CASE REPORT

New type of hip arthroplasty failure related to modular femoral components: Breakage at the neck-stem junction

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Summary Total hip replacements (THR) with modular femoral components (stem-neck interface) make it possible to adapt to extramedullary femoral parameters (anteversion, offset, and length) theoretically improving muscle function and stability. Nevertheless, adding a new interface has its disadvantages: reduced mechanical resistance, fretting corrosion and material fatigue fracture. We report the case of a femoral stem fracture of the female part of the component where the modular morse taper of the neck is inserted. An extended trochanteric osteotomy was necessary during revision surgery because the femoral stump could not be grasped for extraction, so that a long stem had to be used. In this case, the patient had the usual risk factors for modular neck failure: he was an active overweight male patient with a long varus neck. This report shows that the female part of the stem of a small femoral component may also be at increased failure risk and should be added to the list of risk factors. To our knowledge, this is the first reported case of this type of failure.

Introduction

Modular femoral components (stem-neck interface) were first introduced in France in the 1980’s for revision THR with locked stems [1]. Modular components improve management of extramedullary femoral parameters (height, offset and anteverision), which theoretically improve tension of the gluteal muscles and reduce the risk of dislocation [2–4]. Moreover a modular design reduces the amount of stock and the manufacture of less common sizes and normally optimizes exposure for isolated acetabular revisions because the modular neck can be removed [5]. However, the addition of an additional interface is associated with complications from corrosion [6,7] or stem-neck disassociation [8] in particular during reduction maneuvers for dislocation [9]. More recently cases of breakage of modular necks have been reported, all located at the base of the modular neck and all associated with stress fractures caused by corrosion.
[10–15], so that titanium has been replaced by cobalt-chromium in modular necks [7]. We report the case of a fracture of the metaphysis of the female part of the femoral stem where the cone shaped neck is inserted. This complication has not yet been described in the literature and it was associated with problems of extraction and revision, while illustrating the fragility of the implant when the size of the femoral stem component where the modular neck is inserted is small.

Observation

A 59-year-old man who was a farmer and overweight (98 kg, 1.83 m, BMI 29.2) underwent in 2007 a THR through a posterolateral approach for arthritis of the hip with coxa vara. A cementless, titanium alloy implant (Ti6Al4V) with hydroxapatite coating (56 mm cup, 32 mm femoral head, alumina ceramic bearing and a small femoral stem (size 3) was used (Amplitude, Neyron, France)). Immediate revision surgery was indicated due to anterior dislocation identified on the postoperative X-ray associated with insufficient offset. The former modular neck was a “standard” titanium component with an elliptical distal morse taper (TA6 V). This was replaced by a modular “lateral plus” neck with a “long neck” 32 mm ceramic femoral head (Al2O3). The outcome was good with a Merle d’Aubigné (PMA) score of 18 [16]. Three years after surgery, the patient felt an intense pain and heard a crack as he was putting his pants on, resulting in significant functional impairment. X-rays showed a fracture of the stem at the stem-neck interface on the female part of the component where the modular varus neck was inserted (Fig. 1). Revision surgery was performed 5 days later through the same surgical approach confirming the fracture of the femoral component at the base of the female part where the modular neck is inserted (Fig. 2) making it impossible to extract the femoral component which was perfectly well integrated to the diaphyseal region. An extended trochanteric osteotomy was therefore performed along the entire stem. A cemented revision “Integrale” femoral stem (Amplitude, Neyron, France) was used with cerclage wires. A new 32 mm ceramic femoral head-long neck was implanted (Fig. 3). The patient underwent a follow-up consultation 18 months later with a PMA score of 16 [16] and a Harris score [17] of 88. A report was sent to ANSM (former AFFS-APS) in 2010. Explants underwent a metallurgical evaluation by optic and electronic microscopic analysis. The expert’s report concluded that the materials used were in accor-

Figure 2 Explanted femoral component: fracture of the female part of the stem where the titanium modular neck is inserted.

Figure 1 AP view X-ray showing the metaphyseal fracture of the stem at the neck-stem interface.

Figure 3 Postoperative X-ray: long cemented femoral stem with cerclage wiring of the extended trochanteric osteotomy.
dance with ISO norms for titanium. The microscopic analysis concluded that the implant had failed due to deterioration of the surface from fretting corrosion. The experts, based on a Swedish register, confirmed that the rate of implant breakage had been stable since 1998 at 1.7%, and that our case probably corresponded to one of these. The report excluded any industrial responsibility.

Discussion

Numerous clinical reports have described failure of the modular neck of femoral components, accidents which always occur at the base of a neck which is usually titanium [10—15]. This complication is certainly underestimated because the FDA [10] has reported 37 modular neck fractures in 10 years (2000—2009) while Grupp et al. [7] reported 68 fractured modular femoral necks/5000 THA in 3 years (2004—2006). Our report is original because failure occurred where the stem is in contact with the distal part of the modular neck, which, to our knowledge is the first report of this type. The femoral stem and the modular neck were made of titanium alloy (Amplitude, Neyron, France). The modular neck had a double Morse taper: proximally circular 10—12 (5 42') for the femoral head, and distally elliptical (11 mm by 8 mm) for the stem. There are four reversible necks providing eight positions which, associated with head length, provide 24 possible articular centers. There are six femoral stem sizes (size 2—7) where the modular component is inserted, while the one-piece (monoblock) series has seven (sizes 1—7), because the smallest size (1) is only found in one-piece design. Care should therefore be taken using the modular stem-neck with small sized stems where the cavity must be 15 mm deep for insertion of the elliptical part of the modular neck. In addition to this limitation, the increase in the lever arm of a ‘‘lateral plus’’ femoral neck increases loading by 25—33% depending on the length of the neck [11—15]. Although the expert’s report excluded any industrial responsibility, our personal analysis supported by the results in the literature suggests the following interpretation. First the mechanism of fretting corrosion is at the center of the explanation. Fretting is defined as small amplitude oscillating movements (wear) between two contact surfaces due to external vibrations and cyclic loading producing oxide debris, thus the term fretting corrosion [18]. Studies of explanted broken modular necks have shown that the causal element is always micro-movements at the neck-stem interface [7,19], and that these movements are three times greater with titanium necks than with cobalt-chromium necks, which has gradually resulted in the former being replaced by the latter [7,19,20]. Jauch et al. [20] have shown that soaked interfaces were at a greater risk of micro-movements and have suggested that the interface be carefully cleaned before connecting the pieces. In the same way, Baxmann et al. [21] showed that the presence of fluid increased the corrosive effect of fretting. Component failure in the present case may be explained in part by the early revision and replacement of the modular neck due to instability. During this procedure, the contact surfaces may have been damaged or contaminated by fluids in the female part of the stem. This hypothesis was suggested by Atwood et al. [11] who performed revision surgery in a patient for a fractured alumina femoral head. During revision, they changed the titanium modular neck but 2 years later, the latter fractured at its base [11]. These reports do not support what is supposed to be easy isolated acetabular revision using modular necks. Not only is the titanium modular contact a source of cold fusion making disassembly impossible, but more important, the effort necessary to extract the neck can leave the female portion of the stem damaged or soiled which can result in a short term stress fracture. Although the risk of fretting corrosion may have been increased by changing the neck, our clinical case was unique because breakage did not occur at the base of the neck but on the stem, which we felt was favored by its small size (size 3 for sizes 2—7) in a man presenting with all the other risk factors for failure of a modular neck (active overweight male, with a long lateral neck with a long head) [7,10—15]. Revision of a modular neck is difficult, especially in our case, because there was no way to grasp the femoral stump of a perfectly integrated component.

In conclusion, besides the usual risks of failure for modular femoral necks, a small femoral stem is also associated with a risk of fracture of the female part of the stem where the modular neck is inserted. The use of modular necks requires perfect drying before assembly to limit the risk of fretting corrosion which can be the source of failure. Care should be taken with long varus necks, which are usually the indication for modular necks. There seems to be less risk of failure with cobalt-chromium modular necks, but they can also cause pseudotumors related to immune-allergic reactions [22].

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References