

Helical blade compression failure occurred during PFNA implantation

A rare case and ingenious solution

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Abstract

Rationale: Femoral intertrochanteric fracture happens easily in the elderly, especially those with osteoporosis. As a standard intramedullary fixation implant, Proximal Femoral Nail Anti-rotation (PFNA) is applied to various types of stable or unstable intertrochanteric fractures of femur. Due to blade-related factors, such as cutting-through into the hip joint, cutting out or back out, there are endless postoperative failure cases of internal fixation, but reports about perioperative failure that the helical blade cannot be tightened are lacking. In this case, we firstly report an intraoperative blade compression failure and an effective technique to help surgeons out of the dilemma by using cannulated hexagonal screwdriver which was already included in the orthopedic instrument box.

Patient concerns: An 81-year-old lady suffered left hip pain, swelling and limitation of activity, after slipping and falling when she was in the toilet.

Diagnoses: X-ray and computed tomography (CT)-scan showed comminuted left intratrochanteric fracture with a Jensen classification of IIa type.

Interventions: The patient was treated by closed reduction and internal fixation with PFNA. We suffered an unprecedented problem that helical blade cannot be tightened by the blade impactor as usual. For fear of helical blade disintegration during removal and a significant decrease in pullout strength after reinsertions, we eliminated the dilemma by using a cannulated hexagonal screwdriver to tighten the “problem” helical blade.

Outcomes: The “problem” helical blade was finally locked by using the SW4.0mm cannulated hexagonal screwdriver which was already included in the instrument box. The operation ended successfully after completing subsequent steps.

Lessons: The cannulated hexagonal screwdriver is an effective instrument that can help surgeons out of the dilemma when the blade impactor fails to tighten the helical blade in PFNA implantation.

Abbreviation: PFNA = Proximal Femoral Nail Anti-rotation.

Keywords: cannulated hexagonal screwdriver, compression failure, femoral intertrochanteric fracture, helical blade

1. Introduction

There is an extremely high incidence of femoral intertrochanteric fracture in the elderly, especially those with osteoporosis. With

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increase in life expectancy, the incidence of these fractures is also increasing. By 2040, the incidence is expected to have doubled.^[3] It is widely accepted that surgical treatments for femoral intertrochanteric fracture can reduce the mortality and morbidity of bed-related complications.^[4] For the purpose of improving the quality of life of elderly patients with intertrochanteric fractures of femur, surgical treatments, including open or closed reduction, intramedullary or extramedullary fixation, should be carried out as soon as possible. As a standard intramedullary fixation implant, Proximal Femoral Nail Anti-rotation (PFNA), an improved version of Proximal Femoral Nail (PFN), is applied to various types of stable or unstable intertrochanteric fractures of femur.^[5,6] The obvious change is that the helical blade design enables rotational and angular stability with 1 single element and does not require an additional screw as is used for the conventional PFN.^[7] Once tightened, the helical blade provides both angular stability and anti-rotation, otherwise, internal fixation failure will happen as a result of unsecured fixation. In the Synthes PFNA Technique Guide, it underlines removing and replacing the blade if it cannot be locked intraoperatively. However, for fear of helical blade disintegration during removal and a significant decrease in pullout strength after reinsertions, surgeons may face a dilemma whether to pretend nothing has happened and continue the operation at the risk of internal

fixation failure or replace the blade in case of both possible success and higher risk of failure. Due to blade-related factors, such as cutting-through into the hip joint, cutting out or back out, there are endless postoperative failure cases of internal fixation,^[2,7-9] but reports about perioperative failure that the helical blade cannot be tightened are lacking. Now we firstly report an intraoperative blade compression failure and an effective technique to help surgeons out of the dilemma by using cannulated hexagonal screwdriver which already included in the orthopedic instrument box.

2. Case presentation and surgical technique

An 81-year-old lady suffered a comminuted intratrochanteric fracture after slipping and falling in the toilet, with a Jensen classification of II_a type. After all contraindications excluded, a series of pre-operation plans were drew up, including measuring medullary cavity diameter, anterior femoral arch angle, the optimal entry point, and so on. The patient was treated with closed reduction on a traction operating table under combined spinal-epidural anesthesia. After sterilizing the operation area thoroughly, we made a 5 cm incision proximal from the tip of the greater trochanter, made a parallel incision of fasciae of the gluteus and split the gluteus medius in line with the fibers. Next, we determine the best entry point with awl instrument under the help of C-arm radiation. Later, we inserted a 10 × 240 mm PFNA nail using slight bidirectional turns of the insertion handle as far as possible into the femoral shaft medullary cavity. Further, an appropriate aiming arm for PFNA blade inserting was fixed firmly to the insertion handle. In sequence, proximal locking was

performed step-by-step. Unfortunately, after hammering a 10.5 × 90 mm helical blade to the appropriate degree of depth, we found the gap on the blade was not closed in radiographs no matter how we turn the blade-impactor clockwise (Fig. 1), and felt no resistance as expected. We realized that the internal fixation might be unsuccessful if we failed to tighten the blade. So an extremely tough challenge for locking the “problem” blade was in front of us.

The impactor was pulled out, assembled with another 10.5 × 110 mm PFNA blade in several different locked states, then we immobilized the blade with left hand and turn the impactor clockwise with right hand to simulate the process of tightening helical blade. We accidentally discovered that the blade cannot be locked anyway when it was supplied in a certain unlock state, because the SW4.5 mm hexagonal screwdriver on the impactor is not long enough to insert into the hexagonal hole in the blade, while thread on the impactor can still screw into the inside thread of blade (Fig. 2). At that moment, to solve this problem, a SW4.5 mm hexagonal screwdriver was in urgent need, which is long enough to insert into the hexagonal hole, more important, is able to dodge the inside thread of blade. Searching for the desired tool throughout instruments box, we finally picked out a SW4.0 mm cannulated hexagonal screwdriver, which is used for the end cap insertion. This is the only screwdriver that we can find in the instruments box and best matches hexagonal hole in the blade besides the impactor. Attempting to tighten the 10.5 × 110 mm blade in my hands, we inserted the screwdriver into hexagonal hole and rotated clockwise (Fig. 3). As the screwdriver rotated, the resistance increased; finally the blade was locked after making about 9 times of trials (Fig. 3). We repeated this process under

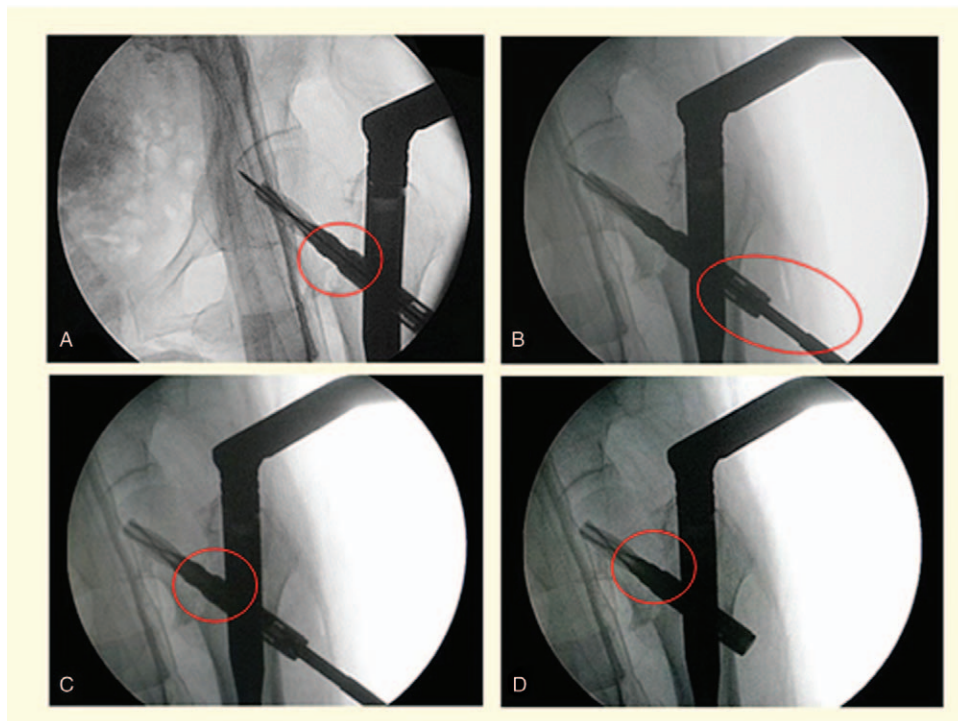


Figure 1. a. The gap on the blade was not closed in radiographs no matter how we turn the blade-impactor clockwise. b. The blade-impactor was removed and a SW4.0 mm cannulated hexagonal screwdriver was inserted into the “problem” blade. c. The gap on the blade got smaller after 4 times of rotations. d. The gap disappeared finally.

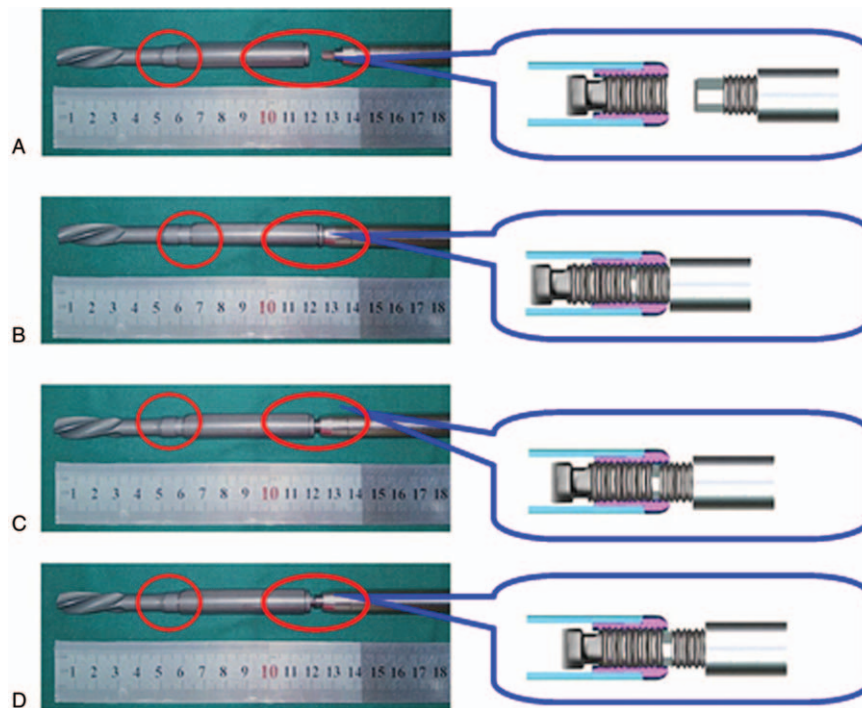


Figure 2. The process that blade-impactor fails to lock the helical blade. Pay attention to the size of the gap on this helical blade in the physical pictures and the position of internal screw nut in the analog diagrams. a. An unlocked helical blade is supplied, with gap existing. b. Counterclockwise rotations gets the external screw thread of the impactor connected tight with internal screw thread of the helical blade, but the SW4.5mm hexagonal screwdriver on the impactor is not long enough to insert into the hexagonal hole in the blade, so the internal screw nut does not move and the gap on the blade has no change. c. After 5 times of clockwise-rotations, the connection between external screw thread of the impactor and internal screw thread of the helical blade gets looser, but the internal screw nut does not move and the gap on the blade has no change. d. The blade-impactor is pulled out, but the helical blade keeps unlocked.

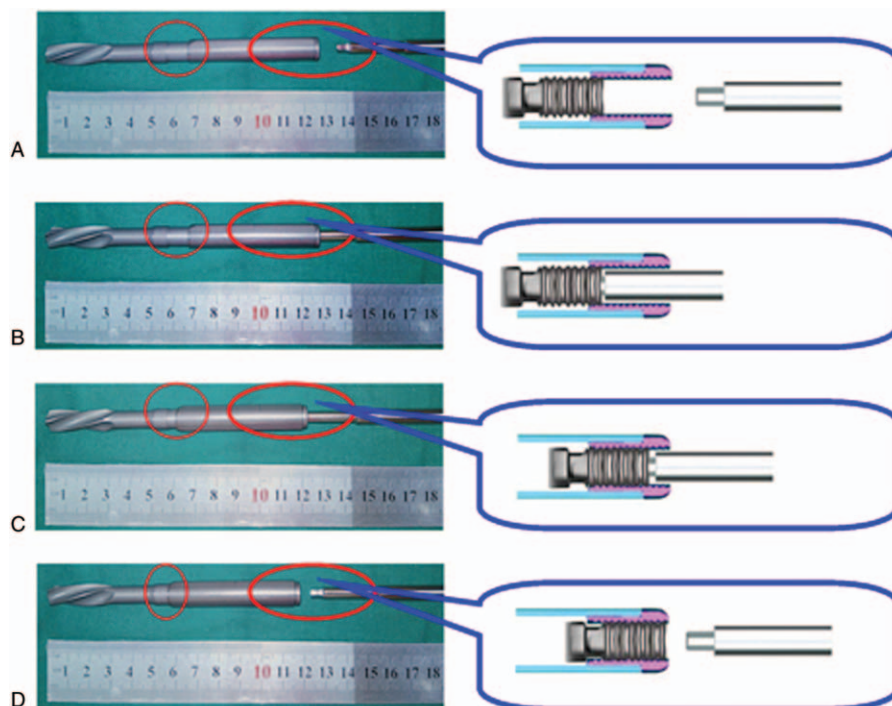


Figure 3. The cannulated hexagonal screwdriver helps to tighten an unlocked helical blade. Pay attention to the size of the gap on this helical blade in the physical pictures and the position of internal screw nut in the analog diagrams. a. An unlocked helical blade is supplied, with gap existing. b. A SW4.0mm cannulated hexagonal screwdriver can get out of the internal thread of helical blade and directly plug into hexagonal hole of internal screw nut. c. After 5 times of clockwise-rotations, the inside screw nut is caught by the cannulated hexagonal screwdriver and moves outward. The gap on the blade gets smaller. d. The helical blade is locked, at the same time the gap on the blade disappears.

radioscopy, as expected, we successfully locked the “problem” helical blade with the SW4.0mm cannulated hexagonal screwdriver (Fig. 1). The operation ended successfully after completing subsequent steps.

3. Discussion

With the increasingly aging population in China, the proportion of elderly patients experiencing osteoporosis-related complications has significantly increased, and the incidence of femoral intertrochanteric fractures has also increased year by year.^[1,2] In case of substantial mortality and morbidity of bed-related complications associated with these fractures,^[10] early operation is recommended so as to avoid the increased complications caused by long-term bed rest. The PFNA was widely proved to be a reliable implant to fix femoral intertrochanteric fractures,^[5,6,11,12] and the augmentation of the helical blade gives the fixation construct much more stability due to a large bone-implant interface.^[13,14] The helical blade theoretically enhances local bone quality via impaction, removes less bone than a lag screw, and touts greater surface area to resist superior cut-out.^[18,9] So significant as the blade is, once loosened, the whole internal fixation fails.

The episode was dissected postoperatively. The tip of the impactor is combined with SW4.5 mm hexagonal screwdriver and SW4.5 mm left-hand screw thread (Fig. 4). Under normal circumstance, when the blade is supplied in a locked state (Fig. 4), we firstly insert the SW4.5 mm hexagonal screwdriver in the front of the impactor into the hexagonal hole in the helical blade, turn the impactor counterclockwise to get the external screw thread of the impactor connected tight with internal screw

thread of the helical blade (Fig. 4). Furthermore, the helical blade is unlocked and fastened with the impactor. At that moment, the tip of the blade rotates freely and shows rotary movement into neck and head of femur along with our hammering. Then we rotate the impactor clockwise in order to tighten the blade until the blade arrives at destination. An inside screw nut, assembled together with the tip of the blade without considerable rotary resistance, will be caught and moved outward by the clockwise rotation. Results followed are that the inside screw nut is connected tighter and tighter with internal screw thread of the helical blade while the external screw thread of the impactor gets looser and looser connection with the blade until the impactor get separated finally (Fig. 4). The gap on the blade gets closed in radiographs (Fig. 1), the impactor cannot get rotated clockwise any more, this is the so-called locked state of a helical blade.

To the best of our knowledge, no previous cases of failing to tighten the helical blade have been reported in implanting a PFNA. In our case, however, the helical blade might be supplied in an unlocked state. The problem is that the hexagonal screwdriver failed to insert into the inside screw nut even though the external screw thread of the impactor get tight connection with internal screw thread of the helical blade. This mistake had no influence on inserting the helical blade, but trouble came when we were to tighten the blade. In this circumstance, matched with no hexagonal screwdriver, the inside screw nut, whose movement can drive the tip of blade along with major axis, will not move outward anymore. A SW4.0mm cannulated hexagonal screwdriver, without thread on its external surface, is designed to insert end cap. Differ from the impactor, this cannulated hexagonal

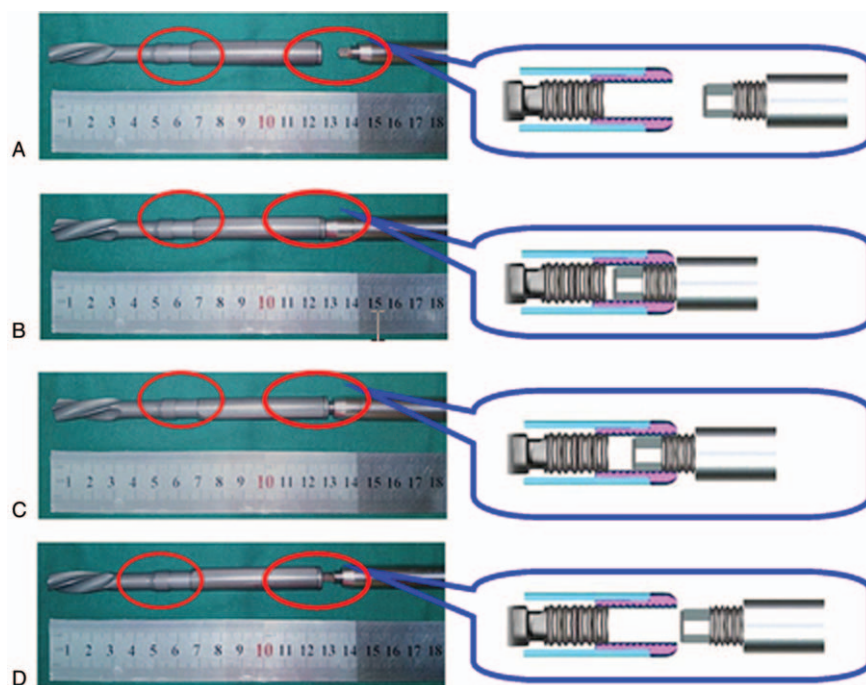


Figure 4. The normal process that blade-impactor tightens the helical blade. Pay attention to the size of the gap on this helical blade in the physical pictures and the position of internal screw nut in the analog diagrams. a. A locked helical blade is supplied, with no gap existing. b. Counterclockwise rotations gets the external screw thread of the impactor connected tight with internal screw thread of the helical blade, at the same time the internal screw nut moves inward and the gap on the blade appears. c. After 5 times of clockwise-rotations, the connection between external screw thread of the impactor and internal screw thread of the helical blade gets looser, at the same time the internal screw nut moves outward and the gap on the blade gets smaller. d. The helical blade is locked, at the same time the gap on the blade disappears.

screwdriver can get out of the internal thread of helical blade and directly plug into hexagonal hole of internal screw nut to finish locking the helical blade successfully (Fig. 3).

In the Synthes PFNA Technique Guide, it suggests that the blade must be supplied in a locked state. The Guide also underlines removing and replacing the blade if it cannot be locked. In our case, we did not remove the “problem” blade in case of disintegrating it, which would take us into greater trouble. In addition, reduplicated insertion and extraction will get the sclerotion loose, and this is unfavorable for the treatment of fracture fixation, especially when we operate on patients who suffer from osteoporosis.^[15–17] We suggest tightening the helical blade by using the cannulated hexagonal screwdriver instead of removing or replacing it. However, theoretically, the SW4.5 mm hexagonal hole of the inside screw nut cannot be locked totally by the SW4.0 mm screwdriver, so we still need the impactor to finish this last step for safety, or we can ask instrument supplier for an extra SW4.5 mm cannulated hexagonal screwdriver in advance. However, what is the most important is that we ensure every helical blade being supplied in a locked state before assembling.

In the final analysis, we present a case that a cannulated hexagonal screwdriver was used to lock the helical blade successfully when the blade-impactor failed to tighten the blade during PFNA implantation. This method could be an effective way to eliminate the dilemma that whether to pretend nothing has happened and continue the operation at the risk of internal fixation failure, or replace the blade in case of both possible success and higher risk of failure when surgeons fail to lock a helical blade with the impactor.

Author contributions

Resources: Chaoqun Wang, Qingxian Wang.

Supervision: Qingxian Wang.

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