Case report

Fracture of the cobalt-chromium modular femoral neck component in total hip arthroplasty


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ABSTRACT

Total hip prostheses using cervico-metaphyseal modularity were designed to better replicate the geometry of the native extra-medullary femur. However, they are associated with numerous complications including corrosion, disassembly, pseudotumours and, most notably, fractures of the modular neck. All reported cases of modular neck fractures occurred with titanium components (Ti-6Al-4 V). To prevent this weakness, manufacturers developed modular necks made of cobalt-chromium (Co-Cr). We report a fracture of a long, 8° varus, Co-Cr modular neck connected to a 36-mm short (−3.5 mm) femoral head. The fracture occurred 22 months post-insertion in a woman who had a low level of physical activity and a body mass index of 28.7 kg/m². To our knowledge, this is the first reported instance of Co-Cr modular neck fracture. It may challenge the wisdom of further developing this modularity design, as our patient had none of the known risk factors for modular neck fracture. In addition, cases of pseudotumour have been reported with Co-Cr modular necks subjected to fretting corrosion, which contributed to the fracture in our patient.

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1. Introduction

Total hip prostheses (THPs) with cervico-metaphyseal modularity, although introduced in the 1980s for revision surgery, have been widely used since the 1990s for primary total hip arthroplasty (THA) [1,2]. Modularity provides greater versatility for matching the prosthetic hip to the native bone and joint geometry in terms of length, anteversion, and femoral offset [2]. However, modular THPs have been incriminated in a long list of complications including corrosion, pseudotumours, disassembly and, most notably, fracture of the removable-neck [3–12]. Most of the reported fractures occurred with titanium-alloy (Ti-6Al-4 V) necks. Several manufacturers consequently switched to cobalt-chromium (Co-Cr) on the grounds of presumed greater mechanical strength. To our knowledge, the case described herein is the first report of a fracture of a removable cone made of Co-Cr alloy.

2. Case description

In October 2011, a 66-year-old woman with a height of 169 cm and a weight of 82 kg (body mass index, 28.7 kg m⁻²) received a THP on the right side via a postero-lateral approach, because of hip osteoarthritis. A Novium (X-Nov, Héricourt, France) cementless cup and cementless ProfemurL (Wright, Arlington, TN, USA) modular stem were implanted, using a ceramic-on-ceramic friction couple (BioLox-Delta®, Ceram Tec GmbH, Gennevilliers, France). A long, 8° varus, modular Co-Cr neck was selected, as well as a short head (−3.5 mm) measuring 36 mm in diameter. The postoperative course was uneventful and the patient experienced no symptoms during the first 22 months.

In August 2013, she experienced a painful internal derangement of her right hip during a physical effort involving hip flexion and weight bearing. She was then rapidly able to walk without pain. On the next day, a painful giving way of the right hip occurred, with no fall but with complete loss of function of her right lower limb.

The radiographs disclosed a fracture of the modular prostatic neck (Fig. 1). Surgical revision showed that the fracture was located at the stem-cone junction (Fig. 2) and that the cup was intact. Extraction of the male distal part of the cone wedged into the stem proved impossible. A trans-femoral approach was therefore used to remove the implant and to insert a long cementless stem (HLc, X-Nov, Héricourt, France) without locking screws (Fig. 3). The immediate postoperative course was favourable but without weight bearing for the first 6 weeks.

Examination of the fracture surfaces showed two fatigue-crack fronts and two sudden semi-fragile fracture zones on either side of the neck (Fig. 4) with evidence of superficial fretting corrosion (Fig. 5).


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Fig. 1. Radiograph showing the fracture of the modular neck 22 months after implantation.

Fig. 2. Photograph of the explanted stem. A. Enlarged view of the fracture site in the modular neck (the distal part is still in the female part of the Morse taper of the stem). B. The proximal piece has been turned over in the horizontal plane, and the two white arrows indicate the anterior and medial parts of the removable cone.

Fig. 3. Postoperative view after revision via a trans-femoral approach.

Fig. 4. Binocular magnifier view of the modular neck fracture surface showing areas of progressive fatigue-cracks (red arrows) and areas of sudden semi-fragile fracture (blue arrows) on either side of the neck.

3. Discussion

Modularity improves the surgeon's ability to match the geometry of the prosthesis to the patient's native geometry during the procedure and, given the theoretical possibility of disassembling the components, simplifies isolated cup revisions by improving surgical exposure [1,2]. The risk factors for removable-neck fracture have been well documented [8,10]: obesity, a high level of physical activity, a metal-on-metal friction couple with a large diameter, a long modular neck in varus and/or ante/retroversion, and corrosion.

Dangles et al. [4] described the first case of fracture of a titanium-alloy modular cone, which occurred after 42 months in an active obese patient, underlining the role for fatigue and corrosion. Subsequently, many cases of modular titanium neck fracture were published [3–5,8,10–12]. Most of them occurred in active and/or obese patients who had the ProfemurZ implant, which is the most widely used hip prosthesis with cervico-metaphyseal modularity in the USA. Prodromal symptoms (snapping sensation with cracking sounds, groin pain) preceded the fracture in most, but not all, of the cases. In every case, a long neck in varus associated with a 32.7%...
increase in the moment of force had been used [8]. A trans-femoral approach was consistently needed to remove the well-integrated stem, as extraction of the fractured neck proved impossible.

The greater number of junctions between femoral implant components increases the production of wear particles [13,14]. These particles are chiefly released at the interface between the neck and the stem, as a result of the difference in mechanical loads applied to the proximal and distal junctions of the removable-neck [11]. Pure compression forces are applied to the proximal junction. Distally, in contrast, the length of the femoral neck and the weight of the patient produce a moment of force that generates tensile forces at the lateral portion of the Morse taper and compression forces at its medial portion, which cause micro-motion. Grupp et al. [15] demonstrated that fatigue fractures consistently started at the antero-lateral area located at the upper part of the conical connection, where electron microscopy studies showed surface cracks that led to fracture of the implant. These authors also showed that micro-motion exacerbated both corrosion and micro-particle generation [15]. Co-Cr modular necks were introduced to minimise the risk of corrosion and fracture [15]. Nevertheless, evidence of corrosion and fatigue fractures have been documented on Co-Cr adapters placed within a physiological environment [3,16], and pseudotumours have been reported with Co-Cr modular cones implanted on titanium stems [7]. The fracture surface in our case was particularly atypical, with two fracture fronts secondary to fretting corrosion, whereas classical fractures have a single front that eventually leads to a small fractured area.

Our case report demonstrates that the use of Co-Cr to produce modular necks has not eliminated the risk of fracture. The data in our patient suggest, on the contrary, an increased risk with Co-Cr, since we found several crack fronts secondary to corrosion in a patient free of risk factors. Therefore, the use of modular prostheses is inadvisable in patients with risk factors such as obesity and/or a high level of physical activity.

Disclosure of interest

Maxime-Louis Mencière, Thomas Amouyal, Jérôme Taviaux, Mathieu Bayle, and Cécile Laterza declare that they have no conflicts of interest concerning this article. Patrice Mertl declares no conflict of interest related to this work but is a training and research consultant for Zimmer, B-Braun, Stryker, and DePuy.

References
