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Case report

BREAKAGE OF A ZNN NAIL IN AN ACTIVE ELDERLY FEMALE: A CASE REPORT AND LITERATURE REVIEW

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ABSTRACT

Trochanteric fractures are common in elderly patients with osteoporosis and are surgically treated to facilitate early rehabilitation and to prevent lodging-related comorbidities. Nonunion and hardware breakage of intertrochanteric hip fractures is a relatively rare occurrence resulting from an incorrect surgical procedure. We present a case of ZNN nail breakage caused by fatigue of an unstable trochanteric fracture in a very active elderly female.

An 84 year-old woman was treated with a long, pertrochanteric femoral nail. Six months after surgery, she returned to the emergency department due to the ruptured nail. The patient underwent hemiarthroplasty with a stem revision and, after removing the nail, was stabilized with a trochanteric gripping plate and rims.

Long-term results assessed with the Harris Hip Score and the Oxford Hip Score were excellent. The patient's quality of life improved greatly. Our experience confirms that total hip hemiarthroplasty is a satisfactory revision procedure after failed treatment of an intertrochanteric fracture in elderly patients with poor bone stock and high functional demands in daily activities.

1. Introduction

Trochanteric fractures of the femur are common in elderly people with osteoporosis and are usually surgically treated to facilitate early rehabilitation [1,2]. Many devices are available to fixate these fractures. The most commonly used devices are the sliding hip screw (SHS) and the intramedullary nail for lateral fractures of the proximal epiphysis of the femur (AO 31A1.2; 31 A2.2; 31 A2.3). The intramedullary nail has a biomechanical advantage compared to the SHS because its shorter lever arm reduces the load shearing [3,4]. From 1999 to 2006, Anglen et al (6) show an increased use of the intramedullary nail compared to the SHS (from 3% in 1999 to 67% in 2006). The Zimmer Natural Nail System or ZNN (Zimmer-Biomet®, Warsaw, Indiana, USA) represents a new generation of intramedullary nails. Its characteristics include an anatomical shape which replicates the anatomic profile of the femur. Key characteristics of the ZNN are: anterior bows to match the natural anatomic shape, stabilized technology for solid interface between nail and bone, stable fixation even in the presence of poor bone quality, various diameters and lengths available to match the anatomy of individual patients, and spiral or straight flutes to moderate stiffness and facilitate insertion.

Nonunion of intertrochanteric hip fractures is relatively rare with a reported incidence of 1–5%[7]. Nevertheless, the newer nail designs and materials can still result in complications such as cut-out of the implant, fracture of the femoral shaft distal to the tip of the implant, or medial migration of the implant[7]. The 1-year mortality rate after hip fracture is estimated at 20–30%[7]. This article presents a case of ZNN breakage due to fatigue of an unstable trochanteric fracture in a very active elderly female. It also includes a review of the literature and discussion of the incidence, the causes, and treatment of implant failure.

2. Case Report

An 84 year-old woman (height: 160cm, weight:45 kg, BMI = 17.58) was admitted to our Orthopedics and Traumatology department for a reverse pertrochanteric fracture, according to the AO classification: 31 A-2 (Figure 1).

As reported in Table 1, she had a history of severe cardiovascular disease, but her social life was very active with an Oxford score of 46/48. Considering these conditions, the anesthesiologist evaluated the anesthetic risk with ASA 3.

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The fixation of this fracture was performed with a ZNN intramedullary long nail with two distal locking screws, one static and one dynamic (Figure 2).

Figure 1 - Pertrochanteric multifragmentary reverse fracture of proximal femur. According A.O. Classification: 31-A2.

Author	Total cases	Cases of broken nails	Nail type	Breakage site	Time	Cause of breakage
Valverde et al. [14]	223	1 (0.4%)	1st GN	Proximal	N/A	N/A
Boriani et al. [15]	1181	5 (0.4%)	1st GN	N/A	N/A	N/A
Gaebler et al. [13]	839	2 (0.2%)	1st GN	Distal	4 months	Direct trauma
			1st GN	Distal	5 months	Nonunion
Pervez and Parker [16]	35	2 (5.7%)	Long GN	Middle	3 months	Delayed union
			Long GN	N/A	5 months	Delayed union (PF)
Van Doorn and Stapert [17]	101	2 (2.0%)	Long GN	Proximal	7 months	Nonunion (PF)
			Long GN	Middle	9 months	Nonunion (PF)
Docquier et al. [18]	439	1 (0.2%)	1st or 2nd GN	N/A	N/A	Delayed union
Álvarez et al. [19]	843	5 (0.6%)	1st GN	Proximal	7 months	Nonunion
			1st GN	Distal	7 months	Nonunion
			2nd GN	Proximal	7 months	Nonunion
			Long GN	Middle	10 months	Nonunion
			Long GN	Proximal	8 months	Nonunion
Sehat et al. [11]	100	1 (1.0%)	Long GN	Middle	N/A	Insufficient reduction

Table 1 - Review of literature of Gamma nail breakage (8) compared with our experience with ZNN. (Legend: 1st GN: the first generation Gamma nail, 2nd GN: the second generation Gamma nail, ZNN: *Zimmer Natural Nail System*, Long GN: long Gamma nail, Proximal: the opening for the lag screw, middle: nail midshaft, distal: the opening for the distal locking screw, N/A: not available in the literature, and PF: pathological fracture.)

Figure 2 - XR after reduction and osteosynthesis with ZNN (Zimmerbiomet®, Warsaw, Indiana, USA) with one static and one dynamic locking screw (on the right picture).

In the 4th postoperative day, the patient began physiotherapy exercises in bed, and on the 5th day, she started walking with total progressive bearing. She was discharged on the 10th postoperative day with good clinical conditions. A month after the operation, the patient returned to the orthopedic clinic for a clinical and radiographic examination. The Oxford Hip Score was performed and the result was 24/48. The third month post-op, the result was 40/48, and the patient referred that she had resumed all of her normal daily activities. The fifth month post-op, the Oxford hip score was 44/48 (Figure 5). Six months after surgery, the patient was admitted to the emergency room for a traumatic, sudden severe pain in her right hip. The X-rays evidenced nail breakage proximal to the locking head screw insertion site (Figure 3 and Figure 4). The Oxford Hip score was 12/48 (Figure 5). The patient refused surgery due to her high cardiovascular risks associated with the intervention. A few months later, the patient asked to be operated on to improve her quality of life (Oxford hip score of 2/48) (Figure 5). X-ray showed a nonunion in the trochanteric area. Broken nail removal was performed, followed by open-book osteotomy of the greater trochanter, uncemented hip endoprosthesis (Wagner stem) implantation, cerclage of the greater trochanter, and bone graft and stem cells from the iliac crest (Figure 4) .

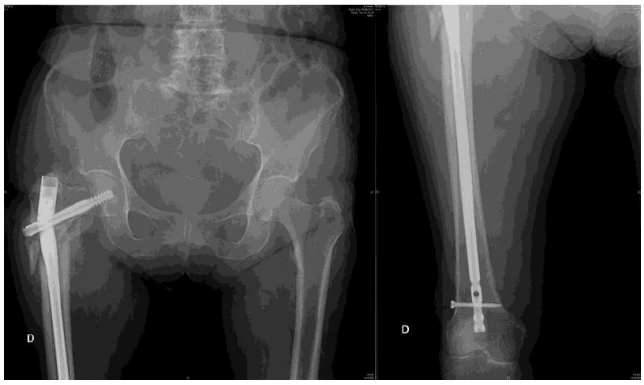

Figure 3 - The XR show the breakage of the nail in its proximal part. The right picture shows one dynamic locking screw.

Figure 4 - XR after the nail removal and replacement with endoprothesis (Wagner's stem) and Cable Ready Great Trochanter Reattachment Zimmer® (Zimmerbiomet®, Warsaw, Indiana, USA)

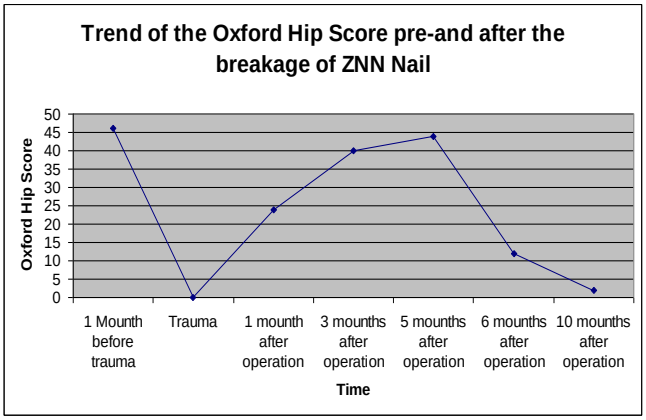

Figure 5 - This tub shows the trend of the Oxford Hip score in these patients before the pertrochanteric facture, after the nail operation and after the breakage of ZNN Nail.

3. Discussion

In literature, there is no evidence of ZNN nail breakage. This discussion is based upon the comparison between ZNN, PFNA, Gamma nail and other nails.

The Gamma nail is one of the most commonly used devices for the fixation of trochanteric fractures of the femur, especially in unstable fractures [6,9,10]. Due to its material strength and mechanical advantage, implant failure of the Gamma nail is rare [11, 12]. In 2013, Iwakura et al.(8) presented a case of breakage of a third generation Gamma nail used to treat an unstable trochanteric fracture, which was associated with insufficient reduction of the fracture. They explained that an inadequate surgical procedure, such as insufficient fracture reduction, may result in nonunion and implant breakage, even when using a high-strength, well-designed implant[8]. The most common cause of nail breakage is metal fatigue, while the second most common cause is delayed union or nonunion. Nails are temporary implants with a limited lifetime expectancy under continuous dynamic stress loads [3][18]. We compared the Iwakura et al report [8] about Gamma nail breakage **(Table 1)** with our ZNN experience. The reported incidence of breakage of Gamma nails in the Iwakura study, including long Gamma nails, ranges from 0.2% to 5.7% **(see Table 1)**. Norris et al. described a 1,7% incidence of secondary peri-synthetic fractures. The percentage of fractures is reduced in 3rd generation Gamma nails compared to the older nails (1.7% versus 2.6%, p value 0.03). Long nails had a slight tendency towards a lower risk of fracture, the difference was not statistically significant (1.1% versus 1.7%, p value 0.28) [10].

Kristek D et al. [20] used PFNA (Proximal Femoral Antirotation Nail) in 76 patients (mean age 73 years, age range 22-91 years) with pertrochanteric femoral fractures, and they reported no cases of implant breakage and only one cut-out occurred. Wang W et al.[21] used PFNA in 30 Reverse oblique fractures of the intertrochanteric region of the femur (mean age 69 years, age range 40-88 years), and they had complications such as cut-out or breakage of the implants. In these study cases, the number of patients examined was too small to determine if the device was an adequate method for avoiding bad outcomes in femoral pertrochanteric fractures.

In 100 pertrochanteric fractures, Erez et al [22] used cephalomedullary devices to fix the fractures and highlighted mechanical complications such as: six patients with significant collapse of the femoral neck, six fractures distal to the implant, one cut-out, four infections, and one implant breakage. The implant breakage occurred at the screw-nail interface. In his paper, Zhao et al.[23] reported 164 intertrochanteric fractures treated with Trigen short reconstruction trochanteric antegrade nails. The fracture rate at the tip of the nail was about 17 %, poor reduction rate of was15.9%, and cracking rate of the lateral trochanter for type 31-A.3 fracture was 41,4%. All of these cracking cases displayed 31 A.3 unstable fractures combined with comminuted lateral trochanter fractures; Two shaft fractures required revision and one cut-out was treated with total hip arthroplasty.

Risk of distal shaft fractures was not associated with patient age, gender, fracture type or cortical bone index. Maniscalco et al.[7] present a rare case of nonunion of an intertrochanteric fracture due to the failure of dynamic distal nail locking (Endovis, Citieffe, Bologna, Italy), caused by distal jamming of the tip of the nail against the anterior cortex. A surgical failure due to distal jamming has never been described in the literature. Liu W et al [27], in their retrospective review of 341 intertrochanteric hip fractures treated with the TFN, found that the overall rate of mechanical complications was 20.5%: twenty-one patients (9.4%) had excessive lateral migration of the helical blade (≥10 mm), fifteen patients (6.7%) had blade migration in the head, including 7 patients (3.1%) with typical cut-out and 8 patients (3.6%) with medial perforation without loss of reduction. Three patients (1.3%) sustained a femoral shaft fracture at the tip of the nail. The quality of calcar reduction was significantly predictive of all modes of failure ($p < 0.05$), except femoral shaft fracture at the nail tip. It is known in the literature that no device is without breakage problems. From experience and the literature, it is known that the opening for the lag screw seems to be the weakest point, as it has a relatively small cross-sectional diameter [24]. Indeed, this is the critical zone where forces from the femoral neck are transmitted to the nail in the diaphysis [19, 25]. It is reported that inappropriate drilling of the nail at this site due to an improperly placed guide, or off- center introduction of the lag screw, may damage the nail and contribute to nail breakage [26]. Our experience reported the first case of ZNN fatigue nail breakage.

Revision procedure of failed trochanteric fracture fixation is performed by internal fixation or arthroplasty or hemiarthroplasty [28]. The choice of the procedure involves several factors, such as the anatomical site of the nonunion, the quality of the remaining bone and articular cartilage, and patient-related factors such as age and activity level [28-32]. In younger patients with a well-preserved hip joint, treatment typically involves revision internal fixation with or without osteotomy or bone grafting. In older patients, however, arthroplasty is indicated to help restore function and relieve pain when the bone stock is poor or the hip joint is badly damaged [33,34], although arthroplasty or hemiarthroplasty usually require management of the discontinuous greater trochanter [33]. Other factors, such as deformity and femoral bone defects, also need to be considered. In our patient, bipolar hemiarthroplasty was performed due to the needed removal of the broken implant. Homograft bone from the iliac crest and stem cells were used to facilitate bone healing and to increase bone stock and improve bone-implant interface. Cable Ready Great

Reattachment Zimmer® (Zimmerbiomet®, Warsaw, Indiana, USA) was used to reduce the open-book osteotomy of the femur. This procedure allows for earlier mobilization in older patients compared with revision internal fixation [33-39].

Our experience confirms that total hip hemiarthroplasty is a satisfactory procedure after failed treatment of an intertrochanteric fracture in elderly patients without serious orthopedic complications and good clinical outcomes.

References

1. Handoll HH, Parker MJ: Conservative versus operative treatment for hip fractures in adults. Cochrane Database Syst Rev. 2008;(3):CD000337.
2. Lix LM, Quail J, Teare G, Acan B: Performance of comorbidity measures for predicting outcomes in population-based osteoporosis cohorts. Osteoporos Int. 2011; 22(10):2633-43. Wee JL, Sathappan SS, Yeo MS, Low YP: Management of gamma nail breakage with bipolar hemi-arthroplasty. Singapore Med J. 2009;50(1):e44-7.
3. Lorich DG, Geller DS, Nielson JH: Osteoporotic pertrochanteric hip fractures: management and current controversies. Instr Course Lect. 2004;53:441-54.
4. Bernstein J, Ahn J: Provider factors associated with intramedullary nail use for intertrochanteric hip fractures. J Bone Joint Surg Am. 2010;92(15):2619; author reply 2619-20.
5. Anglen JO, Weinstein JN; American Board of Orthopaedic Surgery Research Committee: Nail or plate fixation of intertrochanteric hip fractures: changing pattern of practice. A review of the American Board of Orthopaedic Surgery Database. J Bone Joint Surg Am. 2008;90(4):700-7.
6. Maniscalco P, Rivera F, D'Ascola J, Del Vecchio EO: Failure of intertrochanteric nailing due to distal nail jamming. J Orthop Traumatol. 2013;14(1):71-4.
7. Iwakura T, Niikura T, Lee SY, Sakai Y, Nishida K, Kuroda R, Kurosaka M:Breakage of a third generation gamma nail: a case report and review of the literature.Case Rep Orthop. 2013;2013:172352.
8. De Grave PW, Tampere T, Byn P, Van Overschelde J, Pattyn C, Verdonk R: Intramedullary fixation of intertrochanteric hip fractures: a comparison of two implant designs. A prospective randomised clinical trial. Acta Orthop Belg. 2012;78(2):192-8.
9. Norris R, Bhattacharjee D, Parker MJ: Occurrence of secondary fracture around intramedullary nails used for trochanteric hip fractures: a systematic review of 13,568 patients. Injury. 2012;43(6):706-11.
10. Sehat K, Baker RP, Pattison G, Price R, Harries WJ, Chesser TJ: The use of the long gamma nail in proximal femoral fractures. Injury. 2005;36(11):1350-4.
11. Yoshino N, Watanabe Y, Takenaka N, Watanabe N, Fukuda Y, Fujita N, Maruyama N, Sumiyoshi H, Takai S: Implant failure of long Gamma nail in a patient with intertrochanteric-subtrochanteric fracture. J Orthop Sci. 2006;11(6):638-43.
12. Gaebler C, Stanzl-Tschegg S, Tschegg EK, Kukla C, Menth-Chiari WA, Wozasek GE, Heinz T: Implant failure of the gamma nail. Injury. 1999;30(2):91-9.
13. Valverde JA, Alonso MG, Porro JG, Rueda D, Larrauri PM, Soler JJ: Use of the gamma nail in the treatment of fractures of the proximal femur. J Orthop Trauma. 2003;17(8):S51-6.
14. Boriani S, De Iure F, Bettelli G, Specchia L, Bungaro P, Montanari G, Capelli A, Canella P, Regnoli R, Triscari C: 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(2):193-203.
15. Pervez H, Parker MJ Results of the long Gamma nail for complex proximal femoral fractures. Injury. 2001; 32(9):704-7.
16. Van Doorn R, Stapert JW: Treatment of impending and actual pathological femoral fractures with the long Gamma nail in The Netherlands. Eur J Surg. 2000;166(3):247-54.
17. Docquier PL, Manche E, Autrique JC, Geulette B: Complications associated with gamma nailing. A review of 439 cases. Acta Orthop Belg. 2002;68(3):251-7.
18. Alvarez DB, Aparicio JP, Fernández EL, Múgica IG, Batalla DN, Jiménez JP: Implant breakage, a rare complication with the Gamma nail. A review of 843 fractures of the proximal femur treated with a Gamma nail. Acta Orthop Belg. 2004;70(5):435-43.
19. Kristek D, Lovric I, Kristek J, Biljan M, Kristek G, Sakic K:The proximal femoral nail antirotation (PFNA) in the treatment of proximal femoral fractures. Coll Antropol. 2010;(34):937-40.
20. Wang W, Yang T, Fang Y, Wang G, Pu J, Liu L:Treatment of reverse oblique fractures of intertrochanteric region of femur with proximal femoral nail antirotation. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2009;(23):1306-10.
21. Erez O, Dougherty PJ: Early complications associated with cephalomedullary nail for intertrochanteric hip fractures. J Trauma Acute Care Surg. 2012;72(2):E101-5.
22. Zhao X, Yan S G, Li H., Wu H B: Short reconstruction nail for intertrochanteric fracture: does it really fit Asian feature? Arch Orthop Trauma Surg, 2012:(132):81-6.
23. Zafiropoulos G, Pratt DJ: Fractured Gamma nail. Injury. 1994;25(5):331-6.
24. Barquet A:The treatment of subtrochanteric nonunions with the long gamma nail: twenty-six patients with a minimum 2-year follow-up. J Orthop Trauma. 2005; 19(4):294; author reply 294.
25. Maes M, Deboer Y, Brabants K. Failure of the titanium trochanteric gamma nail in ununited metastatic fractures. Acta Orthop Belg. 2012; 78(4):552-7.
26. Liu W, Zhou D, Liu F, Weaver MJ, Vrahas MS: Mechanical complications of intertrochanteric hip fractures treated with trochanteric femoral nails. J Trauma Acute Care Surg. 2013;75(2):304-10
27. Lanzetti RM, Caraffa A, Lupariello D, Ceccarini P, Gambaracci G, Meccariello L, et al. Comparison between locked and unlocked intramedullary nails in intertrochanteric fractures. Eur J Orthop Surg Traumatol. 2018 Feb 9.
28. Rollo G, Tartaglia N, Falzarano G, Pichierri P, Stasi A, Medici A, Meccariello L. The challenge of non-union in subtrochanteric fractures with breakage of intramedullary nail: evaluation of outcomes in surgery revision with angled blade plate and allograft bone strut. Eur J Trauma Emerg Surg. 2017;43(6):853-861.

29. Maiettini D, Bisaccia M, Caraffa A, Rinonapoli G, Piscitelli L, Bisaccia O, Rollo G, Meccariello L, Ceccarini P, Rebonato A. Feasibility and Value of Radiographic Union Score Hip Fracture after Treatment with Intramedullary Nail of Stable Hip Fractures. Acta Inform Med. 2016; 24(6): 394-396. Rollo G., Rotini R., Pichierri P., Giaracuni M., Stasi A., Macchiarola L., Bisaccia M., Meccariello L. Grafting and fixation of proximal humeral aseptic non union: a prospective case series. CCMBM 2017; 14(3):298-304.
30. Rollo G., Pichierri P., Marsilio A., Filipponi M., Bisaccia M., Meccariello L. The challenge of nonunion after osteosynthesis of the clavicle: is it a biomechanical or infection problem? CCMBM 2017; 14(3):372-378.
31. D'Arrigo C, Perugia D, Carcangiu A, Monaco E, Speranza A, Ferretti A: Hip arthroplasty for failed treatment of proximal femoral fractures. Int Orthop. 2010;34(7):939-42.
32. DeHaan AM, Groat T, Priddy M, Ellis TJ, Duwelius PJ, Friess DM, Mirza AJ: Salvage hip arthroplasty after failed fixation of proximal femur fractures. J Arthroplasty. 2013;28(5):855-9.
33. Castillón P, Bartra A, Vallejo G, Salvador J, Torres R, Anglés F: Hip arthroplasty with conventional stem as rescue treatment after failed treatment of intertrochanteric hip fractures. Rev Esp Cir Ortop Traumatol. 2013;57(3):194-200
34. Grubor P, Mitković M, Grubor M, Mitković M, Meccariello L, Falzarano G. Biomechanical Stability of Juvidur and Bone Models on Osteosyntesic Materials. Acta Inform Med. 2016 Jul 16;24(4):261-265.
35. Carta S, Fortina M, Riva A, Meccariello L, Manzi E, Di Giovanni A, Ferrata P. The Biological Metallic versus Metallic Solution in Treating Periprosthetic Femoral Fractures: Outcome Assessment. Adv Med. 2016;2016:2918735.
36. Schiavone A, Bisaccia M, Inkov I, Rinonapoli G, Manni M, Rollo G, Meccariello L, Vicente CI, Ceccarini P, Ruggiero C, Caraffa A. Tranexamic Acid in Pertrochanteric Femoral Fracture: Is it a Safe Drug or Not? Folia Med (Plovdiv). 2018 Mar 1;60(1):67-78.
37. Rollo G, Rinonapoli G, Pichierri P, Bisaccia M, Caraffa A, Meccariello L. Breakage in Two Points of a Short and Undersized "Affixus" Cephalomedullary Nail in a Very Active Elderly Female: A Case Report and Review of the Literature. Case Rep Orthop. 2018;2018:9580190.

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