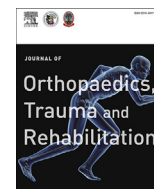


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Case Report

An Unusual Case of “Late” Central Protrusion of the Helical Blade of Proximal Femoral Nail Antirotation

防旋型股骨近端髓內釘的螺旋狀刀片中央突出

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ABSTRACT

Central protrusion, or “cut-through” of the helical blade in proximal femoral nail antirotation (PFNA), is a unique and novel complication. Cases reported in the literature were presented early in the postoperative period and were associated with no bone healing, and managed with either revision or total hip replacement. We reported a case that presented late in the postoperative period that showed some bone healing and was erroneously treated with removal of the implant, resulting in varus malunion after implant removal. Possible causes for late presentation, preventive measures, and the need for early surgical intervention are discussed.

中文摘要

防旋型股骨近端髓內釘的螺旋狀刀片中央突出的或切出，是獨特和新的併發症。早前文獻主要描述術後“早期”的病例，我們報告一個“晚期”的病例，並討論它的成因和預防方法。

Introduction

Intramedullary devices have revolutionized the treatment of unstable intertrochanteric fractures (31.A.2 and A.3 fractures according to the AO (Arbeitsgemeinschaft für Osteosynthesefragen) classification). They enable closer distance to the centre of axial loading, which results in a shorter lever arm and bending moment.

Proximal femoral nail antirotation (PFNA) is an intramedullary device that is advantageous because of its helical blade design, which provides rotational and angular stability to the fracture, in turn allowing patients to bear weight immediately after surgery. In addition, it increases the contact surface area between the blade and the femoral head cancellous bone in comparison with a column screw device. The cutout rate is lower with PFNA.^{1,2}

However, cut-through, defined by Frei et al³ as a central perforation of the PFNA blade into the hip joint without any displacement of the neck–head fragment, is a novel complication of PFNA.

The current report documents a late postoperative cut-through of the helical blade femoral head, which has not previously been reported in the literature.

Case report

An 80-year-old man with a history of diabetes mellitus, hypertension, and thyrotoxicosis was admitted to our unit after slipping and falling, which resulted in an AO 31A2.2 trochanteric fracture of the right hip (Figure 1). Closed reduction and internal fixation was performed within 48 hours and a 130°, 170-mm-long PFNA device was inserted. The procedure went smoothly and took 70 minutes, and predrilling into the femoral head without overdrilling occurred for placement of the spiral blade. Immediate postoperative X-rays showed satisfactory alignment with a neck-shaft angle of 127° and Garden alignment index of 165° in the anteroposterior view, whereas repeat radiographs at 2 months showed satisfactory reduction was maintained with a tip-apex distance of 19 mm and Garden alignment index of 163° and 172° in the anteroposterior and lateral view, respectively (Figure 2). The tip-apex distance and Garden alignment index in the lateral view cannot be determined during the immediate postoperative period because a straight lateral view was not available.

The patient started full weight-bearing walking exercise with a frame on postoperative Day 5 and was transferred to a rehabilitation centre on postoperative Day 7 for further training. When

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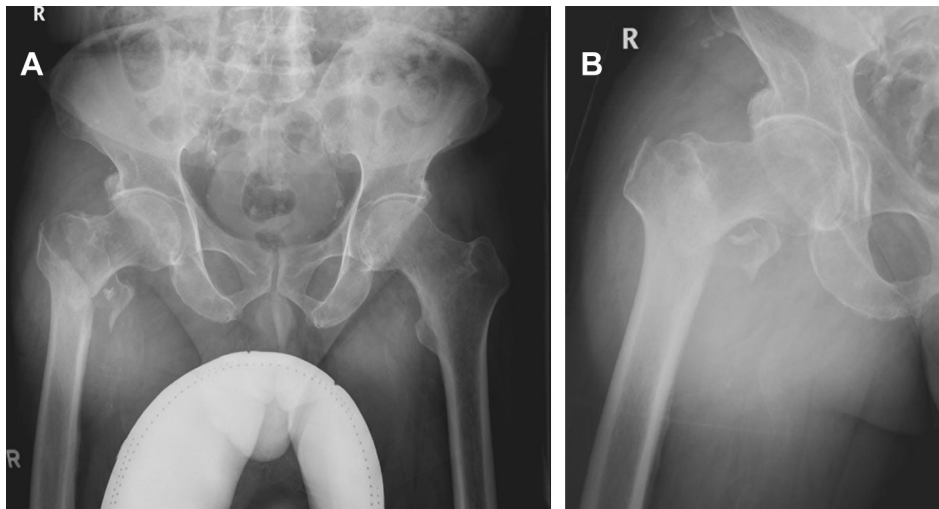


Figure 1. (A, B) Injury films of the right hip show an AO 31A2.2 trochanteric fracture.

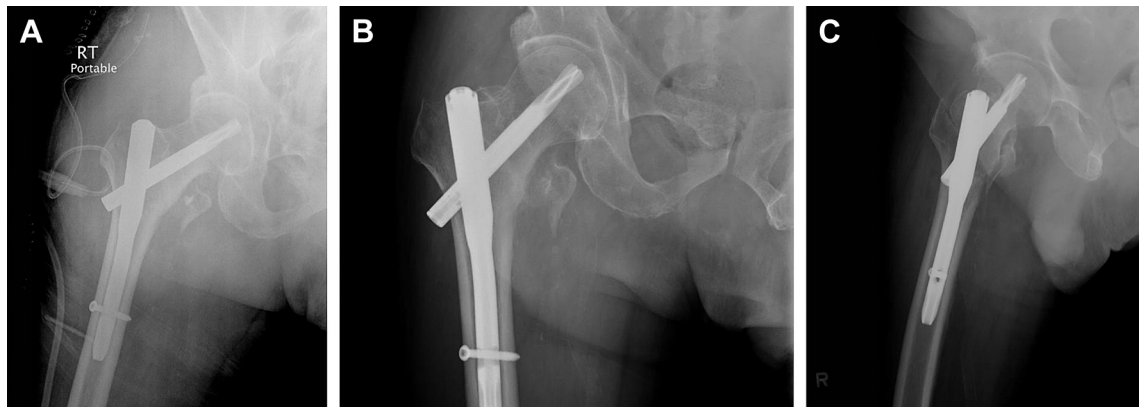


Figure 2. (A) Immediate postoperative radiograph shows good reduction. (B) Radiograph at 2 months shows that satisfactory reduction was maintained.

discharged, the patient managed to walk with a frame with good stability.

The patient was followed up at regular periods. The placement of the helical blade was at the centre of the femoral head in both the lateral and anteroposterior views at 4 months' follow-up (Figure 3). The patient had minimal hip pain and was able to walk unaided. He remained asymptomatic, but radiographs 6 months later revealed central protrusion of the helical blade with decreased tip-apex

distance of 14 mm (Figure 4). Some bone healing was present and there was no associated varus or rotational deformity. Nonsurgical treatment with partial weight-bearing walking exercise was adopted because the patient was relatively asymptomatic and callus was seen radiographically at 10 months (see Figure 5).

However, progression of central protrusion of the helical blade from the femoral head was found at 13 months postoperative. The patient experienced an increase in right hip pain. Serological,

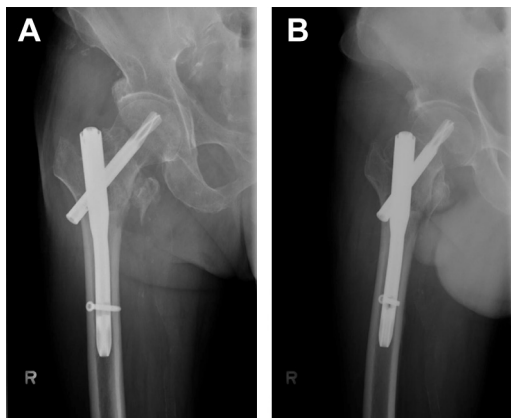


Figure 3. (A, B) Radiographs at 4 months reveal callus formation and good position of the femoral blade.

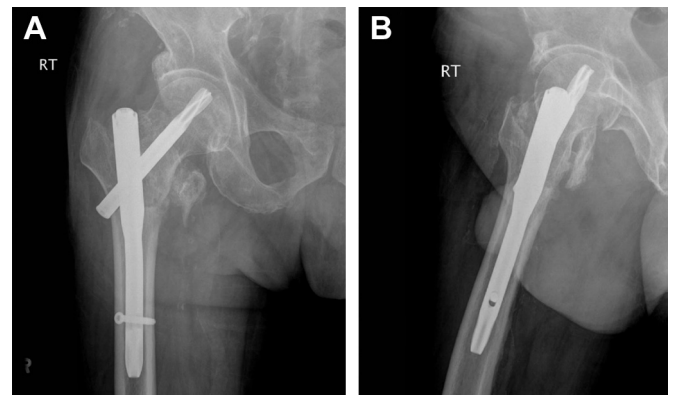


Figure 4. (A, B) Radiographs at 6 months show central migration of the helical blade without varus deformity.

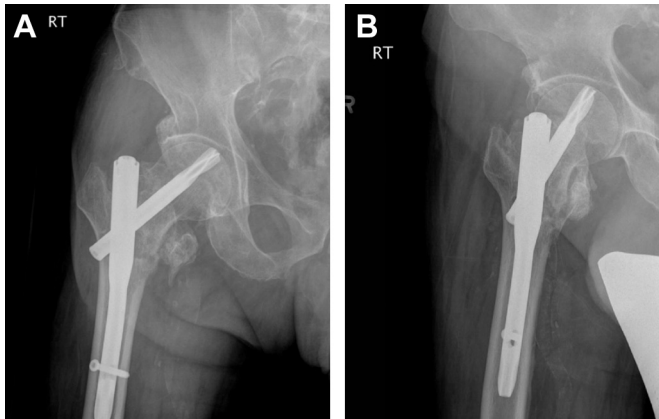


Figure 5. (A, B) Radiographs at 10 months show perforation of the femoral head by the helical blade.

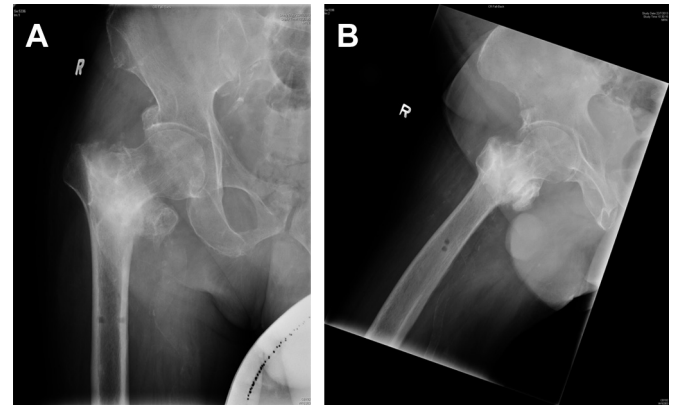


Figure 7. (A, B) Radiographs 3 months after the removal of the proximal femoral nail antirotation device show established varus malunion.

radiological, and clinical features of infection all were absent (see Figure 6).

The PFNA device was removed 15 months after the initial surgical procedure because of the persistent symptoms. Intraoperatively, the spiral blade became jammed within the nail and was removed with some difficulty. However, there were no obvious obstacles, such as abutting of the spiral blade with the lateral cortex of the femur, or soft tissue or callus formation at the blade–nail junction causing the jamming. Progressive varus deformity of the fracture was evident after removal of the device, and radiographs obtained 3 months after removal revealed varus malunion of the fracture (Figure 7). The patient could walk with a frame, but had mild residual hip pain and refused further revision surgery.

Discussion

Trochanteric fractures are a major health risk for elderly individuals, and the case load is on the rise because of the increase in the elderly population in Hong Kong. The best treatment remains controversial. For unstable fractures, the intramedullary nail performs better than the extramedullary one.⁴ The helical blade of the PFNA device was proven in biomechanical studies to be suitable in unstable trochanteric fractures.⁵ The unique design of the helical blade compresses cancellous bone to overcome rotational instability with subsequent varus deformity and cutout of the blade into the hip joint. Nevertheless, cases of central head penetration have been reported by different authors since 2008.^{3,6–10} Cutout was the

general term used to describe displacement of the spiral blade through the femoral head. Frei et al³ further clarified different types of perforations, and cutout was defined as an antero cranial perforation associated with a secondary varus displacement of the neck–head fragment. By contrast, cut-through was defined as a central perforation of the helical blade into the hip joint without displacement of the neck–head fragment.

A novel and unique complication is associated with the helical spiral blade in PFNA. In the series by Frei et al,³ the cut-through rate was even higher than the cutout rate (6.3% vs. 0.9%). There have been 12 cases of cut-through reported in the literature thus far.¹⁰ Although some were associated with direct trauma, one case was associated with technical error with the spiral blade abutting on the lateral cortex, another with low-grade infection, and others were without obvious causes. Revision surgeries were performed in all reported cases with either revision with a shorter spiral blade or total hip replacements.

Regarding etiology, many authors hypothesize that failure of the helical blade to lateralize is the primary reason for perforation of the femoral head as impaction at the fracture site progresses.^{3,6,8} The failure to lateralize can be partly attributed to potential disruption of the normal gliding mechanism of the spiral blade (inherent drawback of the gliding mechanism as it is equivalent to a short barrel sliding device). In addition, the Z-effect is characterized by medial and central migration of the spiral blade in relation to the nail. The changing site of support of the spiral blade at the nail–blade interface during cycling loading in walking will develop

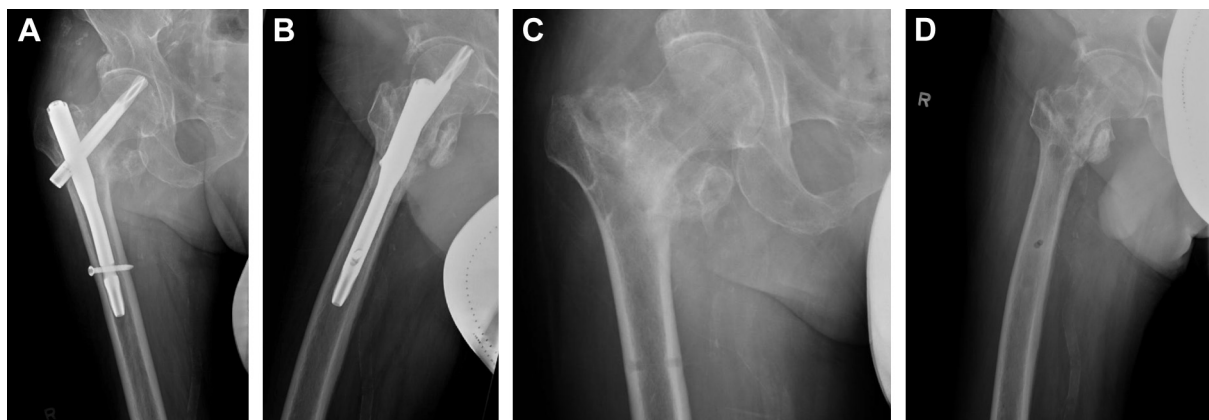


Figure 6. (A, B) Radiographs just prior to removal of implants. (C, D) Radiographs after removal of the proximal femoral nail antirotation device show varus deformity of the fracture.

into a propagating force to drive the spiral blade in an antegrade manner.³ Direct trauma is another cause.

In our case, the presence of some bone healing and initial hope for complete bone union before protrusion of the spiral blade from the femoral head led us to adopt a “wait-and-see” approach. However, initial bone healing is deceiving and is deemed to fail. Delayed bone union caused by underlying diabetes mellitus, disruption of the normal gliding mechanism of the spiral blade as discussed previously, and poor purchase of the spiral blade in osteoporotic bone all contribute to continuous central protrusion of the blade.

All reported cases without concurrent trauma history presented early postoperatively within 6 weeks.^{3,6,8–10} In our case, the spiral blade presented late at 24 weeks postoperatively with some bone healing. We postulate several reasons for this late presentation. First, the good reduction achieved and relatively intact medial calcar shared some of the stress to the spiral blade during walking exercise. Second, good bone contact over fracture ends after closed reduction and internal fixation allows some bone healing, which in turn slows the central protrusion process.

In our opinion, predisposing factors of central protrusion of the spiral blade including risk factors for delayed bone union (underlying medical illness, open reduction with disturbance of blood supply, etc.), jamming of the spiral blade at the nail-blade junction, underlying osteoporotic bone (which leads to easier central protrusion) are also perpetuating factors. Lack of lateralization of the spiral blade in turn jeopardizes controlled sliding and impaction of the fracture. This results in a vicious cycle of delayed union or nonunion and central protrusion of the spiral blade; therefore, the process of protrusion of the blade will continue and nonunion is inevitable. Protrusion of the blade from the femoral head will occur over time.

Therefore, in late presented cases, even when bone healing is evident, we propose early surgical intervention after central protrusion has been detected. This has an additional benefit because distortion of the bone and changes in surrounding soft-tissue tension in established malunion cases will cause greater difficulty in conversion to total hip replacement. Retrospectively, our case should be managed earlier with either exchange of a shorter spiral blade with bone grafting or conversion to a total hip replacement.

There are ways to minimize the chance for central protrusion of helical blade. Good reduction and fixation are the prerequisites, which were achieved in our case. Pre-drilling into the femoral head prior to insertion of the spiral blade, which leads to cancellous bone loss, should be avoided, especially in patients with osteoporosis.^{3,10}

A tip-apex distance between 20 mm and 25 mm should be adopted so that a shorter spiral blade is used rather than that recommended in the manufacturer's surgical guidelines.¹⁰ More recently, cement augmentation through the perforated blade to enlarge the load-bearing surface enhances the implant anchorage, resulting in a lower rate of cut-through of the spiral blade.¹¹

In conclusion, the complication of cut-through of the helical blade in PFNA is unique, novel, and usually presents during the early postoperative period. Our late presented case illustrates that nonunion and progression of the central protrusion is unavoidable once it starts and therefore, early surgical intervention is recommended.

Conflicts of interest

The authors declare that they have no financial or non-financial conflicts of interest related to the subject matter or materials discussed in the manuscript.

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