires more surgical time than the standard nails. Further investigations are mandatory and a comparison study is necessary to substantiate our results.

ZÁVĚR

Podle našich zkušeností je LTFN bezpečný a efektivní nitrodřeňový implantát pro léčení subtrochanterických zlomenin femuru. Frekvence komplikací je při správném použití nízká. Chůze v prvních pooperačních dnech je možná při správném zavedení hřebu. Otevřená repozice a použití cerklážních kabelů může být nezbytné k dosažení správného napravení zlomeniny. Vlastní implantace vyžaduje více času než je obvyklé u standardních hřebů. Je nezbytné provést další výzkum a srovnávací studie k ověření našich časných výsledků.

References

- AL-YASSARI, G., LANGSTAFF, R. J., JONES, J. W. M., AL-LAMI, M.: The AO/ASIF Proximal Femoral Nail (PFN) for the treatment of unstable trochanteric femoral fracture. *Injury*, 33: 395–399, 2002.
- ALVAREZ, J. R., CASTELEIRO, R., ARANDA, R. L., BLANCO, M. F., DEHESA, M. C.: Indications for use of the Long Gamma Nail. *Clin. Orthop.*, 350: 62–66, 1998.
- BAUMGAERTNER, M. R., CURTIN, S. L., LINDSKOG, D. M.: Intramedullary versus extramedullary fixation for the treatment of intertrochanteric hip fractures. *Clin. Orthop.*, 348: 87–94, 1998.
- BOYD, H. B., ANDERSON, L. D.: Management of unstable trochanteric fractures. *Surg. Gynec. Obstet.*, 112: 633–638, 1961.
- CACERES, E., LEON, L., MESTRE, C., MARQUES, F., BALLESTER, J., MESTRE, C.: Estudio prospectivo comparativo entre el clavo Gamma trocánterico y el clavo femoral proximal AO (PFN) en el tratamiento de las fracturas trocántéricas inestables. *Rev. Ortop. Traum.*, 49: 11–16, 2005.
- DOUSA, P., BARTONÍČEK, J., JEHLICKA, D., SKÁLA-ROSENBAUM, J.: Osteosynthesis of trochanteric fractures using proximal femoral nails. *Acta Chir. orthop. Traum. čech.*, 69: 22–30, 2002.
- FIELDING, J. W., MAGLIATO, H. J.: Subtrochanteric fractures. *Surg. Gynecol. Obstet. Surg., Gynec. and Obstet.*, 122: 555–560, 1966.
- FRIEDL, W., CLAUSEN, J.: Experimental examination for optimized stabilisation of trochanteric femur fractures, intra- or extramedullary implant localisation and influence of femur neck component profile on cut-out risk. *Chirurg*, 72: 1344–1352, 2001.
- FRITZ, T., HIERSEMANN, K., KRIEGLSTEIN, C., FRIEDL, W.: Prospective randomized comparison of gliding nail and gamma nail in the therapy of trochanteric fractures. *Arch. Orthop. Trauma Surg.*, 119: 1–6, 1999.
- GARDNER, M. J., BRIGGS, S. M., KOPIAR, B., HELFET, D. L., LORICH, D. G.: Radiographic outcomes of intertrochanteric hip fractures treated with the Trochanteric Fixation Nail. *Injury*, 38: 1189–1196, 2007.
- HANDOLL, H. H. G., SHERRINGTON, C., PARKER, M. J.: Mobilisation strategies after hip fracture surgery in adults. *Cochrane Database Syst. Rev.*, 2004;CD001704.
- HOHAUS, T., BULA, P., BONNAIRE, F.: Intramedullary osteosynthesis in the treatment of lower extremity fractures. *Acta Chir. orthop. Traum. čech.*, 75: 52–60, 2008.
- KUKLA, C., HEINZ, T., GAEBLER, C., HEINZE, G., VÉCSEI, V.: The standard Gamma Nail: a critical analysis of 1000 cases. *J. Trauma*, 51: 77–83, 2001.
- LENICH, A., FIERLBECK, J., AL-MUNAJJED, A., DENDORFER, S., MAI, R., FÜCHTMEIER, B., MAYR, E., HAMMER, J.: First clinical and biomechanical results of the Trochanteric Fixation Nail (TFN). *Technol. Health Care*, 14: 403–409, 2006.
- LENICH, A., MAYR, E., RÜTER, A., MÖCKL, C., FÜCHTMEIER, B.: First results with the Trochanter Fixation Nail (TFN): a report on 120 cases. *Arch. Orthop. Trauma Surg.*, 126: 706–712, 2006.
- MÜLLER, M. E., NAZARIAN, S.: Classification of fractures of the femur and its use in the AO index. *Rev. Chir. Orthop., Reparatrice Appar. Mot.*, 67: 297–309, 1981.
- PAKUTS, A. J.: Unstable subtrochanteric fractures: Gamma Nail versus Dynamic Condylar Screw. *Int. Orthop.*, 28: 21–24, 2004.
- PARKER, M. J., HANDOLL, H. H. J.: Gamma and other cephalocondylic intramedullary nails versus extramedullary implants for extracapsular hip fractures in adults. *Cochrane Database Syst. Rev.*, 2005;CD000093.
- PAVELKA, T., HOUCEK, P., LINHART, M., MATEJKA, J.: Osteosynthesis of hip and femoral shaft fractures using the PFN-long. *Acta Chir. orthop., Traum. čech.*, 74: 91–98, 2007.
- RAMAKRISHNAN, M., PRASAD, S. S., PARKINSON, R. W., KAYE, J. C.: Management of subtrochanteric femoral fractures and metastases using Long Proximal Femoral Nail. *Injury*, 35: 184–190, 2004.
- SCHÜRCH, M. A., RIZZOLI, R., MERMILLOD, B., VASEY, H., MICHEL, J. P., BONJOUR, J. P.: A prospective study on socioeconomic aspects of fracture of the proximal femur. *J. Bone Miner. Res.*, 11: 1935–1942, 1996.
- SEINSHEIMER, F.: Subtrochanteric fractures of the femur. *J. Bone Jt Surg.*, 60-A: 300–306, 1978.
- SIMMERMACHER, R. K., BOSCH, A. M., VAN DER WERKEN, C.: The AO/ASIF-Proximal Femoral Nail (PFN): a new device for the treatment of unstable proximal femoral fractures. *Injury*, 30: 327–332, 1999.
- SKLÁDAL, M., PINK, M., LISÝ, M., NOVOTNÝ, L.: Treatment of trochanteric fractures by percutaneous compression plate. *Acta Chir. orthop., Traum. čech.*, 76: 202–207, 2009.
- WATSON, H. K., CAMPBELL, R. D. J., WADE, P. A.: Classification, treatment and complications of the adult subtrochanteric fracture. *J. Trauma*, 4: 457–480, 1964.
- WAGNER, S., RÜTER, A.: Per- and subtrochanteric femur fractures. *Unfallchirurg*, 102: 206–222, 1999.
- WERNER-TUTSCHKU, W., LAJTAI, G., SCHMIEDHUBER, G., LANG, T., PIRKL, C., ORTHNER, E.: Intra- and perioperative complications in the stabilization of per- and subtrochanteric femoral fractures by means of PFN. *Unfallchirurg*, 105: 881–885, 2002.

Ernesto Muñoz-Mahamud,
Department of Orthopaedic and Trauma Surgery,
Hospital Clinic of Barcelona,
C/ Villarroel 170,
Barcelona 08036
Spain
E-mail: e.munoz.mahamud@gmail.com
Phone: 00+34+932275400
Fax: 00+34+932279871