Nonsurgical Management of Distal Femur Stem Cortical Perforation

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A B S T R A C T

Distal femur stem cortical perforation is a rare but potentially catastrophic complication during total hip arthroplasty. If unrecognized, it can lead to transverse fracture of the femur while the patient is ambulating. If an uncemented femur stem was used, previous literature unanimously agrees that revision surgery should be performed. We report a case of uncemented distal femur stem cortical perforation that was treated nonsurgically successfully with protected weight-bearing for 6 weeks. Our patient had previous osteotomy surgeries of the proximal femur with a residual deformity which increased her risk for distal femur stem cortical perforation. At 40-month follow-up, she was asymptomatic, ambulated with normal gait, and was able to perform deep squats. The discussion involves avoiding, recognizing, and managing distal femur stem cortical perforation.

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Introduction

Distal femur stem cortical perforation (DFSCP) is a rare but potentially catastrophic complication during total hip arthroplasty (THA). If unrecognized, it can lead to transverse fracture of the femur while the patient is ambulating [1,2]. For primary THA, its incidence was between 0.4% and 4% in a number of series published between 1966 and 1972 [2]. In 1980, Pellicci et al. reported that the incidence of distal stem cortical perforation was 0.3% [3]. In 2006, Wade et al. concluded that its incidence was 0.07% [4].

Improvement in femur stem design and better surgical technique likely contribute to the reducing incidence of DFSCP over the decades. Given its reduced incidence, there is a lack of report on DFSCP in the literature in the last decade. Yet it remains important to understand how to pick up this rare complication in the operating room, as well as how to manage the patient when DFSCP is picked up postoperatively. In this article, we report the first case of an uncemented femur stem with distal cortical perforation that is managed nonsurgically with success. We discuss our experience with the factors to consider before deciding if patient requires revision surgery or can be treated nonsurgically.

Case history

Our patient is a 24-year-old female who is 160 cm tall and weighs 45 kg. She presented with right hip mechanical pain and abnormal gait. She had a known history of developmental dysplasia of her right hip (Figs. 1-3). At the age of 17, she underwent right acetabulum osteotomy and right distal femur varus osteotomy with lengthening using ilizarov ring fixator. A year later at 18 years of age, she underwent a second surgery to adjust the ilizarov ring fixator. At the age of 19 years, she underwent a third surgery to excise the maldeveloped femoral head and remove the ilizarov ring fixator.

Clinical examination revealed a short limb gait, with the true limb length of the right lower limb shorter than the left by 3 cm. The Galeazzi test (Allis sign) was positive. The Trendelenburg test was negative. Her right hip range of motion was flexion 40°, extension 5°, abduction 15°, adduction 10°, external rotation 15°, and internal rotation 10°. The Harris hip score for her right hip was 65 points and that for her left hip was 98 points [5,6].

A patient-specific 3D-printed model of her right hip and right femur was prepared before her surgery (Fig. 4). There were 3 angular deformities on her right femur: 1 in the sagittal plane with...
apex anterior and 2 in the coronal plane. However, the coronal alignment of her right lower limb remains acceptable, within 3° of mechanical axis, despite the 2 separate coronal plane deformities.

Using this 3D-printed model, a proximal femur anterior closing wedge osteotomy was planned to correct the sagittal deformity of her proximal femur and to accommodate the femur stem. During her surgery, a similar anterior closing wedge osteotomy of her proximal femur was performed. The THA was performed using Pinnacle acetabulum cup and S-ROM modular femur stem (DePuy Synthes, Warsaw, IN). The osteotomy was augmented with cortical bone graft and Kirschner wire fixation.

It was noted that the distal tip of the modular stem perforated through the femur cortex medially on postoperative radiographs (Fig. 5). In consideration of the intraoperative firm fixation, nonoperative treatment was chosen with the patient’s consent. Our patient was encouraged to perform flexion and extension exercises of the hip on day 1 after the operation. During the first 6 weeks after surgery, the patient was allowed to perform toe-touch bearing on her right lower limb. Thereafter, she was allowed to progressively increase to full weight-bearing by 12 weeks postoperatively. Radiographs were taken at 1, 2, 3, and 6 months to observe whether there was obvious displacement or radiolucent lines. At 12-month follow-up, she was pain-free, ambulating with a normal gait, and has equal limb lengths. At 15-month follow-up, her postoperative radiographs showed stable bony ongrowth around the distal tip of the modular femur stem medially (Fig. 6). At 40-month follow-up, she remained asymptomatic and was able to perform a deep squat and stand independently without aid. Her latest Harris hip score was 91.

Discussion

DFSCP is a known complication during THA. Patient-related risk factors for DFSCP include female gender, old age, osteoporosis, short stature, obesity, and previous fracture or surgery resulting in proximal femur deformity [1,3,4,7-9]. Surgical risk factors are the use of straight rather than anatomic femur stem, long femur stem, femur stem with thick distal end, and surgical approach [3,7]. In our case report, the patient had 3 previous surgeries involving Ilizarov ring fixator, resulting in 3 different angular deformities. Her condition presented us with severe technical considerations including the length and type of femur stem to use, the need for concomitant osteotomy, and the need to correct her femoral version for postoperative stability of the hip joint.

Managing distal stem cortical perforation

All case reports of uncemented femur stems with DFSCP in the current literature underwent revision surgery. Wade et al. reported on 4 cases of uncemented femur stem with posterior cortical perforation picked up only during postoperative radiographs [4]. Two of the patients had achondroplasia with short stature, while the other 2 patients were severely obese. All 4 were sufficiently symptomatic to necessitate revision surgery [4]. Similarly, Huda et al. reported a case of uncemented femur stem with postero-medial cortical perforation at the level of lesser trochanter in a young male patient with residual fibula strut graft in the proximal femur from previous surgery [9]. The DFSCP was identified intraoperatively, and a decision was made for revision surgery, with the postero-medial cortical perforation sealed with cancellous iliac crest bone graft [9].

On the other hand, case reports of cemented femur stems with DFSCP in the current literature remain divided if revision surgery was required [3,8]. Talab et al. reported on 14 cases of distal stem cortical perforation, with more than one-third of them requiring revision surgery and the rest experiencing varying degrees of thigh pain [8]. Pellicci et al. reported on 12 cases of distal stem cortical perforation that did not require revision surgery [3]. Nine had lateral cortical perforation, 2 were medial, and 1 was posterior. Eleven patients were available for follow-up, and they were assessed at a mean 4.5 years after THA. Nine of them were completely asymptomatic, whereas 2 had mild pain during ambulation [3].

The stability of the femur stem in our case report despite DFSCP is significantly contributed by the use of S-ROM modular femur stem, designed to achieve precise fit both in the metaphysis and diaphysis. Metaphysis stability is not compromised by the DFSCP. The proximal sleeve of S-ROM with porous coating helps maintain metaphysis stability and prevent stem subsidence [10]. At perforation, the distal tip of the stem is impacted into medial cortical bone, providing axial stability. The cylindrical stem of S-ROM connects distal and proximal femoral segments and works like an intramedullary nail [10,11]. In addition, the distal flutes and fins in the stem can provide rotation stability [12,13]. Studies have shown that torsional load may play an important role in loosening of the femur stem in THA [14,15], and many daily activities including stair climbing and rising from a chair cause significant torsional load in the proximal femur. Thus, the rotational stability that is obtained in implants is equally important in our case.

Similar to some of the cemented femur stems with DFSCP, our case was successfully managed nonsurgically, and our patient was
asymptomatic at 40-month follow-up. Therefore, we recommend managing postoperative DFSCP based on 3 factors: (1) whether the patient is symptomatic or not and if so, the degree of pain during ambulation; (2) the amount of prominent distal stem (revision surgery if more than 5 cm) [8]; and (3) stability of the femur stem, both torsional and axial. However, it should be noted that the patient in our case is unique given the complex nature of the preoperative deformity. In view of this, it is possible that these opinions may not apply to all patients.

Avoiding distal stem cortical perforation

DFSCP can be avoided by addressing modifiable risk factors. Patients can be started on osteoporosis therapy before THA, although such therapy usually requires years to be effective and may unnecessarily delay the THA. Perioperative teriparatide is an alternative therapy option that has faster efficacy but is costlier [15,16]. Losing weight is also often challenging in obese patients because of their body habitus, as well as pain and stiffness from the arthritic joint [17,18]. We recommend the use of an anatomic tapered short stem with a collar. Cement at the site of osteotomy may compromise healing [19]. A taper and short implant could...
obviate the need to address the deformity to a certain extent. The collar helps maintain axial stability of the femur stem and prevent stem subsidence, in the event of distal stem cortical perforation. In addition, a preoperative plan based on 3D images would be helpful for estimating the anticipated size of the prosthesis. We also recommend the use of posterior Moore approach for high-risk patients, especially those with complex proximal femur deformity, as most of the distal stem cortical perforation cases reported in the literature are posterior. Difficulty with femur exposure using an anterolateral approach may result in a too-far anterior entry point in the proximal femur with a posterior trajectory and hence risk for posterior cortical perforation [4].

Recognizing distal stem cortical perforation

For uncemented femur stems, a simple technique to pick up DFSCP intraoperatively is to perform a quick palpation for any prominence in the soft tissue around the shaft. For cemented femur stems, failure to fill up the medullary canal, a lack of high pressure to give some resistance during insertion of the stem, or obvious cement

![Figure 5. Immediate postoperative anteroposterior (a) and lateral (b) radiographs of our patient.](image)

![Figure 6. Postoperative radiographs of our patient at 15 months (a: Full-length weight bearing lower extremity radiographs, b: Right hip lateral radiographs).](image)
leakage into soft tissue around the femur distally should alert the surgeon of a possibility of DFSCP from the trial. However, palpation usually requires a larger exposure, which means the approach needs to be extended. Two orthogonal-view intraoperative radiographs are an efficient tool to aid intraoperative assessment. In addition, radiographs do not require increased surgical exposure. A previous report had shown that single-view postoperative radiographic surveillance in the operating room missed the DFSCP, and the complication was only picked up with 2 orthogonal views of the femur radiographs performed at a later time during the patients’ hospital stay [4].

Postoperatively, thigh pain during ambulation should also alert the surgeon of a possibility of DFSCP but may not be present. Pellicci et al. reported a series of 12 cases of cemented THA with distal stem cortical perforation and found that 9 of their cases were asymptomatic [3].

Summary

In summary, patients with previous osteotomy surgeries of the proximal femur represent a challenging THA with the increased risk of DFSCP. For uncemented femur stem with DFSCP, there is the option of nonsurgical management with protected weight-bearing for 6 weeks. We recommend looking at the patient’s pain symptoms, the amount of prominent distal stem protrusion, and the stability of the femoral stem to guide the surgeon as to whether revision surgery is indicated.

Conflict of interest

The authors declare there are no conflicts of interest.

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