Fracture of cobalt-crome modular neck in total hip arthroplasty

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Summary. Despite the advantages of modular total hip arthroplasty in terms of neck version, offset and length precise reproduction, titanium necks breakage became a concern. Consequently, titanium has been replaced by cobalt-chrome (Co-Cr). However, four cases of Co-Cr modular neck breakage have been reported in the literature. In the present paper, two cases of Co-Cr modular neck fractures are described together with a literature review. The aim of this work is to discuss the risk factors and characteristics of this rare complication. We described two cases of fracture of long varus Co-Cr modular femoral neck connected with cementless press-fit stem. Some risk factors, such as long varus type of modular neck, overweight and/or high demanding physical activity, might have contributed to implant failure. (www.actabiomedica.it)

Key words: cobalt-crome, modular neck fracture, total hip replacement, hip arthroplasty, risk factors

Background and aim of the work

Over the last decades, the use of modular total hip designs had a significant increase.

Modularity allows for greater versatility of the component with potential advantages in leg length discrepancy correction and optimal offset and anteversion reproduction. On the other hand, significant disadvantages have also been reported.

In particular, many cases of modular titanium necks breakage occurring at the base of the modular neck have been recently described, all associated with stress fractures caused by corrosion (1). As a consequence, titanium has been replaced by cobalt-chrome (Co-Cr) in modular necks (2). Nonetheless, modular neck breakage may remain a concern. One case of Co-Cr modular neck breakage was indeed described by Mencière et al. in 2014 (3) and three cases were reported by Kovac et al. in 2019 (4). Two cases of Co-Cr modular neck fractures are reported in the present paper together with a literature review. Aim of the paper is discussing the risk factors and characteristics of this rare complication. Both patients have given their approval to have their cases discussed in this paper.

Case 1

A 48-year-old man affected by degenerative hip osteoarthritis underwent primary total hip arthroplasty of the left hip in May 2011. The patient was overweight with a BMI of 28,02 (1.87 mt height, 98 kg weight).

A ProfemurL (Wright, Arlington, TN, USA) size 5 modular anatomical titanium (Ti64I4V) cementless stem was implanted on the femoral side, coupled with a cobalt chrome long 8° varus retro modular neck. A size 56 cementless press-fit Procotyl cup (Wright, Arlington, TN, USA) was implanted on the acetabular side. The bearing surface was ceramic on ceramic with

a Biolox Delta size 36 head. Postoperative radiographic control showed a correctly placed hip prosthesis, with a regular post-operative course. The patient resumed his daily activities without limitations or pain. In June 2015 (4 years postoperatively), the patient heard a crack from his left hip while he was jumping from a one-meter high wall. Thereafter, he referred severe hip pain with motion and inability to weight bearing on the affected limb. The patient came at the emergency department at our Institution, where left hip radiographs were taken demonstrating a fracture of the modular neck at the stem-cone junction (Fig. 1a). Both acetabular and femoral components seemed to be well fixed, and the femoral head remained attached to the proximal fragment of the modular neck. There were no clinical, radiographic or laboratory signs of infection.

After 4 days, the patient underwent revision total hip arthroplasty through a postero-lateral approach to the left hip. The modular neck fracture resulted to be complete with fragmentation at the stem-neck junction. Minimal fretting and corrosion damage on the surface that had mated with the femoral stem was observed (Fig. 1b). No macroscopic signs of metallosis were observed, thus no serum metal levels were obtained. Surgical intervention included femoral head and neck removal, accurate debridement of soft tissues and removal of the well-fixed stem through a Wagner femoral osteotomy. Finally, a cementless Lima Revision stem (Lima Corporate, Udine, Italy) with cerclage wires to stabilize the femoral osteotomy was implanted (Fig. 1c). The bearing surface was ceramic on poly with a Biolox Delta head size 36 head. Intraoperative microbiological coltures confirmed the absence of infection.

Case 2

A 77 -year-old man underwent primary total hip arthroplasty of the left hip for end-stage hip arthritis in 2011. He was overweight with a BMI of 28,73

Figure 1a. Case 1. Left hip AP view radiographs showing a fracture of the modular neck at the stem-cone junction

Figure 1b. Case 1. Photograph showing the removed stem, neck and prosthetic head. A complete fracture of the modular neck occurring at the stem-neck junction is visible

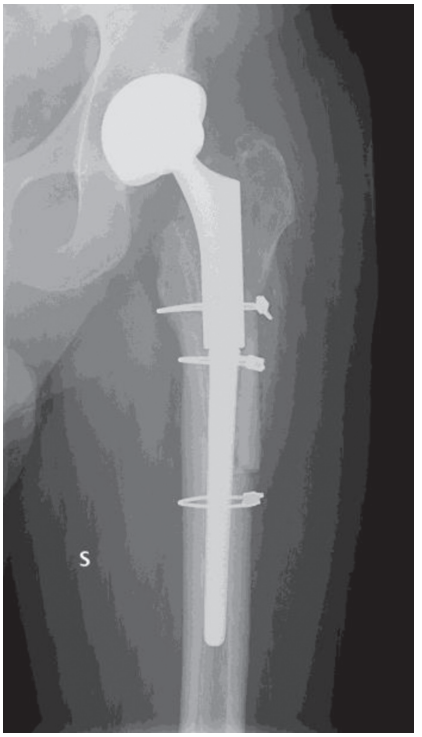

Figure 1c. Case 1. Left hip AP view postoperative radiographs showing implant revision

(1.76 mt height, 89 Kg weight). On the femoral side a Profemur (Wright, Arlington, TN, USA) modular anatomical titanium (Ti64I4V) cementless stem was implanted, coupled with a cobalt chrome long 8° varus modular neck.

Postoperative course was uncomplicated. After 4 years from the index procedure, the patient referred to the emergency department for acute left hip pain with a subjective feeling of instability, without any reported traumatism. Radiological evaluation showed a fracture of the modular neck at the stem-cone junction (Fig 2a). The acetabular and femoral components resulted to be intact. There were no clinical, radiographic, or laboratory signs of infection.

After 7 days, revision surgery was performed through a lateral approach. There were no macroscopic signs of metallosis, no iron particles or fibrosis were seen. Periprostethic soft tissue were free from relevant alterations, being the fracture of the neck the only pathological feature. The well-fixed stem was removed via a Wagner's osteotomy, and revised with a MP Reconstruction Prosthesis (Waldemar Link, Hamburg, Germany). Four cerclage wires were inserted to secure the osteotomy (Fig. 2b).

Discussion

Modularity in total hip arthroplasty has gained great popularity in the past, as it allows to restore optimal hip geometry, leg length, offset and anteversion of the prosthetic hip. Moreover, biomechanical advan-

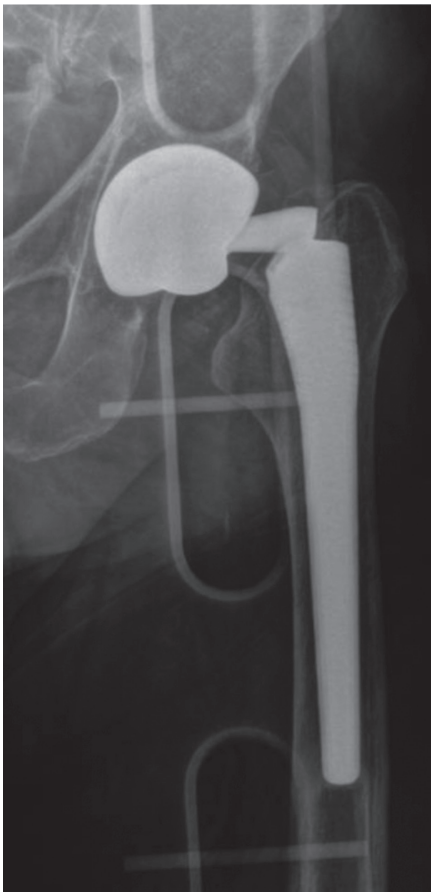

Figure 2a. Case 2. Left hip AP view radiographs showing a complete fracture of the modular neck at the stem-neck junction

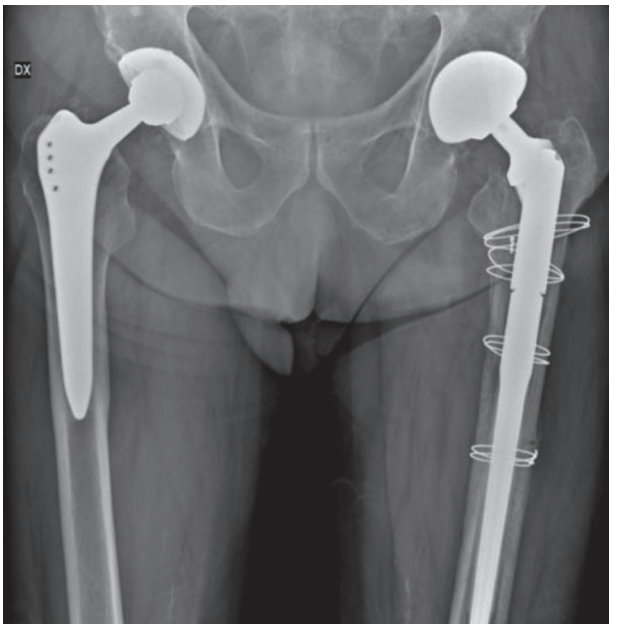

Figure 2 b. Case 2. Pelvic AP view post-operative radiographs showing implant revision of the left hip

tages such as wear reduction and impingement prevention have been described, with a theoretical reduction in dislocation risk (5-7).

However, fracture of the titanium modular neck-stem junction has been recognized as a major complication in these implants, consequently leading to implant failure. Many reports of titanium modular neck fractures can be indeed retrieved in the literature (8-10). The cause of mechanical failure has been ascribed to fretting, crevice and galvanic corrosion resulting in loosening of the modular junction and finally fracture of the implant (11). Corrosion and fretting occur both at the head-neck and at the neck-modular stem junction, augmenting with duration of the implant. Because of the lengthening of the lever arm and the subsequent higher mechanical stress, the degradation is mostly located at the neck-stem junction. Fretting and corrosion produce particles and ionic products that cause the release of inflammatory mediators and may contribute to the fracture of the implant (11-13). Because of the difference in the mechanical loads applied to the proximal and the distal junctions of the modular neck, fatigue fractures mostly start at the antero-lateral portion of the conical connection in titanium necks (2). Indeed, in the proximal junction there are compression forces, while distally there are tensile forces at the lateral part of the Morse taper and compression forces at its medial part. Particularly, in the distal junction this difference is caused by the moment of force produced by the length of the femoral neck and the weight of the patient (14).

Accordingly, both implant and patient related risk factors for titanium modular neck fracture have been reported in the literature. The main implant related factors are long varus neck, excessive neck ante/retroversion and metal-on metal coupling with large diameter heads, while the main patient related factors seem to be obesity and physical activity (15, 16). In order to reduce titanium modular neck fractures, Co-Cr modular necks have been introduced in clinical practice. In vitro, titanium modular necks have shown 38% less load bearing capacity and 72% decrease in fatigue resistance when compared with Co-Cr (2). Nonetheless, some authors suggest that sports and traumatic events may result in hip forces significant enough to potentially determine a fatigue fracture also of Co-Cr modular neck (17). At our knowledge, only 4 cases of Co-Cr modular neck breakage have been reported in the literature (3, 4). However, 3 more cases can be retrieved in the US Food and Drug Administration (FDA) adverse events database (18). Mencière et al. firstly reported a case of fracture of the Co-Cr modular femoral neck component in a 66 years old woman with a BMI of 28,7 kg/m^2, who received a modular THA as a result of hip osteoarthritis. A long, 8° varus modular Co-Cr neck was implanted and connected to a 36 mm short femoral head. The patient had a low level of physical activity and experienced no symptoms during the first 22 months. After this period of time, she felt acute pain in her hip during a physical exercise involving hip flexion and weight bearing. On the following day, she underwent a complete loss of function of the lower limb. The radiograph demonstrated a fracture at the stem-cone junction of the modular prosthetic neck, while the cup was intact. After that, she underwent surgical revision via a trans-femoral approach.

Recently, three more cases were reported by Kovac et al (4) in a multicentric study. Among 23 modular neck fractures registered in Slovenia between 2002 and 2015, three occurred in Profemur Z cobalt-chromium alloy modular necks (Wright, Arlington, TN, USA). The patients were male with a long varus neck. Their BMI was 30.7, 35.6 and 26. Time to revision surgery has been of 3.1, 3.2 and 2 years. No further descriptions are available.

The two cases of Co-Cr modular neck fracture reported in the present paper represent the third description in the literature for this rare complication. Some similarities with the other cases reported in the literature should be underlined. Indeed, a long varus modular Co-Cr neck was used in all the implants. In detail, the varus angle in both cases reported in the present paper was the same as the Mencière's case (8°). The fractures occurred at the stem-cone junction, that is the most reported breakage point in titanium modular necks too.

No previous traumatism had been reported. Moreover, the cases described by Mencière et al. and Kovac et al. studies involved overweight or obese patients as in the two cases reported in the present paper. Nonetheless, long varus type of modular neck and overweight and/or high demanding physical activ-

ity had already been reported in the literature as risk factors in titanium neck fractures. Moreover, clinical presentation was quite similar, with acute pain referred during weight bearing activities without any detectable trauma. Finally, the time lapse between prosthetic implantation and modular neck fracture was 2 to 5 years in all the reported cases.

In most titanium neck breakage cases described in the literature, prodromal symptoms such as groin pain and clicking sensations were reported to precede the fracture. Conversely, both in the cases described in the present paper and in the case described by Mencière et al. no prodromal symptoms were reported, suggesting a possible difference in Co-Cr neck fracture modality.

Summary

The two cases of Co-Cr modular neck fracture reported in the present paper represent the third description in the literature for this rare complication. In the present cases, long varus type of modular neck and overweight might have contributed to implant failure, as already reported in the literature.

Conflict of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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