CASE REPORT

Unusual mode of failure of intertrochanteric femur fracture fixation

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SUMMARY

The dynamic hip screw fixation is a commonly used modality of treatment for intertrochanteric femur (ITF) fractures. Various modes of failure in an operated case of ITF fracture have been described. The most frequent mode of failure is screw cut-out through the head. Occurrence of mechanical failure is rare and usually involves the shaft of the plate. We describe an unusual case with failure at the barrel of the plate and hip screw. A middle-aged man with a previously operated ITF fracture presented with pain in the same hip. Radiographs revealed non-union of the fracture with an implant failure. Revision surgery was performed during which a unique mode of implant failure was found to have occurred. The barrel of the plate had broken resulting in a bent Richard's screw. This case underlines the importance of high stress failure in non-union as opposed to high cycle, low stress failure, which is more frequently seen.

BACKGROUND

In clinical practice, failure of the dynamic hip screw (DHS) fixation for intertrochanteric femur fracture is commonly seen in the form of a screw cut-out from the head, or plate breakage at the shaft. Failure of osteosynthesis due to breakage of the barrel is a rare cause and has not been reported earlier in the literature.

CASE PRESENTATION

A 55-year-old man presented with a 1-month history of pain in the left hip and difficulty walking. He had a history of a sustained intertrochanteric femur fracture on the same side 18 months prior, for which he had been operated on with a DHS and fixed angle barrel plate (figure 1). The patient walked with a Trendelenburg gait. The surgical scar had healed with primary intention and there were no local signs of infection.

INVESTIGATIONS

Radiographs of the hip in anteroposterior and lateral views were obtained (figure 2A, B), revealing non-union of the intertrochanteric fracture with a bent DHS in situ. The top nut had come off. There were signs of osteolysis around the DHS screw. The proximal femur was in varus angulation with a neck shaft angle of 108°. Traction X-ray was performed, which revealed a break in the barrel of the plate. Baseline haemogram and acute phase reactants, namely, erythrocyte sedimentation rate (ESR) and C reactive protein (CRP), tested to rule out the possibility of local infection, were normal.

TREATMENT

Since there was non-union of an intertrochanteric fracture with varus collapse and implant failure, we decided to perform revision surgery. Implant removal was carried out and the broken part of the barrel was found to be in two pieces (figure 3). After removal of the implant, the non-union site was exposed and all fibrous tissue and sclerotic bone edges were removed. Revision fixation was performed with a dynamic condylar screw (DCS) and 95° fixed angle barrel plate. A calcar screw was passed through for additional stability. An autologous bone graft from the ipsilateral iliac crest was harvested and inserted at the non-union site.

Immediately postoperatively, the patient was mobilised, non-weight bearing, with a walker. Full weight bearing was started after demonstration of union in X-rays.

OUTCOME AND FOLLOW-UP

Radiological union was seen at 6 months (figure 4). The gait of the patient was normal at final follow-up at 1 year. The patient was pain-free and resumed his pre-trauma occupation.

DISCUSSION

DHS fixation is used by many surgeons for osteosynthesis in intertrochanteric femur fractures, due to its reliability and familiarity in using it. Additionally, it also leads to controlled collapse at the fracture site for most fracture patterns.¹ The osteosynthesis construct in these cases can be imagined as an axially and transversely loaded cantilever beam. These substantial cantilever forces are

Figure 1 (A) Prefixation X-ray prior to original fixation. (B) Immediate postoperative X-ray of previous surgery demonstrating inadequate reduction of fracture. Distraction at the fracture site is represented by a solid arrow. The dashed arrow represents lack of medial cortical continuity. The solid star demonstrates increased tip-apex distance.

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Figure 2 (A) X-ray at the time of presentation. (B) Intraoperative C-arm shoot showing a break in the barrel of the side plate.

transmitted from the femoral head to the femur shaft by the hip screw-side plate construct as the trochanteric region is unable to do so due to the fracture. Concentration of these forces at any specific point in the construct may lead to a subsequent failure of fixation. Mechanical failure is usually a multiple cycle, low stress failure as opposed to a low cycle high stress failure seen in cases with non-union and poor reduction of fracture.²

Common causes of failure of osteosynthesis include poor bone quality or osteoporosis,³ inadequate reduction, unstable pattern of fracture, position of screw and non-union.^{3,4}

Important modes of failure of DHS fixation are:

1. Cut out of the hip screw from the femoral head^{1,5};
2. Bending or breaking of the Richard's screw reported by Arastu *et al*,⁶ Khanna and Parker,⁷ and Jakobsen⁸;
3. Breakage of the barrel of the plate (seen in the present case);
4. Breakage of the shaft of the plate reported in a case series by Spivak *et al*²;
5. Back-out or breakage of the cortical shaft screws leading to loosening of the plate from the femur shaft.

Figure 3 Image of the failed implant demonstrating a break in the barrel and bend in the Richard's screw.

Figure 4 (A, B) Anteroposterior and lateral X-rays at 1 year follow-up demonstrating union at fracture site.

In this case, the cause for implant failure appears to be multifactorial. First, at the initial surgery, a poor reduction (figure 1B) had been achieved. The fracture site appeared to be distracted with lack of medial cortical continuity. Additionally, presence of posteromedial comminution and void should have been dealt with by bone grafting or controlled collapse of the proximal fragment, which was lacking. This, along with the occurrence of non-union, led to all the stress being borne by the implant instead of being shared by the implant and bone–bone interface at the fracture site. This increased implant loading, and finally caused a (high stress, low cycle) fatigue implant failure. Furthermore, a short barrel plate was used with a Richard's screw of 90 mm, where ideally a long barrel plate should have been used.

Simpson *et al*⁹ recommended the use of a short barrel plate with screw lengths of 80 mm or less. The use of a short barrel with a long Richard's screw increases the bending stress at the screw barrel interface, further increasing the chances of implant failure. This can be understood by imagining the construct to be a tip-loaded cantilever.

The tip-apex distance (TAD) in this patient at initial surgery was calculated to be 29 mm. Baumgaertner *et al*¹⁰ describe TAD as the sum of the distance between the tip of the screw and the apex of the femoral head on anteroposterior and lateral view. They recommend it to be <25 mm to prevent the occurrence of screw cut-out from the head. Although the TAD in this case was more than this recommended value, the screw had possibly not cut-out due to an inferior placement in the femoral neck and head, and non-osteoporotic bone.

Arastu *et al*,⁶ in their case, faced a similar problem with only the Richard's screw having bent. They treated this by revising the surgery using a larger angled (145°) plate and a new Richard's screw. However, 8 weeks postoperatively, they found that even the new Richard's screw had bent. However, we opted for fixation with a fixed angle 95 DCS plate, which led to fracture union and a satisfactory clinical outcome. Larsson *et al*⁵ reported 607 intertrochanteric femur fractures treated with DHS fixation, but reported no implant breakages. Chirodian *et al*¹ reported 1024 cases of DHS fixation and no cases of implant breakage. In both these series, failure occurred primarily due to cut-out at the screw bone interface. When mechanical failure does occur, it normally involves the shaft of the plate rather than the barrel or the Richard's screw. Hardware failure of a Richard's screw and side plate is rare and very few cases

have been reported in the literature. Moreover, none of these report the breakage of the barrel of the side plate. The biomechanical cadaveric study by Haynes *et al*¹¹ showed that the γ -locking nail resists superior loads prior to implant failure compared to a DHS. An interesting finding of this study was that the common mode for failure of the DHS in hard bone was the bending of the Richard's screw itself and, in soft bone, cut-out of the screw from the femoral head.

Learning points

- ▶ A long barrel plate should be used when the length of the dynamic hip screw (DHS) screw is more than 80 mm.
- ▶ Breakage of the barrel is one of the modes of implant failure following fixation of intertrochanteric fracture with DHS and barrel plate.
- ▶ Special X-ray projections such as traction radiographs or even CT, might be necessary in cases with suspicion of failure of implant.
- ▶ A meticulous and good reduction reduces implant loading and therefore helps prevent implant failure.
- ▶ Revision surgery with a 95° fixed angle barrel plate and dynamic condylar screw is an effective modality of treatment for such patients. Bone grafting in addition to revision plating helps to achieve union in cases of non-union intertrochanteric fracture.

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