Case Report

Femoral Nerve Compression due to Adverse Local Tissue Reaction After Ceramic-on-ceramic Total Hip Arthroplasty

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ABSTRACT

The use of metal bearings in total hip arthroplasty (THA) has been linked with adverse local tissue reactions (ALTRs). There is 1 reported case of ALTR from a ceramic-on-ceramic (CoC) bearing and none that resulted in nerve compression. In this case, a 71-year-old man presented with an ALTR after a CoC THA that resulted in femoral nerve compression. An anterior approach was utilized to revise his THA, which resulted in nerve decompression and near-resolution of his preoperative symptoms. We conclude that CoC bearings may not be completely inert and can result in ALTRs and nerve compression.

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Introduction

The use of hard-on-hard bearings in total hip arthroplasty (THA) has been shown to have benefits including better stability, decreased wear rate, and greater longevity [1]. These bearings, such as metal-on-metal (MoM) and ceramic-on-ceramic (CoC), gained popularity due to the concern for polyethylene wear in metal-on-polyethylene (MoP) implants. Despite the elimination of the polyethylene particles, metal wear debris has also led to its own complications. The debris formed from MoM implants has led to both mechanically assisted crevice corrosion (MACC) and adverse local tissue reactions (ALTRs) [2–4]. These lesions are nonneoplastic in nature but can lead to tissue necrosis, instability, and spontaneous dislocations [5]. There are only a few cases describing MACC or ALTRs after CoC THA, and there are no reported cases of such complications resulting in femoral nerve compression [6,7]. The purpose of this report is to present a distinctive case of ALTR in a CoC THA resulting in femoral nerve compression with sensory findings.

Case history

Patient informed consent was obtained for publication of this deidentified case report.

In July 2020, a 71-year-old male presented with left hip pain 13 years after a posterior-approach left THA. The patient’s medical history was significant for hyperlipidemia and deep vein thrombosis with pulmonary embolism for which he is on atorvastatin and rivaroxaban, respectively. The patient received a Stryker Trident titanium acetabular shell (Stryker, Kalamazoo, MI) with a titanium-backed third-generation Trident 0°C14 alumina insert ceramic liner and a 32-mm alumina taper ceramic head. A Stryker Accolade TMZF (Stryker, Kalamazoo, MI) was used for the femoral component. The patient’s 6-week history of pain and simultaneous “squeaking” started after he flexed at the hip to retrieve a ball while playing pickleball. He also had associated sensory numbness in the anterior and anteromedial thigh with no history of trauma or falls. At presentation, he characterized his pain as sharp, intermittent, and nonradiating and rated it a 5/10 on the visual analog scale. His symptoms were alleviated with rest, while his numbness, fullness at the hip, and “squeaking” remained. He denied fever, chills, or recent or remote infections. Physical examination revealed full extension with 80° of flexion, 10° of internal rotation, 30° of external rotation, 30° of abduction, and 10° of adduction.

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patient had a clinically stable left hip. He ambulated with a normal tandem gait without the use of an assistive device. His postero-lateral hip incision was well-healed, and there was no palpable mass or swelling. He had pain with log roll and resisted hip flexion, and Flexion, Abduction and External Rotation and Flexion, Adduc-
tion, Internal Rotation tests were also positive. He had diminished sensation over the anterior aspect of the left thigh, but all other distributions were intact. The rest of the patient’s physical exam including a thorough spine examination was within normal limits.

Radiographs of the left hip and anterior-posterior pelvis demonstrated a well-fixed press-fit THA with a single-wedge taper femoral component consisting of a ceramic head articulating with a metal backed ceramic acetabular liner (Fig. 1). Using the Velys Hip Navigation system templating software (VELYS Hip Navigation; DePuy Synthes, West Palm Beach, FL), the acetabular inclination was found to be 33°, and the anteversion was 17°. The patient’s magnetic resonance images revealed a heterogenous mass along the anterior aspect of the hip from the psoas muscle up through the iliacus measuring 7 × 5 × 5 cm, which also extended into the pelvis (Fig. 2). Blood tests revealed a normal differential with a white blood cell count of 6.5 billion cells/mcl, and the sedimentation rate (9 mm/h) and C-reactive protein (1 mg/L) level were also within normal limits. Cobalt was not detected (0.0-0.9 µg/L), the chro-
mium level was 0.6 µg/L (0.1-2.1 µg/L), and titanium levels <10.0 mg/mL (<10.0 mg/mL) were obtained, which were found to be within normal limits [6,7]. The diagnosis of failed left hip arthro-
plasty and compressive neuropathy of the left femoral nerve due to an ALTR was discussed with the patient, and the patient elected to undergo a revision of his left THA.

An anterior approach was utilized as it was thought to provide the best opportunity to simultaneously revise the hip and decompress the mass while reducing the risk of posterior instability given the measured acetabular anteversion. Intraoperatively, an 8-cm anterior hip incision was made and carried obliquely toward the fibular head. An anterior capsulotomy was performed, and normal appearing synovial fluid was encountered and sent for culture. We encountered some granulomatous tissue at the inferior capsule, but no discrete mass was identified. The anterior capsulotomy was carried out proximally, which revealed a large granulomatous mass that was excised off the pelvic brim and sent for permanent patho-

Discussion

In the literature, there are multiple reported cases of ALTRs and MACC after MoM and MoP THAs. An ALTR from a CoC THA, how-
ever, is rare, with only a few reported cases. Campbell et al. reported ALTR from a CoC THA in a 54-year-old female who presented with a painful postoperative hip [6]. The patient had their THA revised, and it was subsequently concluded that ceramic wear debris may have led to an ALTR due to the lack of metal debris and elevation of either the chromium or cobalt level [6,8]. Movassaghi et al. recently reported on a case of ALTR after a CoC THA in a 67-year-old patient [7]. Their case indicated that a prominent screw head caused abrasive backside liner wear and that ceramic liner malpositioning as well as liner locking failure led to liner fragmentation and loss of
its taper fit that resulted in an ALTR [7]. In addition, further review of the literature revealed only a few cases of femoral neuropathy due to ALTR, and all of them developed after using MoM or MoP bearing surfaces. This is the first reported case, to our knowledge, where a patient developed femoral nerve compression from an ALTR after a CoC THA [9–11]. MoM bearing surfaces became popular in the early 2000s, with about 35% of THAs in 2006 utilizing MoM surfaces [12–14]. However, unique failure modes such as MACC and ALTRs became a great concern. This reaction can lead to bursal soft-tissue growth and result in dysfunction, pain, and neuropathy [12].

Ceramic materials can be prone to mechanical failure, fracture, and wear due their nonexistent ductility when subjected to tensile and load stresses [15]. Impact load stress from the separation of the femoral head bearing surface and the acetabular component can also lead to damage. Additionally, the tensile stress produced from the potential hoop stress between the Morse taper trunnion and ceramic head also contributes. Although wear can occur, advancements in ceramic manufacturing have led to low incidences (0.01%-0.15%) of fracture in comparison to earlier-generation ceramics [16]. Even though newer ceramics have been formulated since the third-generation ceramic used in the original primary surgery, noise generation has persisted and continues to be of concern [17]. Ceramics are composed of alumina and zirconia, which are extremely inert, especially in comparison to metals or polyethylene [18]. However, the inertness of ceramics has been challenged by several studies. In a study by Lerouge et al., ceramic debris induced a granulomatous foreign body reaction that led to aseptic loosening [19]. Bitar and Parvizi found that ceramic debris induced a strong inflammatory response [20]. In theory, ceramic debris can cause an ALTR.

The Stryker Accolade TMZF has a significant history of early failure and MACC, most notably due to trunnion corrosion, leading
implantation. Ricciardi et al. described 3 main categories in which cases of ALTR in hip implants fall: macrophage-dominant, mixed macrophagic and lymphocytic with or without an allergic or a hypersensitivity response, and granulomatous [28]. In this case, the histology seen can be categorized as a mixed macrophagic and lymphocytic response. The significance of this finding may be that we observe this type of response rather than a predominantly macrophagic one due to a lack of local nanoparticle infiltration, as is often seen with MoM ALTRs.

Acute neuropathy following a THA is not common with an incidence of 0.6% to 3.7% and most often involves the sciatic nerve [29]. The cause of neuropathy is often not determined but can be trauma, tension, and hematoma [30]. Delayed-onset neuropathy is rare, and femoral nerve compression is almost nonexistent, especially from ALTRs. In a report by Fokter et al., there were only 3 cases of femoral nerve neuropathy resulting from MoM or MoP bearing debris [31]. A prompt revision arthroplasty is recommended with controversy over either complete excision or indirect decompression via debridement of the ALTR. Harvie et al. reported 2 cases of femoral neuropathy due to ALTRs from an MoM resurfacing arthroplasty [32]. Both cases resulted in revision arthroplasty and femoral nerve neurolysis.

This is the first reported case of an ALTR from a CoC bearing resulting in femoral nerve compression. The lack of backside liner wear, trunnion corrosion, and impingement, as well as normal levels of cobalt, chromium, and titanium, suggests that the ALTR was due to ceramic debris from the CoC bearing.

There are several limitations to the study. First, there was no preoperative aspiration performed, and thus, there was no preoperative histological evaluation. The surgeon did not think that aspiration was warranted given the diagnosis of ALTR using the magnetic resonance images and that infection was highly unlikely. Histological evaluation would have been helpful in identifying the type of ALTR and possibly the cause of its formation.

Summary

We present a case of femoral nerve compression from an ALTR in a patient with a ceramic-on ceramic bearing surface. The ALTR occurred with no source of metal debris and normal levels of cobalt, chromium, and titanium. This case reveals that the ceramic wear debris may not be completely inert and can lead to an ALTR and, in this case, femoral nerve compression.

Conflicts of interest

R. G. Gosthe is a paid consultant for Zimmer Biomet. All other authors declare no potential conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j. artd.2022.08.024.

Informed patient consent

The author(s) confirm that written informed consent has been obtained from the involved patient(s) or if appropriate from the parent, guardian, power of attorney of the involved patient(s); and, they have given approval for this information to be published in this case report (series).

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