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Intertrochanteric osteotomy with a short intramedullary locking nail

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Abstract In this study the Gamma nail was used for fixation after intertrochanteric osteotomy in osteoarthritis. In 31 patients varus, valgus and complex intertrochanteric osteotomies were stabilized. The patients were allowed full weight bearing 2 weeks postoperatively. After a mean follow-up of 25.6 (13–42) months 29 osteotomies were healed. Two patients were lost to follow-up. No femoral shaft fractures or thigh pain occurred.

Résumé Dans cette analyse clinique prospective on a utilisé le clou Gamma comme fixation après l'ostéotomie intertrochantérienne pour la coxarthrose. 31 ostéotomies intertrochantériennes (varus, valgus et complexes) furent stabilisées par le clou Gamma. Deux semaines après l'opération les patients pouvaient charger l'ostéosynthèse de tout leur poids. Après un suivi moyen de 25,6 (13 à 42) mois, 29 ostéotomies étaient consolidées. Deux patients ne sont pas revenus. Il n'y avait ni fractures du fémur ni douleurs de cuisse.

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Introduction

After intertrochanteric osteotomy with conventional extramedullary fixation devices the frequency of complications as implant loosening, breakage, non-union and loss of correction is 4–20% [4,5,14,15,17].

Mechanically, an intramedullary proximal locking nail provides good stability, as the lever arm of the hip

joint forces is decisively reduced [9], especially as to the critical rotational loading around the longitudinal axis of the femur [18]. Thus, the objective of the current study is to report on the clinical results of intertrochanteric osteotomy using a Gamma nail.

Patients and methods

Thirty-one (18 female and 13 male) patients with a mean age of 44.7 (20–62) years were included in a prospective study. Between July 1993 and January 1997 all underwent intertrochanteric osteotomy for secondary osteoarthritis of the hip using a Gamma nail (Howmedica) for fixation. The mean follow-up was 25.8 (13–42) months. The patients were examined 3 months and 1 year postoperatively, and thereafter at yearly intervals. Two patients were lost to follow-up. Patients with simultaneous acetabular osteotomy and adolescent patients were excluded from the study. The different types of osteotomies are shown in Table 1.

For the operation the exact entrance to the proximal intramedullary canal was made according to the preoperative planning. The tendon of the vastus lateralis was only cut corresponding to the osteotomy, which was performed in a conventional manner. After removal of the osteotomy wedge, reduction was achieved by turning the leg holder in all three planes in simultaneous mild distraction. Thus, even complex osteotomies were performed with additional rotation and flexion or extension. Preliminary retention of the osteotomy was provided by clamps and compression induced by the traction table. Overreaming of at least 2 mm was done with flexible reamers. Finally, the Gamma nail was implanted with 0 (2 patients), 1 (25 patients) or 2 (4 patients) distal locking screws.

Postoperatively the patients started walking with about 15 kg weight bearing and crutches on the first postoperative day. After wound healing, 2 weeks postoperatively, they were allowed increased weight bearing. Prophylactic unfractionated heparin or low-molecular heparin was administered for at least 3 weeks postoperatively.

Results

In all a tight direct bone contact and a correct position of hardware were achieved, verified intraoperatively by radiographs (Fig. 1a,b). Thus, sliding of the hip screw was minimized to 1 or 2 mm on the follow-up radiographs. If the hip screw was installed proximally to the osteotomy

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Table 1 Indication and type of intertrochanteric osteotomy in 31 patients

Indication	Osteotomy	Number of hips
Coxa valga	15 to 25° varus with semi-wedge, 10 to 20° external rotation, and medialisation of the femoral shaft	20
Partial femoral head necrosis	20° flexion with 10° valgus and 10° internal rotation of the femoral shaft	4
Coxa vara	15° valgus with full wedge, 10° internal rotation, and lateralisation of the femoral shaft	3
Failed osteotomy with blade plate	20 and 25° varus with semi-wedge, 10 and 20° external rotation, and medialisation of the femoral shaft	2
Previous slipped capital epiphysis	30° flexion with 15° valgus, and 15° internal rotation of the femoral shaft	1
Previous Perthes disease	20° varus with semi-wedge	1

Fig. 1a Preoperative valgus hip in a 27-year-old woman with slight pain at rest and marked pain while working as a nurse. Only mild radiographic osteoarthritis. **b** Result 18 months postoperatively: The femoral head is centered in the acetabulum. Complete healing at the osteotomy. Constant correction angle and implant position. Pain only occasional

Fig. 2a Preoperative valgus hip in a 48-year-old woman with moderate pain at rest and marked pain during normal activity. **b** Result 13 months postoperatively: Complete healing at the osteotomy after secondary extraction of the distal locking screw. The nail has settled slightly distally. Hip pain only occasional

there was no sliding. In all patients the mean distance between the femoral head cartilage and the tip of the head screw was 19.8 (9–45) mm in AP radiographs and 18.1 (6–31) mm in lateral radiographs. These distances did not change at the time of follow-up. At the osteotomy site the mean bone contact area after correction was 75 (65–80)% compared with the area before correction and nailing. The difference between the preoperative planning and the postoperative radiographic results was limited. In 21 varus osteotomies (Table 1) 12 femurs were undercorrected by a mean of 2 (1–5)° and 9 were over-

corrected by a mean of 3 (2–5)°. All valgus osteotomies were undercorrected by a mean of 2°. In 15 patients the prominence of the proximal tip of the nail in relation to the greater trochanter was a mean of 4 (1–10) mm and in 9 patients the tip penetrated with an average of 8 (1–15) mm into the bone. Irritation of the soft tissue by the prominent nail did not occur. Clinically and radiographically complete union of the osteotomy occurred in 29 patients at the last follow-up.

Complications were defined as major if they led to a second operation or influenced the patient's outcome. Major complications appeared in 5 patients and did not affect the final result. In 1 patient both distal locking screws were misplaced. Three patients had radiographically delayed union, which was successfully treated by distal dynamization of the nail (Fig. 2a,b). One patient had non-union due to a technical fault.

In 6 patients minor complications were noted. Four ossifications around the tip of the nail insertion were seen radiologically, 1 non-displaced fracture of the Gamma nail through the proximal hole for the locking screw was found at the routine implant removal and 1

longitudinal fissure of the greater trochanter occurred during reaming.

In the present study there was no patient with thigh pain, which has been reported on by Hardy et al. [8], when proximal intramedullary locking devices were used in trauma.

Discussion

The concept of Gamma nail fixation for intertrochanteric osteotomy has been developed by the authors [1] and also reported by Kreusch-Brinker et al. [10] and Moeller and Letsch [13]. The Gamma nail is not designed as a press-fit, self-locking intramedullary device that depends on exact matching of the proximal femur, as the anatomy of the femur varies markedly [7,11,19]. Therefore, over-reaming of at least 2 mm is advised. If, additionally, the entrance of the nail at the greater trochanter was exactly planned pre-operatively, the Gamma nail could be inserted by hand into all femurs of the present study without changing the desired femoral alignment. As in Kreusch-Brinker's series [10] we succeeded in obtaining exact correction angles and reduction at the osteotomy according to preoperative planning with direct bone contact. Sliding of the hip screw was minimized to 1 or 2 mm on the follow-up radiographs. Thus, angular positioning of the osteotomy was maintained until bone healing occurred.

As in blade plate osteosynthesis three-dimensional correction with extensive flexion can also be difficult with the Gamma nail. If there is any doubt, the osteosynthesis should preoperatively be simulated by insertion of the nail into an osteotomized model made according to computed tomography scans.

When the Gamma nail began being used, some authors reported on femoral fractures [3,16]. In our study with Gamma nail osteosynthesis for intertrochanteric osteotomy, no femoral shaft fracture occurred.

In the literature the rate of non-unions encountered in blade plate fixation of intertrochanteric osteotomy ranges from 4–20% [4,5,14,15,17]. In this study it was reduced to 4% (1 osteotomy). Among our patients the distal locking screws were removed in 4 nails because of prolonged radiographic bone bridging. In the comparable series [10] 2 patients underwent secondary dynamization.

In Gamma nail osteosynthesis the contact area of cancellous bone at the osteotomy site is reduced, because the implant passes through. A negative clinical effect on bone healing was not found. In the current series the mean bone contact area at the osteotomy site was 75 (65–80)% of the original area before correction and nailing. According to Rosborough and Stiles [17] the incidence of non-union increases sharply, when there are only 40% or less of bone contact area. The merely radiographic phenomenon of prolonged bridging at the osteotomy site, which led to dynamization in our and Kreusch-Brinker's series [10], could be ex-

plained by predominantly cortical bone remodeling, which is slower in comparison with cancellous bone healing.

In femoral nailing avascular necrosis of the femoral head has been described due to intraoperative damage of the medial circumflex artery [12]. In the present study the nail could always be inserted laterally to the piriformis fossa and no head necrosis was registered.

When carrying out intertrochanteric osteotomy the surgeon should bear in mind the possible need for a subsequent total hip arthroplasty. In a series of 305 conventionally fixed intertrochanteric osteotomies followed by total hip arthroplasty at the Mayo Clinic, Ferguson et al. [6] described technical problems in 23%. After the removal of the Gamma nail, however, a straight intramedullary cavity filled with fibrous tissue remains, which facilitates reaming and rasping for prosthesis insertion and prevents femoral perforation.

Gamma nail osteosynthesis in intertrochanteric osteotomy requires less dissection but certainly is a demanding technique depending on experience in intramedullary osteosynthesis.

References

1. Barden B, Fitzek JG, Lr F (1994) Intertrochantre Osteotomien mit dem Gammanagel. Eine experimentelle Untersuchung. In: Heine J (ed) 42. Jahrestagung der Vereinigung Sddeutscher Orthopden. Med Lit Verlag, Uelzen
2. Brookes M (1971) The blood supply of bone. Butterworths, London
3. Davis TRC, Sher JL, Horsman A, Simpson M, Porter BB, Checketts RG (1990) Intertrochanteric femoral fractures: mechanical failure after internal fixation. *J Bone Joint Surg [Br]* 72:26–31
4. D'Souza SR, Sadiq S, New AMR, Eng B, Northmore-Ball MD (1998) Proximal femoral osteotomy as the primary operation for young adults who have osteoarthritis of the hip. *J Bone Joint Surg [Am]* 80:1428–1438
5. Dutkowsky JP (1992) Miscellaneous nontraumatic disorders: hip, proximal femoral osteotomy. In: Crenshaw AH (ed) Campbell's operative orthopaedics. Mosby, St. Louis Baltimore Boston Chicago London Philadelphia Sydney Toronto
6. Ferguson GM, Cabanela ME, Ilstrup DM (1994) Total hip arthroplasty after failed intertrochanteric osteotomy. *J Bone Joint Surg [Br]* 76:252–257
7. Halder SC (1992) The Gamma nail for peritrochanteric fractures. *J Bone Joint Surg [Br]* 74:340–344
8. Hardy DCR, Descamp PY, Krallis P, Fabek L, Smets P, Bertens CL, Delince PE (1998) Use of an intramedullary hip-screw compared with a compression hip-screw with a plate for intertrochanteric femoral fractures. *J Bone Joint Surg [Am]* 80:618–630
9. Kreusch-Brinker R, Rohlmann A, Jensen HI (1998) Biomechanische Untersuchungen zur Dauerschwingbeanspruchung trochantrer Femurosteosynthesen. In: Gahr RH, Leung K-S, Rosenwasser MP, Roth W (eds) Der Gammanagel: Standortbestimmung nach den ersten zehn Jahren. Einhorn, Reinbeck
10. Kreusch-Brinker R, Halder A, Kapella M (1998) Intertrochantre Korrekturosteotomie mit dem Gamma-Nagel. In: Gahr RH, Leung K-S, Rosenwasser MP, Roth W (eds) Der Gammanagel: Standortbestimmung nach den ersten zehn Jahren. Einhorn, Reinbeck

11. Lyddon DW Jr (1996) The prevention of complications with the Gamma Locking Nail. *Am J Orthop* 25:357–363
12. Mileski RA, Garvin KL, Linn AC (1994) Avascular necrosis of the femoral head in an adolescent following intramedullary nailing of the femur. *J Bone Joint Surg [Am]* 76:1706–1708
13. Moeller KM, Letsch R (1998) Mehrdimensionale Korrekturosteotomie des proximalen Femur unter Verwendung des Gammanagels. *Unfallchirurg* 101:323–325
14. Morscher E (1971) Die intertrochantere Osteotomie bei Coxarthrose: Multizentrische Nachuntersuchung von 2251 intertrochanteren Osteotomien bei Coxarthrose. Huber, Bern Stuttgart Wien
15. Müller M E (1971) Die hüftnahen Femurosteotomien. Thieme, Stuttgart
16. Parker MJ, Pryor GA (1996) Gamma versus DHS nailing for extracapsular femoral fractures. Meta-analysis of ten randomised trials. *Int Orthop* 20:163–168
17. Rosborough D, Stiles PJ (1967) Non-union after intertrochanteric osteotomy with internal fixation for osteoarthritis of the hip. *J Bone Joint Surg [Br]* 49:462–467
18. Savvidis E, Löer F, Barden B (1990) Untersuchungen zum Festigkeitsverhalten pertrochanterer Frakturen nach Anwendung verschiedener Osteosynthesetechniken unter besonderer Berücksichtigung der Torsionsbelastung am proximalen Femur. *Z Orthop* 128:661–667
19. Taglang G (1998) Der TGN-Nagel (Trochanteric-Gamma-Nagel). In: Gahr RH, Leung K-S, Rosenwasser MP, Roth W (eds) *Der Gammanagel: Standortbestimmung nach den ersten zehn Jahren*. Einhorn, Reinbeck