



# Femoral insufficiency fractures in the elderly – Excessive medial femoral bowing complicates intramedullary nailing

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**Objective:** The aim of this study was to evaluate the characteristics of low-energy femoral insufficiency fractures in elderly patients.

**Methods:** The study retrospectively evaluated the clinical course of 4 patients with low-energy femoral shaft and subtrochanteric fractures admitted to our department between 2009 and 2011. Three patients had prior long-term alendronate therapy and one had prior glucocorticoid therapy.

**Results:** There were 5 femoral shaft fractures, 2 incomplete shaft fractures, 2 subtrochanteric and 1 intertrochanteric fractures. All femoral shaft fractures had characteristic fracture patterns with thickened lateral cortices at the proximal fragment. Six femurs had excessive medial femoral bowing, which complicated intramedullary nailing. Additional fractures were seen on both femurs of one patient who had been primarily treated with short implants. A bifocal femoral fracture was seen in one femur. Union was achieved in all patients. Two patients were able to walk independently, one with a cane and one with double crutches.

**Conclusion:** We suggest the addition of another radiographic pattern of 'excessive medial femoral bowing' in low-energy femoral shaft fractures in elderly patients. This bowing complicates intramedullary nailing. Moreover, these insufficiency fractures should be fixed with long cephalomedullary nails.

**Key words:** Elderly; femoral shaft; intramedullary nail; low-energy fracture; medial femoral bowing.

Femoral insufficiency fractures are being reported with increasing frequency.<sup>[1-10]</sup> Bisphosphonates and glucocorticoids suppress bone turnover which in turn causes accumulation of microdamage and decreases bone strength.<sup>[1,11,12]</sup> The bone becomes more fragile and more susceptible to low-energy trauma.<sup>[13]</sup> Recent evidence of a relationship between these fractures and long-term bisphosphonate and/or glucocorticoid use has been reported.<sup>[1,7,10]</sup> Many treatment alternatives, from plate and

screw osteosynthesis to nailing, have been reported for the treatment of femoral insufficiency fractures. However, there is no clear consensus regarding the optimal treatment.<sup>[1,3,4,8-10]</sup>

These fractures are typically transverse or oblique.<sup>[1,14-18]</sup> Moreover, radiographs show beaking of the cortex on the lateral side and hypertrophy of the subtrochanteric and/or diaphyseal lateral cortex.<sup>[15-18]</sup> On the other hand, excessive medial femoral bowing can be seen

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**Table 1.** Demographic and treatment data of the patients.

No	Age (yrs.)	Side	Femoral fracture type	Etiology	Duration of exposure to etiological agent	Follow-up period	Femoral bowing	Result
1	84	Left	Shaft; intertrochanteric	Alendronate	10 years	28 months	Bilateral	Mobile with one cane
		Right	Shaft; subtrochanteric					
2	77	Left	Subtrochanteric; shaft incomplete	Glucocorticoids	12 years	21 months	Bilateral	Mobile with double crutches
		Right	Incomplete shaft fracture					
3	74	Left	Shaft	Alendronate	9 years	11 months	Left	Independently mobil
		Right	Incomplete shaft fracture					
4	82	Left	Shaft	Alendronate	6 years	42 months	Left	Independently mobile
		Right	Shaft (previous operation)					

in these patients. Although not clearly mentioned in the literature, such pathology can be seen in radiographs of some cases described in previous reports.<sup>[1,10,19-23]</sup>

The purpose of the study was to discuss the treatment methods of femoral insufficiency fractures and to draw attention to the excessive medial femoral bowing in these cases.

### Patients and methods

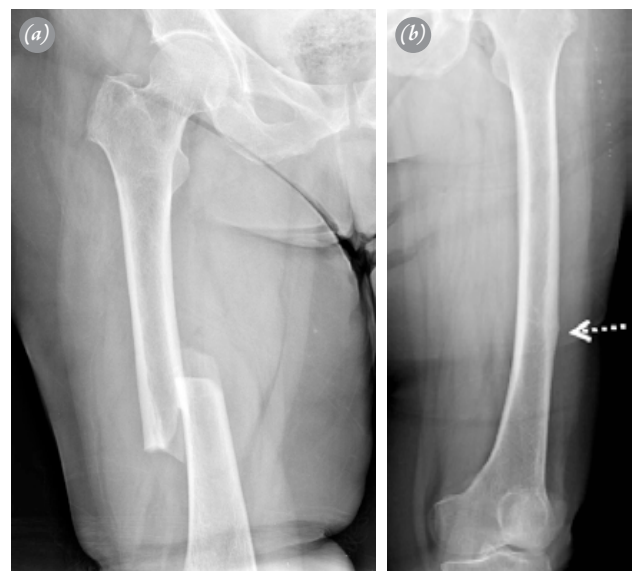
All adult patients referring to our clinic with femoral fractures due to low-energy trauma between 2009 and 2011 were retrospectively evaluated. Patients with fractures due to high-energy trauma, primary or metastatic bone tumors or chronic renal disease were excluded. Low-energy trauma is described as falling from an altitude equal to or less than the patient's standing height.

Four patients with femoral insufficiency fractures were included in the study (Table 1). Patient 1 had bilateral femoral shaft fractures followed by a subtrochanteric and an intertrochanteric fracture. One other patient (Patient 2) had a bifocal femoral fracture on admission and developed an incomplete shaft fracture on the contralateral femur and ulnar shaft insufficiency fracture on one forearm. One patient (Patient 3) had a femoral shaft fracture on one side and an incomplete stress fracture on the contralateral femur. Patient 4 was admitted with a femoral shaft fracture but had a previous atypical femoral shaft fracture treated elsewhere with intramedullary nailing.

At admission, the contralateral femurs were checked for lateral cortical hypertrophy at the subtrochanteric or shaft region and lateral femoral cortical periosteal reaction. If present, prophylactic intramedullary nailing (IMN) was recommended for patients with radiological findings and groin pain.

### Results

All 4 patients were female, with a mean age of 79 (range: 74 to 84) years. Three patients had a history of long-term (more than 6 years) oral bisphosphonate use. The other patient had a history of using low-dose steroids for 12 years. Radiologically, all diaphyseal and subtrochanteric fractures presented lateral cortical hypertrophy and showed a transverse or partially oblique fracture pattern (Fig. 1a). Beaking of the cortex on the lateral side and hypertrophy of the subtrochanteric and/or diaphyseal lateral cortex were present in all shaft and subtrochanteric fractures. During the referral of 4 patients with their first fracture, excessive medial femoral bowing was observed in 6 femurs (Fig. 1b) (Table 1).



**Fig. 1.** (a) Typical fracture pattern in a patient (Patient 3) who used long-term bisphosphonates: oblique and transverse fracture lines and lateral cortical hypertrophy are seen. (b) Insufficiency fracture on the contralateral femoral diaphysis (dotted arrow). Medial bowing and lateral cortical hypertrophy can be seen.



**Fig. 2.** (a) Right femoral distal diaphyseal fracture of Patient 1 treated with short retrograde IMN. Femoral medial bowing is visible. (b) Left reverse intertrochanteric fracture proximal to the plate. (c) Intraoperative radiograph indicating difficulty of nail passage because of femoral bowing. (d) Early postoperative radiograph of the left femur. (e) Final radiograph of Patient 1, two years after the final operation. Note the left distal femoral cut out of the nail.

Patient 1 referred to our department with a fracture on the distal one-third of her right femur (Fig. 2a). A retrograde IMN was applied since the fracture was close to the distal end. Due to excessive medial femoral bowing, a retrograde nail designed to reach the trochanter minor was not feasible and a short nail was applied. Eight months later, the patient presented again with right intertrochanteric femoral fracture proximal to the retrograde IMN and left femoral diaphyseal fracture after a simple fall at home. Osteosynthesis with a 4.5 mm limited contact dynamic compression (LCDC) plate-screw on the left side and a dynamic hip screw (DHS) on the right side was performed. Because of the excessive femoral bowing on the left side, plate-screw construct was used. Ten months later, the patient presented again with left subtrochanteric femoral fracture proximal to the plate (Fig. 2b). The plate-screw was removed and a long cephalomedullary nail was applied to fix both fractures. During IMN insertion, the tip of the nail touched the anterior and lateral cortices of the distal diaphysis and could not be easily passed distally (Fig. 2c). Early postoperative radiographs were satisfactory (Fig. 2d). However, after the patient attempted weight-bearing 1 week postoperatively, the tip of the nail cut the anterolateral cortex. Since the patient was ambulatory with a walker, non-surgical treatment with close follow-up was decided (Table 1). Two years after the final operation,

she was able to walk with a cane (Fig. 2e).

A cephalomedullary nail was applied to Patient 2 for a left subtrochanteric femoral fracture. Mid-diaphyseal lateral cortical thickening was also seen in the same femur, indicating a stress fracture (Fig. 3a). This radiological appearance was accepted as a bifocal fracture. There was also medial femoral bowing. Four months later, the patient developed pain on her right thigh and proximal part of her left forearm. Incomplete fracture of the ulna and stress reaction in the femur were detected in the radiographs. (Figs. 3b and 3c) A cephalomedullary nail was applied to the femur and plate-screw fixation with a 3.5 mm LCDC plate to the ulna. Excessive femoral bowing precluded passage of the nail distally and a closed osteotomy with multiple K-wire perforations at the stress reaction site was performed to straighten the femur and pass the nail in the center of the medullary canal (Figs. 3d and 3e).

Intramedullary fixation with a long cephalomedullary nails was performed in the other 2 patients with femoral shaft fractures. Prophylactic nailing to the contralateral femur was recommended to Patient 3, but the patient declined. Patient 4 had undergone intramedullary fixation to her right femur at another center two years before. She was referred to our clinic with a left femur shaft fracture and was treated with intramedullary fixation.



**Fig. 3.** (a) Left subtrochanteric femoral fracture (white arrow) and stress reaction of the mid-shaft region (dotted white arrow) in Patient 2, which was fixed with a long cephalomedullary nail. (b) Femoral and (c) ulnar insufficiency fractures (straight and dotted white arrows). (d) Intraoperative fluoroscopy image of the right femur indicating excessive femoral medial bowing precluding nail passage. (e) Closed osteotomy with multiple K-wire perforations at the stress reaction site had to be performed to straighten the femur in order to pass the nail in the center of the medullary canal.

In total, 5 femoral shaft fractures, 2 incomplete shaft fractures 2 subtrochanteric and 1 intertrochanteric fracture developed in 4 patients. Union was achieved in all patients. Two of the patients can walk independently, 1 patient with a cane and 1 patient with double crutches (Table 1).

## Discussion

The most important finding in our cases was the presence of excessive medial femoral bowing. This pathological appearance has not been reported clearly in the literature but mention was made in a brief sentence by Einhorn et al.<sup>[1]</sup> On the other hand, this pathology can be seen in radiographs in some case examples in the reported studies.<sup>[10,19-23]</sup> Medial femoral bowing complicates the introduction of a femoral intramedullary nail no matter if it is a trochanteric or piriformis entry. Since the nails are straight in the mediolateral plane, their passage through the medullary cavity becomes difficult or complicated. This bowing complicates prophylactic intramedullary nailing in particular when there is no real fracture. We had to osteotomize the femur at the stress fracture zone in one of our cases while applying a prophylactic nail. However, converting an incomplete fracture to a complete one with osteotomy brings the possibility of delayed union which is a reported problem in these patients.<sup>[3,8]</sup> Therefore, our suggestion of making

an osteotomy could be criticized both for the possibility of an incomplete fracture becoming complete as well as for the risk of delayed bone healing. Another alternative solution might be the use of specially designed bowed custom-made nails, or intraoperative bending and shaping the thinner sized nails. However, the use of custom made nails creates the problem of cost and time for the production of the nail. Moreover, bending the nails might decrease their stiffness.

Bisphosphonates are used on a widespread basis in the treatment of osteoporosis and prevention of osteoporosis-related fractures.<sup>[1,7]</sup> Alendronate was the first and is currently the most commonly used bisphosphonate.<sup>[7,9]</sup> It significantly reduces clinically important fractures when compared to a placebo.<sup>[7]</sup> However, studies showing its relation with atypical femoral insufficiency fractures with long-term use have been reported recently.<sup>[5,6,15,16]</sup> On the other hand, glucocorticoids have a suppressive effect on bone metabolism and is accepted have an effect on the susceptibility to femoral insufficiency fractures.<sup>[7,10]</sup> In our series, three patients were using alendronate and one was using steroids in the long-term.

Another observation in our cases was the occurrence of concomitant fractures in the same femur. In one of our cases (Patient 1), we observed an additional subtrochanteric fracture on one side and an intertrochanteric fracture on the contralateral site after fixation of the di-

aphyseal fractures (Fig. 2e). In another case, a concomitant stress fracture was seen in the mid-diaphysis below a subtrochanteric fracture (Fig. 3a). The type of fixation in femoral insufficiency fractures is a controversial issue. We believe that the pathology involves the entire femur, not just a particular region. Therefore, we suggest that the whole femur from the neck to the supracondylar area should be included in the fixation by using a cephalomedullary nail. Similarly, Bjørgul and Reigstad<sup>[24]</sup> reported a patient with subtrochanteric stress fracture who was treated with a DHS plate. The patient later had additional fractures distal to the plate. The case was revised using an IMN with proximal locking with two transverse screws. Since the proximal fixation did not extend to the neck, the patient was admitted with a femoral neck fracture afterwards. Patton et al.<sup>[25]</sup> also suggested that the risk of proximal femoral fracture increases after conventional locking IMN, especially in female patients over 60 years of age. The authors also recommended cephalomedullary nailing to protect the femoral neck from subsequent fractures.

The major limitation of our study was the retrospective collection of a limited number of patients. As our awareness of these specific fractures has increased over the last several years, we may not have identified all similar cases prior to that period.

In conclusion, we can suggest 'excessive medial femoral bowing' as an additional radiologic pattern to the radiologically defined stress reactions of atypical femoral fractures. Moreover, we suggest that femoral insufficiency fractures should be treated with long cephalomedullary nails which fix the femur from the neck to the supracondylar area. However, excessive femoral bowing complicates IMN introduction.

**Conflicts of Interest:** No conflicts declared.

## References

1. Einhorn TA, Bogdan Y, Tornetta P 3rd. Bisphosphonate-associated fractures of the femur: pathophysiology and treatment. *J Orthop Trauma* 2014;28:433-8. [CrossRef](#)
2. Giusti A, Hamdy NA, Papapoulos SE. Atypical fractures of the femur and bisphosphonate therapy: A systematic review of case/case series studies. *Bone* 2010;47:169-80.
3. Çakmak S, Mahiroğulları M, Keklikçi K, Sarı E, Erdik B, Rodop O. Bilateral low-energy sequential femoral shaft fractures in patients on long-term bisphosphonate therapy. *Acta Orthop Traumatol Turc* 2013;47:162-72. [CrossRef](#)
4. Graham J, Irgit K, Smith WR, Bowen TR. Diaphyseal femur fractures associated with bisphosphonate use. *Acta Orthop Traumatol Turc* 2013;47:255-60. [CrossRef](#)
5. Murphy CG, O'Flanagan S, Keogh P, Kenny P. Subtrochanteric stress fractures in patients on oral bisphosphonate therapy: an emerging problem. *Acta Orthop Belg* 2011;77:632-7.
6. Yoon RS, Hwang JS, Beebe KS. Long-term bisphosphonate usage and subtrochanteric insufficiency fractures: a cause for concern? *J Bone Joint Surg Br* 2011;93:1289-95.
7. Feldstein AC, Black D, Perrin N, Rosales AG, Friess D, Boardman D, et al. Incidence and demography of femur fractures with and without atypical features. *J Bone Miner Res* 2012;27:977-86. [CrossRef](#)
8. Weil YA, Rivkin G, Safran O, Liebergall M, Foldes AJ. The outcome of surgically treated femur fractures associated with long-term bisphosphonate use. *J Trauma* 2011;71:186-90. [CrossRef](#)
9. Ha YC, Cho MR, Park KH, Kim SY, Koo KH. Is surgery necessary for femoral insufficiency fractures after long-term bisphosphonate therapy? *Clin Orthop Relat Res* 2010;468:3393-8. [CrossRef](#)
10. Demiralp B, Ilgan S, Ozgur Karacalioglu A, Cicek EI, Yildirim D, Erler K. Bilateral femoral insufficiency fractures treated with inflatable intramedullary nails: a case report. *Arch Orthop Trauma Surg* 2007;127:597-601. [CrossRef](#)
11. Mashiba T, Hirano T, Turner CH, Forwood MR, Johnston CC, Burr DB. Suppressed bone turnover by bisphosphonates increases microdamage accumulation and reduces some biomechanical properties in dog rib. *J Bone Miner Res* 2000;15:613-20. [CrossRef](#)
12. Mashiba T, Turner CH, Hirano T, Forwood MR, Johnston CC, Burr DB. Effects of suppressed bone turnover by bisphosphonates on microdamage accumulation and biomechanical properties in clinically relevant skeletal sites in beagles. *Bone* 2001;28:524-31. [CrossRef](#)
13. Boivin GY, Chavassieux PM, Santora AC, Yates J, Meunier PJ. Alendronate increases bone strength by increasing the mean degree of mineralization of bone tissue in osteoporotic women. *Bone* 2000;27:687-94. [CrossRef](#)
14. Goh SK, Yang KY, Koh JS, Wong MK, Chua SY, Chua DT, et al. Subtrochanteric insufficiency fractures in patients on alendronate therapy: a caution. *J Bone Joint Surg Br* 2007;89:349-53. [CrossRef](#)
15. Kwek EB, Goh SK, Koh JS, Png MA, Howe TS. An emerging pattern of subtrochanteric stress fractures: a long-term complication of alendronate therapy? *Injury* 2008;39:224-31. [CrossRef](#)
16. Lenart BA, Lorich DG, Lane JM. Atypical fractures of the femoral diaphysis in postmenopausal women taking alendronate. *N Engl J Med* 2008;358:1304-6. [CrossRef](#)
17. Lenart BA, Neviasser AS, Lyman S, Chang CC, Edobor-Osula F, Steele B, et al. Association of low-energy femoral fractures with prolonged bisphosphonate use: a case control study. *Osteoporos Int* 2009;20:1353-62. [CrossRef](#)
18. Puhaindran ME, Farooki A, Steensma MR, Hameed M,

- Healey JH, Boland PJ. Atypical subtrochanteric femoral fractures in patients with skeletal malignant involvement treated with intravenous bisphosphonates. *J Bone Joint Surg Am* 2011;93:1235-42. [CrossRef](#)
19. Wang K, Moaveni A, Dowrick A, Liew S. Alendronate-associated femoral insufficiency fractures and femoral stress reactions. *J Orthop Surg (Hong Kong)*. 2011;19:89-92.
20. Cermak K, Shumelinsky F, Alexiou J, Gebhart MJ. Case reports: subtrochanteric femoral stress fractures after prolonged alendronate therapy. *Clin Orthop Relat Res* 2010;468:1991-6. [CrossRef](#)
21. Isaacs JD, Shidiak L, Harris IA, Szomor ZL. Femoral insufficiency fractures associated with prolonged bisphosphonate therapy. *Clin Orthop Relat Res* 2010 Dec;468:3384-92. [CrossRef](#)
22. Shane E, Burr D, Ebeling PR, Abrahamsen B, Adler RA, Brown TD, et al. Atypical subtrochanteric and diaphyseal femoral fractures: report of a task force of the American Society for Bone and Mineral Research. *J Bone Miner Res* 2010;25:2267-94. [CrossRef](#)
23. Puah KL, Tan MH. Bisphosphonate-associated atypical fracture of the femur: Spontaneous healing with drug holiday and re-appearance after resumed drug therapy with bilateral simultaneous displaced fractures-a case report. *Acta Orthop* 2011;82:380-2. [CrossRef](#)
24. Bjørgul K, Reigstad A. Atypical fracture of the ulna associated with alendronate use. *Acta Orthop* 2011;82:761-3.
25. Patton JT, Cook RE, Adams CI, Robinson CM. Late fracture of the hip after reamed intramedullary nailing of the femur. *J Bone Joint Surg Br* 2000;82:967-71. [CrossRef](#)