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Accolade TMZF trunnion corrosion and mechanical failure 9 yr after primary surgery: A case report and treatment options

Matias Hemmilä, MD, Mikko Karvonen, MD, Hannes Keemu, MD, Matti Seppänen, MD and Keijo Mäkelä, MD, PhD

Department of Orthopaedic Surgery, University of Turku and Turku University Hospital, Turku, Finland

INTRODUCTION

Preserving patient anatomy in total hip arthroplasty (THA) is important to achieve good functionality and satisfied patients. Modular femoral heads are designed to help achieve this aim by managing limb-length, offset, and soft-tissue balance. Normal anatomy can be more easily preserved, and acetabular component exposure is achieved with removal of the femoral head in revision surgery. However, modularity increases the risk for mechanically assisted crevice corrosion (MACC) (also called trunnion corrosion) and may lead to trunnionosis, adverse local tissue reaction (ALTR), early femoral head dissociation, and implant failure. MACC is a multifactorial and poorly understood phenomenon. Affecting factors can be divided into patient-related, component-related, and surgery-related factors.[1–3] Patient-related factors include male gender and high body mass index (BMI). Component-related factors include stem design, high-offset implants, head-neck angle, femoral head diameter, and the metal alloy. Surgical-related factors include damage to the head-neck surfaces and inappropriate surgical technique. It has been estimated that 3% of all hip revision procedures worldwide are currently performed due to trunnion corrosion.[4–6] Femoral head dissociation with implant failure still remains a rare complication, and there are only a few reports of that complication that have been published.[7,8]

The patient was informed that data concerning the case would be submitted for publication, and he provided consent.

CASE REPORT

The patient in this report is a 75-year-old male patient who has asymptomatic lung asbestosis and somewhat limited physical capacity due to right hip osteoarthritis but otherwise is fit. The patient's BMI was 29, and the goal for postoperative activity was to gain normal physical activity and pain relief. Surgery was performed using a Stryker (Mahwah, NJ, USA) Accolade® TMZF® (Stryker, Mahwah, NJ) size 4 standard offset 127 caput-collum-diaphyseal (CCD) angle-stem with a Stryker Mitch 50-mm + 8-mm head and a Stryker MITCH cementless 54-mm cup with metal-on-metal bearing surfaces (Stryker, Mahway, NJ) in 2008. In the postoperative radiograph, there was a thin 0.5-mm radiolucent line in the bottom of the cup without other signs of complications. The cup anteversion was 20 degrees and inclination 37 degrees. Three days after the primary operation, the patient fell, and the cup tilted. An early cup revision operation was performed 7 days after the primary operation using the MITCH 50-mm + 8-mm head and MITCH cementless 56-mm cup with metal-on-metal bearing surfaces. There was *Staphylococcus capitis* growth in the bacterial cultures taken during the cup revision. A repeated joint aspiration was performed, and the result was negative; positive bacterium culture was considered as a contamination. The patient recovered well, and after 1 yr he was asymptomatic and could walk several kilometers without a problem. The range of motion of the hip was good, lower limbs were of equal length, and the Trendelenburg test was negative.

The patient was totally asymptomatic in the right hip for 9 yr until he stood up from the chair and suddenly felt right hip pain and was unable to bear weight. The radiographs showed dissociation of the femoral head from the trunnion and probable trunnion damage (Figure 1). The re-revision was performed 2 days later, and the stem was revealed. Some metallosis was found in the joint, but no pseudotumor was evident. The trunnion was corroded and severely damaged meaning the stem needed to be replaced (Figures 2 and 3). The stem was well-fixed, and an extended trochanteric osteotomy of the femur was performed. The stem was replaced with a modular Arcos revision stem (ZimmerBiomet, Warwaw, IN). A 12-mm x 150-mm STS distal bearing stem and a cone B60 high-offset proximal part was used. The cup was exposed. Since it was in an acceptable position and was well fixed, the cup was retained to avoid possible damage resulting from component removal. A 56-mm dual mobility system was used to prevent damage and dislocation (Figure 4).

Financial Disclosure: The authors report no conflicts of interest.

Correspondence to Matias Hemmilä, MD, Department of Orthopaedic Surgery, University of Turku and Turku University Hospital, Luolavuorentie 2, PL 28, 20701, Turku, Finland
Tel: +358 2 3130000; fax: +358 (0)2 313 6884;
e-mail: matias.hemmila@tyks.fi.

FIGURE 1. Anteroposterior radiograph presenting dissociated femoral head from the trunnion after a total hip arthroplasty.

The patient recovered well, and 4 mo after the revision he was free from pain and satisfied. He could walk without pain in his right hip. There were no radiolucent lines in the radiographs. One year after the revision operation, he was still asymptomatic and could walk over 1.5 kilometers. His leg lengths were equal, his Trendelenburg test was negative, and his Harris hip score was 93/100. Radiolucent lines were not seen in radiographs.

DISCUSSION

There are different severity levels of MACC and trunnion corrosion and variable presentations. Wear and corrosion at the head-neck interface can induce an ALTR through molecular mediators.[9] A combination of ALTR symptoms include pain in the groin, thigh or buttock, and limb.[10] The symptoms occur typically 3.7 to 4.3 yr from the primary surgery.[10,11] Pain is not universally present, and some patients might have first symptoms when the femoral head dissociates, as with the patient in this case. If suspicion of trunnion corrosion and ALTR is raised, serum cobalt (Co) and chromium (Cr) ion levels need to be measured. It has been reported that patients with clinically important trunnion corrosion often have elevation of Co and Cr levels of 5 to 1 in relation to normal levels.[10] It should also be kept in mind that symptoms of periprosthetic joint infection (PJI) and those of ALTR resemble each other, and PJI should be ruled out.

FIGURE 3. MITCH 50-mm + 8-mm head and Accolade® TMZF®-stem with femoral neck wear.

FIGURE 2. Severe trunnion corrosion and wear of the Accolade TMZF stem.

FIGURE 4. Anteroposterior radiograph showing the outcome after revision operation with Arcos 12-mm x150-mm STS distal bearing stem and a cone B60 high-offset proximal body.

Diagnostic imaging includes anteroposterior pelvic and cross-table lateral hip views. Dissociation of the femoral head can be easily diagnosed from radiographs, and osteolysis in the calcar and greater trochanteric areas might implicate ALTR.[11] Patients with suspected ALTR need further imaging, and metal artifact reduction sequence (MARS) MRI is currently considered to be the gold standard. MARS MRI enables the evaluation of the soft-tissue envelope around the hip joint.[12] MARS MRI findings should be interpreted critically since abnormal imaging findings can be seen even in well-functioning metal-on-polyethylene total hip replacement.[13]

Once corrosion of the trunnion has been diagnosed, revision surgery should be planned carefully. If the components are well fixed and positioned, the revision could be accomplished with liner and femoral head exchange.[10,11] Short-term data suggest that doing so did not increase the re-revision rate with 3.3-year follow–up time.[14] In the case of head dissociation or cold welling, the stem would need to be replaced and revision components available when performing these procedures. After removing the head, the trunnion should be cleaned and inspected for damage. If the trunnion is crushed or severely damaged, it needs to be replaced, and the surgeon should perform stem revision, which may require the use of an extended trochanteric osteotomy (ETO). A component-specific sleeve adapter can be used and combined with a ceramic head if the trunnion is only minimally damaged. Exchange of the CoCr femoral head to another CoCr femoral head should be avoided since it has been reported that it may result in relapse of ALTR.[11] A liner change is recommended due to potential embedded metal debris.[10,11]

There are few case reports on Accolade trunnion corrosion and early failure. Matsen Ko *et al*.[8] reported five patients from their clinic with catastrophic Accolade trunnion failures. All heads were made of cobalt-chromium and were 36-mm or 40-mm in diameter, and in four patients the surgeon chose a femoral head that further increased neck length. All acetabular components were Trident acetabular shells with highly cross-linked-polyethylene liners. In three of five patients, a lateral offset stem with a head-neck angle of 127 degrees was used, and the other two stems were standard offset designs with a head-neck angle of 132 degrees. Raju *et al*.[15] published a report of three patients of trunnion corrosion after total hip arthroplasty with Stryker Accolade TMZF stems. Accolade plus stems with a head-neck angle of 127 degrees were used in all three with a 36-mm head with +5-mm neck and V40 taper. Trident acetabular shells (Stryker, Mahway, NJ) were used as acetabular components, but bearings were not mentioned in the report. Spanyer *et al*.[16] reported three catastrophic Accolade I femoral neck failures. In two of the three patients, high-offset stems were used, and in one of the three, a head-neck angle 127-degrees stem was used. The femoral head diameter of 36 mm was used in two of three patients and the third head was 32 mm. The femoral head length of 8 mm to 10 mm was used in all patients. Runner *et al*.[17] also reported three gross trunnion failures with Stryker V40 tapers. A 36-mm diameter +5-mm head was used with all three patients. Elevated serum cobalt levels were measured in every patient. Patel *et al*.[18] published similar head-neck taper corrosion in the Stryker Meridian TMZF stem. Serum cobalt levels were elevated, and MARS MRI revealed ALTR. Trunnionosis and elevated metal ion levels without component failure are reported with Accolade TMFZ stems. Craig *et al*.[19] reported raised metal ion levels in the blood after Trident-Accolade total hip replacement with 36-mm diameter femoral head, and the result was statistically significant compared with 28-mm diameter femoral heads.

The trunnion failure problem is not limited to the Accolade stems. Banerjee *et al*.[7] reported gross trunnion failure after THA in components from five different manufacturers with metal-on-polyethylene or ceramic-on-polyethylene bearings, but no common factor was detected in these patients.

Patient-related factors affect the risk for trunnion corrosion. Greater load to trunnion-head interface is associated with an accelerated corrosion, and a high BMI is a risk factor for trunnion corrosion.[20] Male gender and higher activity levels are also linked with this complication.[8] The patient in our case report presents all of these criteria: male gender, BMI 31.3, and an active lifestyle.

Component-related factors include stem design and geometry, offset, head-neck angle, femoral head diameter, and metal alloy. The Accolade TMZF stem is composed of beta titanium (titanium, molybdenum, zirconium, and fluoride), a titanium alloy with 25% greater flexibility compared with the standard Ti-6Al-4V alloy.[21] Because of this lower modulus of elasticity, it is possible that the normal forces during gait increase bending of the titanium trunnion within the cobalt-chromium femoral head.[8] Taper geometry has been reported to have more influence than stem design on the corrosion.[22] When the taper is smaller and made up of a more flexible alloy, the likelihood of corrosion is higher.[23] A low head-neck angle (i.e, 127 degrees) is another risk factor. The horizontal offset increases the forces at the head and neck junction, leading to increased corrosion.[24] One important factor is that all femoral heads in these case reports were made of cobalt-chromium alloy, which, when combined with a titanium trunnion, can lead to galvanic corrosion and weakening of the trunnion interface.[20] The phenomenon is stronger with large (> 36-mm) heads, and both laboratory and retrieval studies have shown that a large head increases the frictional torque and thus accelerates the wear.[23,25,26] Trunnionosis occurs similarly in metal-on-metal and metal-on-polyethylene total hip replacements as both head-neck junctions consist of metal-on-metal surfaces.

A V40 taper has an angle of 5 degrees 40 min; it is smaller and shorter compared with other taper designs and allows better clearance and prevents impingement.[15] Accolade has a very low surface roughness at the trunnion.[27] This surface smoothness could also be a potential factor leading to dissociation of the head from the taper.[15]

The combination of patient demographics (heavy, tall, and male), component factors (a large-diameter, cobalt-chromium femoral head, and a stem made of flexible titanium alloy), and surgical technique (high offset) may all contribute to this catastrophic event.[8] According to Matsen Ko *et al.* precautions can be taken, such as checking serum cobalt and chromium levels in high-risk patients—i.e, those who are young, are active, have a higher BMI, are male, and have a 36-mm-diameter femoral head. These levels should definitely be checked in symptomatic patients, and patients with elevated metal-ion levels should undergo MARS MRI scans. The

Accolade TMZF stem was available on the market from 2001 to 2011, and there are published reports of failure over 7 yr after the implantation, so more of these catastrophic complications could occur in the future.

The implant combination of an Accolade TMZF stem and a Stryker MITCH cementless 56-mm cup with metal-on-metal bearing surfaces was not used in US markets, but similar trunnion corrosion pattern have been described in the literature with other bearings as well.

CONCLUSION

Mechanically assisted crevice corrosion (MACC) leading to trunnion and femoral head dissociation is a catastrophic event after total hip arthroplasty. MACC is multifactorial phenomenon; affecting factors can be divided into patient-related, component-related, and surgery-related. Severe trunnion corrosion due to MACC is a rare complication. There are some publications about Accolade TMZF stem corrosion, and it is possible that there will be more reports of this problem. It is important to recognize these patients and arrange follow-up.

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