



ELSEVIER

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Trauma Case Reports

journal homepage: www.elsevier.com/locate/tcr

Case Report

Valgus osteotomy for atypical interprosthetic femoral fracture with lateral bowing of the femur

Sammy Banno^{*}, Tomonori Baba, Hiroki Tanabe, Seiya Ishii, Yuta Jinnai, Yasuhiro Homma, Taiji Watari, Kazuo Kaneko

Department of Orthopaedic Surgery, Juntendo University School of Medicine, 2-1-1, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

ARTICLE INFO

Keywords:

Interprosthetic femoral fracture
Atypical femoral fracture
Atypical interprosthetic femoral fractures
Re-fracture
Valgus osteotomy
Orthogonal plate

ABSTRACT

Introduction: In recent years, it has been reported that periprosthetic femoral fractures in the form of atypical femoral fractures (AFFs) are found occasionally as difficult-to-treat conditions. To date, there have been no reports of interprosthetic femoral fractures (IPFFs) having the form of AFFs. We report a case of an atypical IPFF with breakage of the plate due to abnormal femoral alignment.

Case report: A 70-year-old woman was admitted. She underwent left knee replacement and left hemi-arthroplasty at ages 61 and 60. And she had been taking bisphosphonate for 5 years. A plain X-ray revealed IPFF. The fracture was a complete transverse fracture with circumscribed thickening of the lateral cortical bone ("beak sign") at the fracture site. She underwent surgery. A reversed condylar locking compression plate (LCP) was used for internal fixation. Subsequently, she could walk without particular pain. Five months after the operation, she heard the snap of a bone breaking, and had difficulty walking. Plain X-ray revealed a re-fracture of the fracture site and breakage of the plate at the same high position. She underwent re-operation. A valgus osteotomy was performed at an angle of 15°. A reversed condylar LCP was used on the lateral side of the femur. A bone grafting was performed focusing on the fracture site. In addition, a short-LCP was fixed anteriorly to the femur. The bone union 1 year and 6 months postoperatively. She could walk, with no impairment being noted regarding ADL.

Conclusions: We performed osteosynthesis for an IPFF having the characteristics of AFF, but the patient suffered breakage of the plate and re-fracture. Bone union was achieved as a result of re-operation that consisted of valgus osteotomy of the fracture site in combination with autologous bone grafting and double orthogonal plating.

Introduction

Atypical femoral fractures (AFFs) occur in the subtrochanteric region or femoral shaft. These fractures differ from typical fractures in that there is no underlying trauma or minor trauma causes transverse fractures [1]. AFFs are defined in the American Society of Bone and Mineral Research (ASBMR) Task Force report, while periprosthetic femoral fractures (PFFs) are not [1]. In recent years, however, it has been reported that PFFs in the form of AFF are found occasionally as difficult-to-treat conditions. Fractures that occur between the proximal (hip) and distal (knee) implants in the ipsilateral femur are referred to as interprosthetic femoral fractures (IPFFs) [2]. To

^{*} Corresponding author.

E-mail address: sbanno@juntendo.ac.jp (S. Banno).

<https://doi.org/10.1016/j.tcr.2020.100381>

Accepted 6 December 2020

Available online 10 December 2020

2352-6440/© 2020 The Authors.

Published by Elsevier Ltd.

This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

date, there have been no reports of IPFFs having the form of AFFs. We report a case of an atypical IPFF with breakage of the plate due to abnormal femoral alignment.

Case report

A 70-year-old woman was transported to our hospital with a chief complaint of left femoral pain. She had rheumatoid arthritis since she was 50 years old, and underwent left knee replacement at ages 61. Left hemi-arthroplasty was performed for a left femoral neck fracture when she was 60. She had been taking bisphosphonate for 5 years. Regarding ADL, she was able to walk independently, and she felt pain in the left femoral region 3 days before the injury. However, femoral pain subsequently increased while she was at home, and she fell down. Plain X-ray performed at our hospital revealed IPFF (Unified Classification System (UCS) Type D, (Femoral stem stable), Baba classification Type1B-inter) (Fig. 1a). The fracture was a complete transverse fracture with circumscribed thickening of the lateral cortical bone (“beak sign”) at the fracture site. Her fracture corresponded to all five major features put forward by ASBMR.

This UCS Type D fracture was treated with a lateral locking plate with bicortical and monocortical screws with cables because of the well-fixed prosthesis and good bone stock.

Surgical procedure

She underwent surgery in the lateral decubitus position under general anesthesia. Approaching from the lateral side of the femur, we reduced the fracture anatomically while preserving the periosteum as much as possible. A reversed condylar locking compression plate (LCP Distal Femur Plate, Johnson & Johnson, New Brunswick, New Jersey, USA) was used for internal fixation (Fig. 1b).

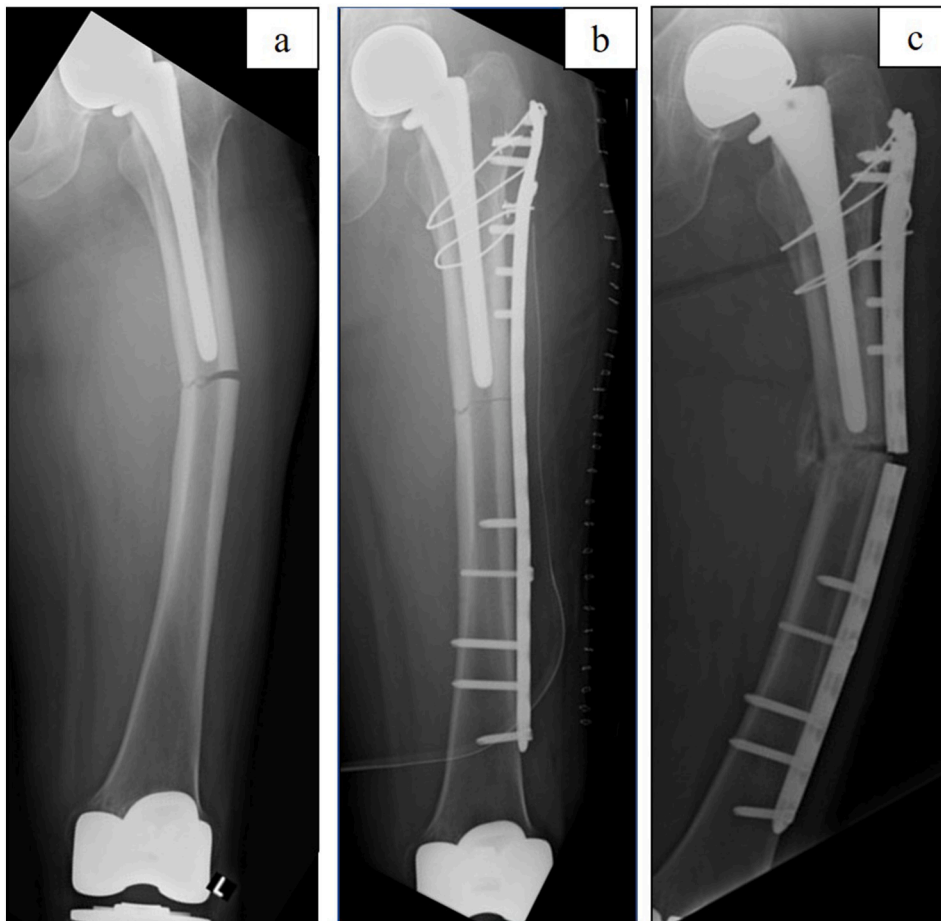


Fig. 1. The radiographs of the femoral (anterior view).

a: The first injury. The fracture was a complete transverse fracture.

b: After the first surgery.

c: The 5 months after the first surgery. Re-fracture of the fracture site and breakage of the plate.

Postoperative treatment

The patient was non-weight-bearing on the affected side for 4 weeks postoperatively, after which partial weight-bearing was allowed. At 8 weeks after surgery, walking exercise with full weight-bearing was started, and she was subsequently able to walk without particular pain.

Re-fracture and re-operation

Five months after the operation, the patient heard the snap of a bone breaking, and had difficulty walking. Plain X-ray revealed a re-fracture of the fracture site and breakage of the plate at the same high position (Fig. 1c). Re-operation was performed in the lateral decubitus position under general anesthesia (Fig. 2a). Fibrous tissue at the fracture site was removed, and valgus osteotomy (lateral closing wedge osteotomy) was performed at an angle of 15°. A reversed condylar LCP was used on the lateral side of the femur. Although sufficient bone contact was obtained on the medial side of the fracture site, there was still a small gap in the fracture site. Therefore, autologous bone was taken from the ipsilateral ilium, and bone grafting was performed focusing on the fracture site. In addition, a short-LCP was fixed anteriorly to the femur.

Postoperative treatment (re-operation)

Following the operation, the patient had an 8-week non-weight-bearing period, after which full weight-bearing gait was allowed. Callus formation was observed at 6 months postoperatively (Fig. 2b), and bone union 1 year and 6 months postoperatively (Fig. 2c). She was able to walk at 2 years postoperatively, with no impairment being noted regarding ADL.

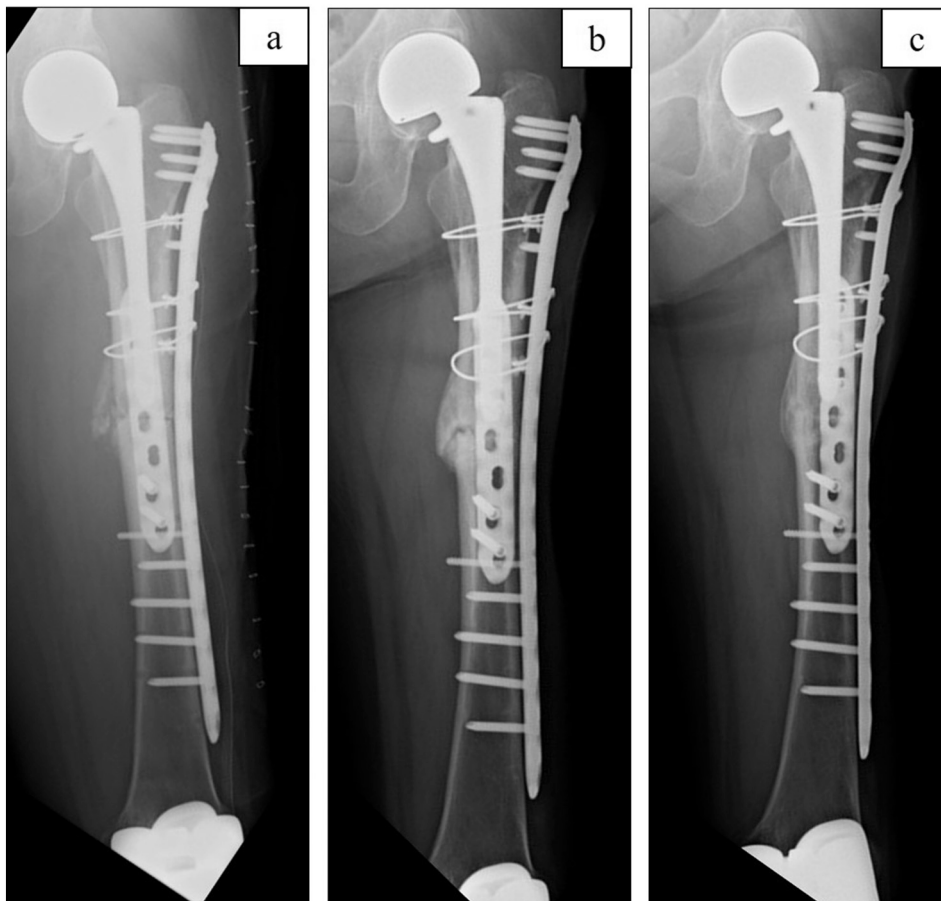


Fig. 2. The radiographs of the femoral (anterior view: after re-operation).

a: After re-operation. Femur laterally bowing was improved. The short plate was fixed anteriorly to the femur.

b: 6 months postoperatively. The callus formation was observed.

c: 1 year and 6 months postoperatively. The bone union was observed.

Discussion

The developmental mechanism of AFF is considered to involve marked suppression of bone turnover (SSBT) by bone resorption inhibitors, such as bisphosphonates, which causes excessive calcification, leading to bone fragility. Even a minor trauma can result in a fracture in the presence of a concentration of stress due to lateral bowing of the femur and accumulation of microdamage due to repeated loading [3]. AFFs may occur in the absence of SSBT, it has been reported that lateral bowing of the femur is a particular risk for AFFs [4]. As she had a long history of bisphosphonate use and lateral bowing of the femur, our patient was at high risk of developing AFF. The previously reported risk factors for IPFF include uncemented fixation of the femoral stem [5,6], a wider femoral marrow cavity/thinner cortex distal to the hip stem [5], and a distance of less than 110 mm between the tips of the hip and knee stems. However, no reliable preventive measures have been established. There are reports of PFFs having the characteristics of AFFs, but there are no reports on IPFFs with the characteristics of AFFs.

For classification of interprosthetic femoral fracture, a unified classification system (UCS) applying the Vancouver classification to periprosthetic fractures of the whole body has recently been reported, incorporating interprosthetic femoral fracture as Type D of this classification [7]. UCS Type D fractures include all interprosthetic or fractures occurring between a total hip and knee arthroplasty. Their treatment again depends on the stability of the prosthetic components, the quality of bone stock, and on the possibility of fixation distally in the condylar area. Locked plates are presently the preferred means of fixation. The authors of Periprosthetic Fracture Management (AO trauma) suggest approaching Type D fractures by separate analyses of implant stability as well as the available bone stock around each of the implant. Treatment should be based upon those separate analyses [7]. Vancouver Type B2,3 (Loose stem) fractures always have a loosened prosthesis, which require a change of the prosthesis. Vancouver Type B1 (Well-fixed stem) fracture is well-fixed prosthesis. This is commonly treated with a lateral locking plate with bicortical and monocortical screws with cables [7].

This UCS Type D fracture was well-fixed prosthesis and good bone stock. For that reason, we did not choose to revision of the hemiarthroplasty to a long stem implant.

MacKenzie SA et al. reported that nonunion and mechanical complication of fixation occurred in 13% and 25%, respectively, in

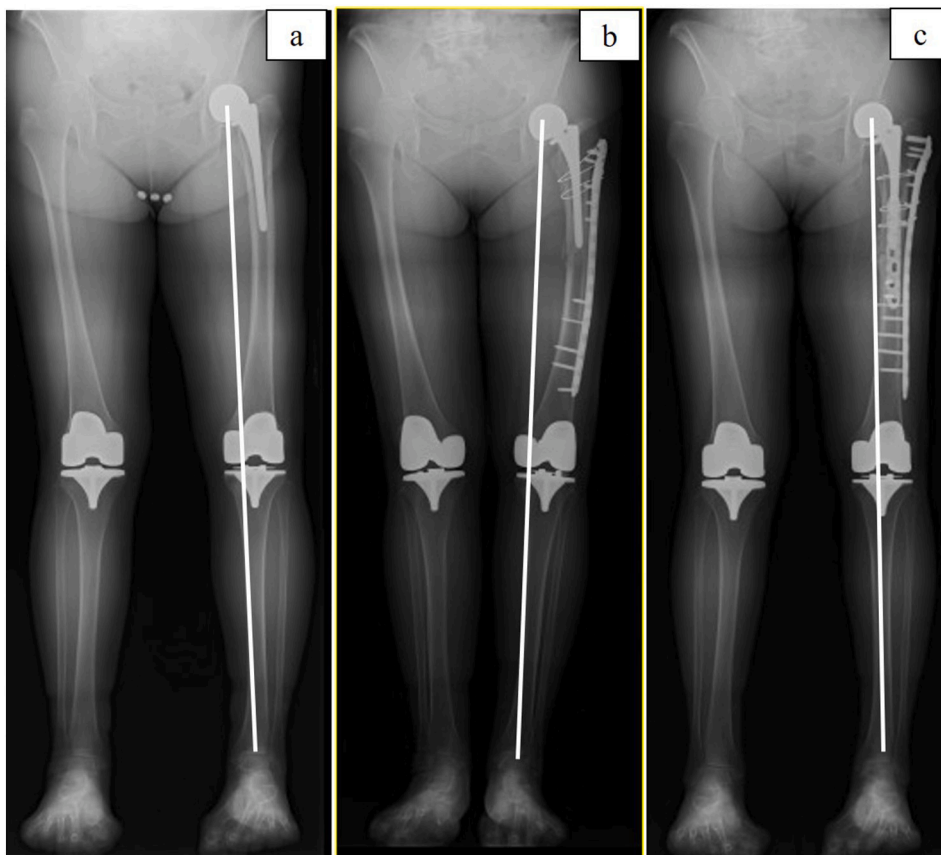


Fig. 3. Standing lower limb full length simple X-ray (anteroposterior view) time series.

The solid line is the functional axis.

a: Before the first injury. The femur laterally bowing was observed.

b: The 3 months after the first surgery. The femur laterally bowing was observed.

c: The 4 months post re-operation. The femur laterally bowing was improved.

patients with atypical PFF (APFF) [8]. When a standard LCP is used for APFF, the proximal femoral stem and a screw interfere with each other, raising a concern of insufficient fixation [9]. For this reason, we use a condylar LCP, which allows more screws to be inserted into the proximal bone fragments. Indeed, we performed the initial surgery in a similar manner in the present case, but a refracture of the fracture site and breakage of the plate on the lateral side. We accordingly reviewed imaging data on refracture of the fracture site and breakage of the plate on the lateral side prior to reoperation, and found that there was extreme lateral bowing of the femur of the affected side on standing position X-ray images before the occurrence of the first fracture event and after the initial surgery (Fig. 3a, b). For classic PFFs, union can be achieved in 2 to 3 months with anatomical reduction and internal fixation using appropriate implants, even in the presence of lateral bowing of the femur. However, the present case was an AFF, and the extent of bone union was markedly low. Although callus formation was observed on the medial side at 4 months postoperatively, bone union was not achieved. Despite anatomical reduction and internal fixation, tensile stress occurs on the convex side of the bowing site (i.e., fracture site), which we believe resulted in the breakage of the plate.

The following were considered necessary for achieving bone union in fracture patients who have low bone union capacity and require a long time for bone union, as in the present case: (1) correction of femoral alignment, (2) bone grafting, (3) and reinforcement of internal fixation. Taking these into consideration, we planned reoperation. We first found that the alignment of the femur could be similar to that of the unaffected femur by performing a lateral closing edge osteotomy at an angle of about 15°, with the apex set at the laterally bowing fracture site (Fig. 3c). We chose the less invasive lateral closing wedge osteotomy instead of the medial opening wedge osteotomy. This osteotomy suggests that the stress applied to the plate installed on the lateral side can be attenuated. This method should be given the highest priority as union has been obtained by using a single plate alone in APFFs with minimal bowing [10]. There is no clear evidence for bone grafting in AFF. However, autologous bone grafting to increase biological activity is promising because the fracture site is in the state of SSBT. Regarding reinforcement of internal fixation, the bone union period in our patient may be long, raising a concern that plate breakage may occur before bone union. In addition to a standard single plate, augmentation by strut allografting or double plating is required [11]. As strut allografting is not readily available at all facilities in Japan, we chose double orthogonal plating.

Therefore, the fact of associating a graft, 2 plates and screws in the second surgery, in addition to not weight bearing in 8-weeks, could be a confounding factor regarding valgus osteotomy as a result of consolidation.

We performed osteosynthesis for an IPFF having the characteristics of AFF, but the patient suffered breakage of the plate and refracture. Bone union was achieved as a result of re-operation that consisted of valgus osteotomy of the fracture site in combination with autologous bone grafting and double orthogonal plating.

However, valgus implies, worsening valgus of the ankle and makes flat feet worse, it destabilizes the knee in the long term in knee arthroplasties of patients with RA and abduction power can be lost in the gluteus with the risk of hip replacement instability and worsening function.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Declaration of competing interest

The author(s) declare(s) no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Acknowledgments

The authors have no acknowledgments.

References

- [1] E. Shane, D. Burr, B. Abrahamsen, et al., Atypical subtrochanteric and diaphyseal femoral fractures: second report of a task force of the American Society for Bone and Mineral Research, *J. Bone Miner. Res.* 29 (1) (2014) 1–23.
- [2] P. Kenny, J. Rice, W. Quinlan, Interprosthetic fracture of the femoral shaft, *J. Arthroplast.* 13 (3) (1998) 361–364.
- [3] C.V. Odvina, J.E. Zerwekh, D.S. Rao, et al., Severely suppressed bone turnover: a potential complication of alendronate therapy, *J. Clin. Endocrinol. Metab.* 90 (3) (2005) 1294–1301.
- [4] S. Sasaki, N. Miyakoshi, M. Hongo, et al., Low-energy diaphyseal femoral fractures associated with bisphosphonate use and severe curved femur: a case series, *J. Bone Miner. Metab.* 30 (5) (2012) 561–567.
- [5] J.A. Valle Cruz, A.L. Urda, L. Serrano, et al., Incidence of and risk factors for femoral fractures in the gap between hip and knee implants, *Int. Orthop.* 40 (8) (2016) 1697–1702.
- [6] T. Baba, K. Kaneko, Y. Homma, et al., The Baba classification focused on implant designs is useful in setting the therapeutic strategy for interprosthetic femoral fracture, *Eur. J. Orthop. Surg. Traumatol.* 28 (2) (2018) 247–254.
- [7] M. Schütz, C. Perka (Eds.), *Periprosthetic Fracture Management*, Georg Thieme, Stuttgart, 2013.
- [8] S.A. MacKenzie, R.T. Ng, G. Snowden, et al., Periprosthetic atypical femoral fractures exist and are associated with duration of bisphosphonate therapy, *Bone Joint J.* 101B (10) (2019) 1285–1291.

- [9] T. Baba, Y. Homma, I. Morohashi, et al., Is internal fixation using a reversed condylar locking plate useful for treating Vancouver type B1 periprosthetic femoral fractures? *Eur. Orthop. Traumatol.* 6 (3) (2015) 137–143.
- [10] T. Wakayama, Y. Saita, T. Baba, et al., Pathological relationship of osteomalacia at the site of atypical periprosthetic femoral shaft fracture after typical femoral neck fracture occurred in the patient with rheumatoid arthritis: a case report, *Journal of Rheumatic Diseases and Treatment* 17 (1) (2015).
- [11] F.J. Muller, M. Galler, B. Fuchtmeier, Clinical and radiological results of patients treated with orthogonal double plating for periprosthetic femoral fractures, *Int. Orthop.* 38 (2014) 2469–2472.