Fracture of Extensively Porous-Coated Cylindrical Femoral Stem Following Revision Total Hip Arthroplasty

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Total hip arthroplasty (THA) is one of the most clinically successful surgeries. Despite the prevalence of THA, the number of revisions for septic or aseptic reasons continues to increase.

In revision THA surgeries, distally fixed, extensively porous-coated femoral stems are often used to achieve a solid initial diaphyseal fixation. However, complications of these stems are not uncommon. Fracture of these stems, although rarely reported in literature,[1-3] is challenging for orthopedic surgeons. Extraction of the broken components is difficult, and special instruments or techniques are usually required.

In this study, we reported two cases of fracture of Solution Stem (DePuy, Warsaw, Indiana, USA) following revision THA in our institute, and aimed to identify some common risk factors for such a rare complication.

A female patient suffered from juvenile rheumatoid arthritis (height: 147 cm, weight: 35.0 kg, and body mass index [BMI]: 16.2) received bilateral THA in 1974 at the age of 18. In 2005, she had left THA infection and received a two-stage revision surgery. Extended trochanteric osteotomy (ETO) was performed to facilitate the removal of the prosthesis, and a Solution Stem (8-inch in length, 10.5 mm in diameter) was implanted [Figure 1a]. She had an uneventful recovery after the surgery. In 2012, which was 7 years after the revision surgery, she sat on a chair and heard a pop sound, and experienced left thigh pain. The X-rays showed left femoral shaft and femoral stem fractures [Figure 1b].

She was then managed with two-stage revision. During the operation, an oblique fracture at the left femoral shaft and stem was found. The proximal part of stem had bone ingrowth, and the distal stem part had stable fibrous ongrowth. The proximal femur was splitted in the sagittal plane to extract the proximal stem. A cortical window with 1/4 circumference of the bone diameter was opened at the middle femur level to facilitate the removal of distal stem. The femur was reconstructed with a 255 mm × 11 mm Kuntscher nail reinforced by a strut allograft [Figure 1c and 1d]. Since the patient had very limited mobility before the fracture, we did not contemplate two-stage revision for her.

The other patient is also a 55-year-old female (height: 164 cm, weight: 66.8 kg, and BMI: 24.8). She had received multiple surgeries since childhood for left hip fracture and then primary THA in 1988, at the age of 29. It was complicated by loosening of the acetabular component at 7 years. Revision THA was performed. Eight years later (in 2003), she developed deep infection and received another two-stage revision. ETO was performed and a Solution Stem (8-inch in length, 10.5 mm in diameter) was implanted. The trochanteric osteotomy was fixed with a trochanteric grip [Figure 1e]. She remained asymptomatic after the surgery until 2013, when she complained of left hip pain for 1 month. The X-ray showed broken femoral stem at the metaphyseal junction [Figure 1f and 1g].

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Figure 1: (a) The implanted Solution Stem (8-inch, 10.5 mm). (b) Displaced Solution Stem and left femoral shaft fracture. (c) Fractured stem was moved out and replaced with a Kuntscher nail reinforced by strut allograft. (d) Extracted stem. (e) A Solution Stem (8-inch, 10.5 mm) was implanted in revision total hip arthroplasty. (f and g) Broken femoral stem with mild displacement at the metaphyseal junction. (h) Stem was removed and a new 10-inch × 13.5 mm Solution Stem was implanted. (i) Extracted stem. The distal part was lost after the operation and is not shown here.

One-stage revision was performed. It was found intraoperatively that the distal part of the stem was well-fixed with solid bone ingrowth while the proximal part of the stem was without bone ingrowth. ETO of 180 mm from the tip of greater trochanter was performed to remove the broken proximal stem. The exposed part of the well-fixed distal stem was broken through by Gigli saws and reamed with an 11 mm core reamer manually. The distal part of the stem was extracted by the use of core reamer and drill bit. After the prostheses removal, a new 10-inch × 13.5 mm Solution Stem was implanted. The osteotomy site was stabilized with three 2.0 mm cables. A strut allograft was used to reinforce the posterolatreral femoral defect [Figure 1h and 1i].

Fracture of distally fixed, extensively porous-coated femoral stems is challenging for orthopedic surgeons. Poor proximal bony support, high body weight/BMI and stems with smaller diameter (<13.5 mm) have been reported to be the risk factors.[1]

Bone loss was observed in both cases. The patients had history of THA infection and were managed with two-stage revision surgeries. Infection could cause osteolysis in the proximal femur. Both patients were menopausal women with low bone mineral density. The first patient had rheumatoid arthritis, which might further worsen her bone quality. The second patient had received multiple surgeries of the left hip during childhood, which resulted in deformity of the proximal femur. The X-rays showed osteopenia and osteolysis in the proximal femur. Intraoperatively, we found no bone ingrowth at the proximal stem. It is likely that when the stem was implanted, there was no good bone contact with the proximal femur. Since the distal stem had solid bone ingrowth, stress shielding was followed and subsequently aggravated the proximal bone loss. The weakening of the proximal bony support can lead to a stress riser between the region without bone ingrowth and the distal well-fixed femoral disphysis. With the cyclic bending stresses fatigue fracture finally occurs.[4]

Stem size is another possible risk factor. Failure of the femoral component is likely due to torsional forces applied to the prosthesis. Stem diameter and the length of diaphyseal contact are two important, influential factors of torsional stability.[5] A biomechanical analysis has shown that larger diameter femoral stems achieve greater torsional stability than smaller stems at a given diaphyseal contact length in revision hip arthroplasty, and a minimum diaphyseal contact length of 3 cm or 4 cm is recommended.[5] For long extensively porous-coated stems, Busch *et al*. have suggested using stems with diameter of over 13.5 mm in re-revision surgery.[2] Both stems had diameters of 10.5 mm. Although the X-rays showed reasonably good contact between the distal stem and femur shaft, given the proximal bone loss, we assume a lager stem (12 mm) would offer better stem-bone contact in the proximal femur, even though much more bone would be sacrificed during canal reaming.

Although some studies have linked excessive body weight of patients to stem fractures,[2,3] in our study, the body weight of the two patients was only 35.0 kg and 66.8 kg, with BMI of 16.2 and 24.8, respectively. They could not be classified as overweight but fractures still happened, which implies that proximal bone loss and stem sizes are more important risk factors than body weight.

We concluded from these two cases that proximal femoral bone loss is the most important risk factor for extensively

coated cylindrical femoral stem fracture. For patients with severe proximal bone loss, stems with larger diameter should be considered. Surgeons should always make sure that there is good bone contact between proximal femur and stem.

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Conflicts of interest

There are no conflicts of interest.

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