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Case Report

Unstable AO/OTA type 31-A1.2 intertrochanteric femur fracture: An unusual case report

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A R T I C L E I N F O

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A B S T R A C T

AO/OTA type 31-A1.2 intertrochanteric femoral fractures generally are considered stable intertrochanteric fractures. We report a case of an unstable AO/OTA type 31-A1.2 intertrochanteric femoral fracture. Primary internal fixation was performed with a long cephalomedullary nail taking instability into account. Postoperative X-rays showed an acceptable reduction with a slight fracture gap in extension on the lateral trochanteric side. However, additional salvage surgery was required because the long cephalomedullary nail broke as a result of the instability caused by non-union and varus deformity of the proximal femur. More attention should be directed to strategies of primary internal fixation including choice of fixation instrumentation in terms of mechanical stability because this type of fracture can be remarkably unstable despite radiographic diagnosis of a usually stable AO/OTA classification type 31-A1.2 fracture.

Introduction

Japan is an aging society, with 28.1% of the population ≥65 years old in 2018 according to the Japanese Bureau of Statistics. In addition, the number of hip fractures has dramatically increased in recent years, from 53,200 in 1987 to 175,700 in 2012 [1]. In January 2018, The AO/OTA Fracture and Dislocation Classification Compendium was revised [2], and the trochanteric region was separated into two groups (31A1 and 31A2). The differentiation between groups was based on the lateral wall thickness from a reference point 3.0 cm below the innominate tubercle of the greater trochanter angled 135° upward to the fracture line on an anteroposterior X-ray. Lateral wall thickness ≥20.5 mm and <20.5 mm were classified A1 and A2, respectively. Lateral wall thickness is an important characteristic for the stability of an intertrochanteric fracture [3,4]. Only 2- part fractures with lateral wall thickness ≥20.5 mm (31A1.2) and a small lesser trochanteric fragment (31A1.3) generally are considered stable intertrochanteric fractures.

We report a case of an unstable AO/OTA type 31-A1.2 intertrochanteric femoral fracture. Although operative treatment was performed with a long cephalomedullary nail taking into account instability, additional salvage surgery was required because the long cephalomedullary nail was broken as a result of the instability caused by non-union and varus deformity of the proximal femur.

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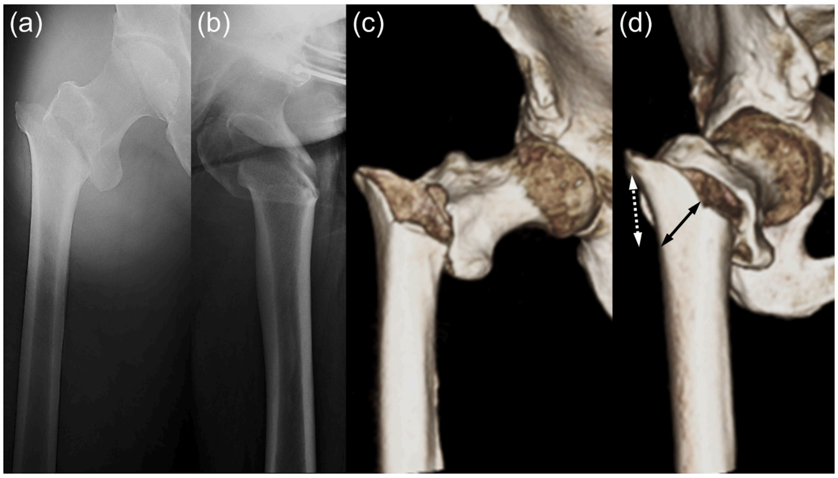


Fig. 1. Preoperative (a) anteroposterior and (b) lateral radiograph. Preoperative (c) anteroposterior and (d) lateral three-dimensional computed tomography. Anteroposterior radiograph shows radiological sign of reverse epsilon ‘3’. The distance between the innominate tubercle of the greater trochanter and the reference point is 3.0 cm as shown by the double-ended white arrow. Lateral wall thickness between the reference point and the fracture line is 27 mm as shown by the double-ended black arrow.

Case presentation

A 67-year-old man was injured in a traffic accident and was transported to the emergency room. The patient had uncontrolled type 2 diabetes mellitus as a medical comorbidity. Physical examination revealed external rotation of the leg, swelling and pain in the proximal femur without an obvious wound. X-ray imaging showed a displaced intertrochanteric femoral fracture with shortening (Fig. 1a, b). Computed tomography (CT) demonstrated a displaced intertrochanteric femoral fracture with a fracture line that extended from the innominate tubercle to the inferior aspect of the lesser trochanter. The proximal fragment was flexed and externally rotated and the distal fragment was externally rotated. Lateral wall thickness from a reference point 3.0 cm below the innominate tubercle of the greater trochanter angled 135° upward to the fracture line was 27 mm. This fracture was diagnosed as a type 31-A1.2 intertrochanteric femoral fracture according to the AO/OTA Fracture and Dislocation Classification Compendium (Fig. 1c, d).

The patient was treated with direct traction of his proximal tibia to prevent shortening and maintain anatomical alignment. Four days were necessary in order to control blood glucose level after injury. An open reduction and internal fixation with the patient in a supine position on a traction table was performed using a Gamma3 long nail (Stryker, Kiel, Germany) in consideration of the instability of the fracture. Postoperative X-rays showed an acceptable reduction of the intertrochanteric femur with a slight fracture gap in extension on the lateral trochanteric side (Fig. 2). Passive and active range of motion of the hip joint was allowed immediately and full weightbearing was permitted after 4 weeks.

Five months postoperatively the patient presented to the hospital again with progressive pain of the right hip. Radiographs revealed a failure of the Gamma3 long nail with a fracture at the junction of the proximal nail and lag screw, non-union and varus deformity of the proximal femur (Fig. 3). Immediately after this finding, revision surgery was planned to remove the broken long nail and restore proximal femoral valgus angulation in a lateral decubitus position. A technique of interference between the nontipped

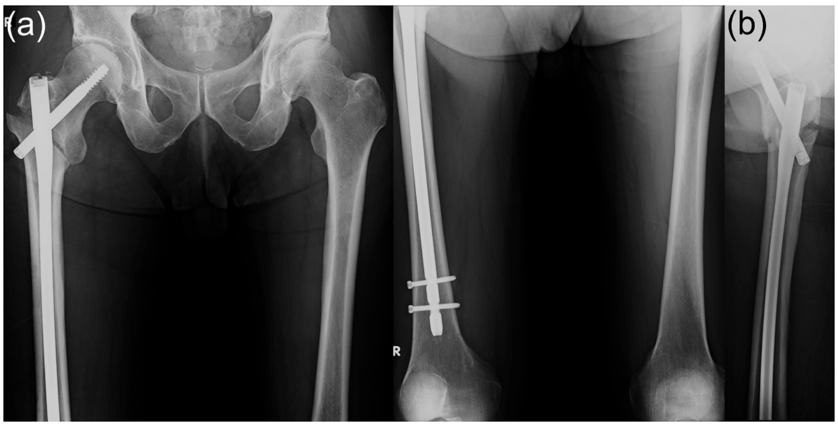


Fig. 2. Postoperative (a) anteroposterior and (b) lateral radiographs.

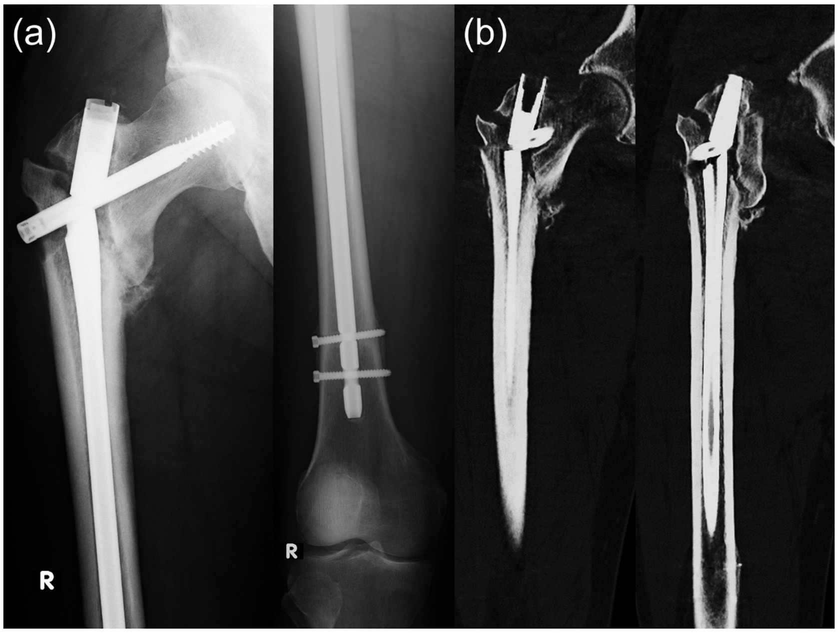


Fig. 3. Five months after surgery, anteroposterior (a) radiograph and (b) computed tomography.

guide wire and the ball-tipped guidewire was used to remove the nail (Fig. 4). After removing the nail, valgus correction of 15–20° with a 95°–angled blade plate (Synthes, West Chester, Pennsylvania, USA) was performed to stabilize the fracture. A chipping procedure using a chisel without bone grafting also was performed at the non-union site (Fig. 5a). The patient was restricted to toe-touch weightbearing for 8 weeks but range of motion was allowed immediately. Fifty percent weight-bearing with a crutch was commenced from 9 to 12 weeks postoperatively and full weight bearing was permitted after that.

At the final follow-up visit 1 year after the revision surgery, concentric reduction with bone remodeling was evident on radiographs (Fig. 5b). Hip function was assessed using the Japanese Orthopedic Association hip score (JOAHS) [5] and the Harris Hip Score (HHS) [6]. JOAHS showed pain at 35 points, range of motion at 17 points, walking at 15 points, activities of daily living at 20 points, with a total of 87 points. HHS showed pain at 40 points, function at 30 points, activity at 14 points, absence of deformity at 4 points, range of motion at 4 points, with a total of 92 points.

Discussion

To the best of our knowledge, only a few reports of broken long cephalomedullary nails have been documented [7–9]. In these previous reports a long cephalomedullary nail was broken after primary treatment for subtrochanteric fracture, atypical femoral fracture or the distal femoral shaft, but there are no previous reports about treatment for intertrochanteric femoral fracture. The important point of our strategy for salvage surgery is the technique for removal and methods of stable internal fixation in the revision surgery.

First, various techniques including specially designed tools have been reported for the extraction of a broken nail as follows: hook [10], hook with wire [11,12], modified smooth guide wire [13], washer and guide wire [14], press fitting of smaller size nail [15],

Fig. 4. Intraoperative view of the long cephalomedullary nail and screws after removal.

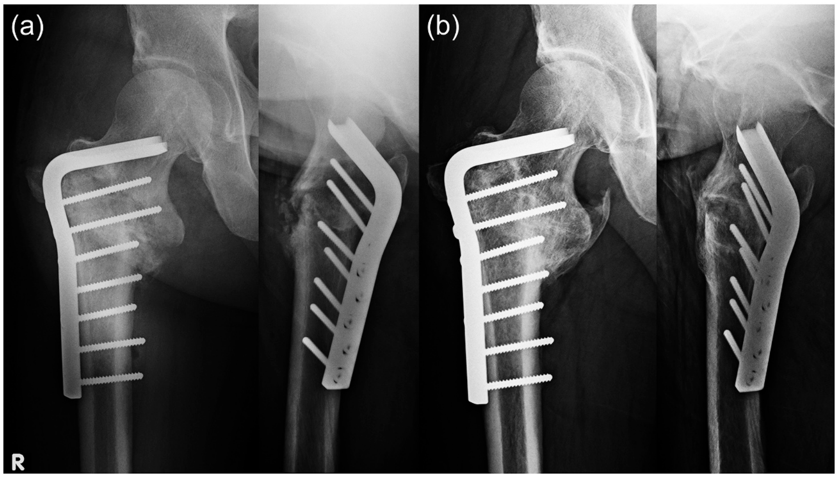


Fig. 5. (a) Anteroposterior and lateral radiographs after re-fixation. (b) Anteroposterior and lateral radiographs one year after re-fixation.

Synthes solid nail extraction kit [16], flexible nail [17] and modified bent tip guide wire from the locking hole [18]. However, removal of a broken nail generally is challenging and difficult. As the technique of interference between the non-tipped guide wire and the ball-tipped guidewire is relatively safe and does not require any specific tool, this technique is commonly used [19,20]. In the current case, the technique was safe and successful for removing the broken long cephalomedullary nail. Second, another important matter was how refixation was undertaken in the revision surgery. Several methods of re-fixation in patients with failed internal fixation of the proximal femur have been reported including a reversed anatomical distal femoral locking compression plate; 90°, 95°, or 130° angled blade plates; a dynamic hip screw; or an intramedullary nail [7,9,21,22]. These reports provide evidence to support the valgus correction performed with a Schanz screw, 3.5 mm reconstruction plate or angled blade plate. Although these tools are useful options, an angled blade plate has the advantage of allowing the plate to be used as the reduction device. In accordance with another recent study of salvage treatment for a failed fixation of an intertrochanteric fracture, these results emphasize the need for valgus correction to compare the restoration of the femoral neck-shaft angle between groups with successful outcomes and those in which the surgical intervention failed [22]. In the present report, valgus correction of 15–20° with a 95°–angled blade plate was performed (Fig. 6). Weight bearing possibly should have been less aggressive and gradually increased during postoperative physical therapy because of the slight anterior gap detected on the lateral radiograph after revision surgery.

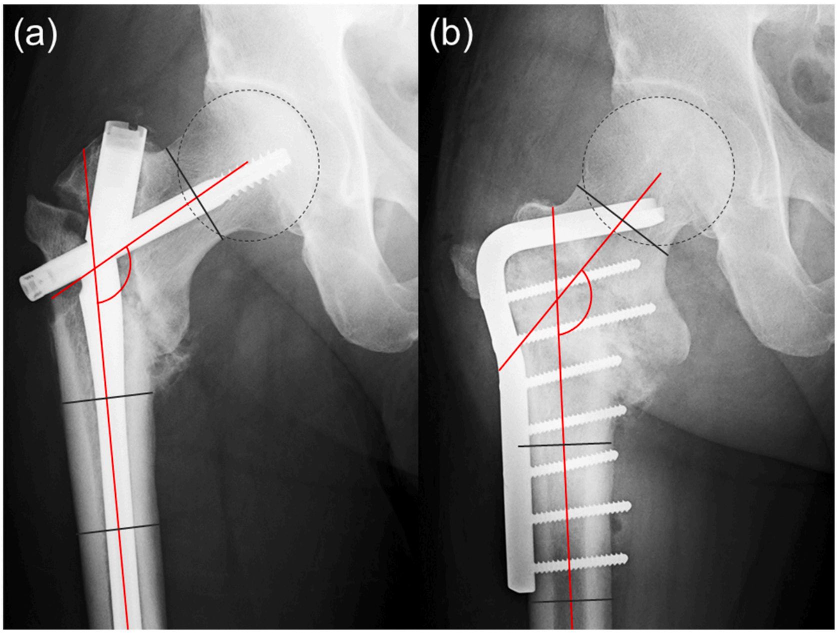
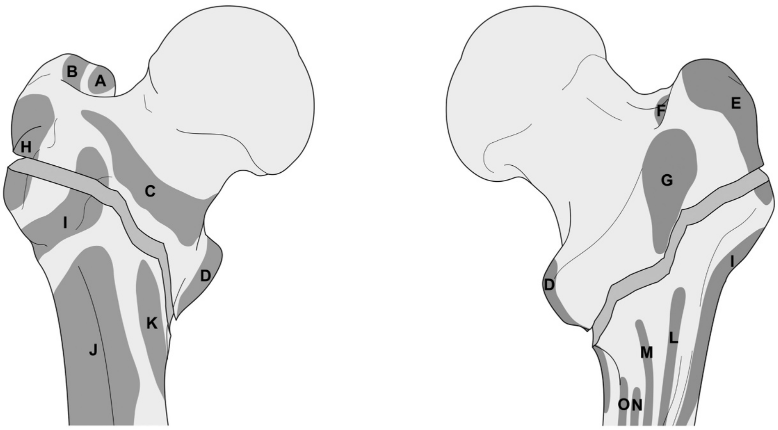


Fig. 6. Comparison between (a) anteroposterior radiographs before re-fixation and (b) anteroposterior radiographs after re-fixation. The femoral neck angle before and after re-fixation was 120° and 138°, respectively.



Proximal fragment	A	Obturator internus muscle Superior gemellus muscle Inferior gemellus muscle	E	Gluteus medius muscle
			F	Obturator externus muscle
			G	Quadratus femoris muscle
	B	Piriformis muscle		
	C	Iliofemoral ligament		
	D	Iliopsoas muscle		
Fracture line	H	Gluteus minimus muscle		
Distal fragment	I	Vastus lateralis muscle	L	Gluteus maximus muscle
	J	Vastus intermedius muscle	M	Adductor magnus muscle
	K	Vastus medialis muscle	N	Adductor brevis muscle
			O	Pectineus muscle

Fig. 7. Drawing of anatomical structures around the fracture line. Modified with permission from the Atlas of Human Anatomy, illustrated by Frank H. Netter, MD. All rights reserved.

In regard to availability of bone graft, Tzioupis C et al. reported ipsilateral Reamer-irrigator-aspirator autografting combined with recombinant human bone morphogenetic protein-7 and injectable hydroxyapatite cement [7]. Furthermore, Vaishya R et al. successfully treated patients using cortico-cancellous bone grafts from the contralateral iliac crest at the fracture site [21]. In contrast, bone union was achieved without bone grafting in all patients according to a study by Said et al. [23]. In the present report, hypertrophic non-union due to mechanical factors allowed inadequate mechanical stability that prevented appropriate biological processes to promote union, causing failure of the fixation. Hence, the tension and shear forces on the non-union were converted to compression forces by the effect of valgus correction with a 95°–angled blade plate, and bone union then was achieved using only a chipping procedure. Although it is generally thought that AO/OTA type 31-A1.2 intertrochanteric femoral fractures are stable, and reduction appeared acceptable from the postoperative X-rays, primary internal fixation failed as a result of a broken long nail caused by non-union and varus deformity of the proximal femur. Because of the slight malreduction, the fracture gap on the extension side was one main reason that compressive forces required for fracture union by sliding of the lag screw were not generated. Previous reports of a similar type of fracture demonstrated good clinical and radiological results of treatment with dynamic hip screws [24] and anti-rotation screws [25]. Although in the present report primary surgical treatment was performed with a cephalomedullary nail based on practice guidelines for unstable intertrochanteric fractures from the American Association of Orthopaedic Surgery [26], dynamic hip screws and an angled blade plate were useful primary fixation instruments to create mechanical stability for this type of fracture. The major advantage of sliding hip screws is the inter-fragmentary compressive force induced by sliding of the lag screw. In addition, based on the anatomical structure and the position of the fracture line from the innominate tubercle to the inferior lesser trochanter and muscles that were attached around the intertrochanteric line of the femur (Fig. 7), the intertrochanteric fracture in the present report was more severely unstable than most AO/OTA type 31-A1.2 intertrochanteric femoral fractures, even though lateral wall thickness was more than 20.5 mm. As established by the seminal study of radiological pattern by Chandak R et al. [16], the radiological sign of epsilon ‘ε’ on the left side and reverse epsilon ‘3’ on the right side (Fig. 1a) indicated a highly unstable situation. This type of fracture made the reduction more difficult than routine methods for an intertrochanteric femoral fracture. The attending orthopedic surgeon who performs primary internal fixation for AO/OTA type 31-A1.2 intertrochanteric femoral fractures should be alert to this possibility.

Conclusion

In the current case report, we present a case of unstable AO/OTA type 31-A1.2 intertrochanteric femoral fracture. Additional surgery was performed using an orthogonal plate with a 95° blade plate to salvage the broken long cephalomedullary nail that occurred as a result of instability caused by non-union and varus deformity. More attention should be directed to strategies of primary internal fixation including the choice of fixation instruments that will establish mechanical stability, understanding that the present type of fracture may be remarkably unstable despite radiographic diagnosis of an AO/OTA classification type 31-A1.2 fracture.

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Declaration of competing interest

The authors declare no conflicts of interest regarding the publication of this paper.

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