Ultrasonographic and Radiographic Findings of Polyethylene Component Displacement with Severe Metallosis and Metal-Induced Synovitis Following Total Knee Arthroplasty

Shane Mallon
*Henry Ford Health System*

Kyle Bussis
*Henry Ford Health System*

Zachary Beswick
*Henry Ford Health System*

Trevor North
*Henry Ford Health System*

Steven Soliman
*Henry Ford Health System*

Follow this and additional works at: https://scholarlycommons.henryford.com/merf2019caserpt

Recommended Citation
Mallon, Shane; Bussis, Kyle; Beswick, Zachary; North, Trevor; and Soliman, Steven, "Ultrasonographic and Radiographic Findings of Polyethylene Component Displacement with Severe Metallosis and Metal-Induced Synovitis Following Total Knee Arthroplasty" (2019). Case Reports. 81.
https://scholarlycommons.henryford.com/merf2019caserpt/81

This Poster is brought to you for free and open access by the Medical Education Research Forum 2019 at Henry Ford Health System Scholarly Commons. It has been accepted for inclusion in Case Reports by an authorized administrator of Henry Ford Health System Scholarly Commons. For more information, please contact acabrer4@hfhs.org.
Aseptic loosening and wear of arthroplasty is second only to infection as the most common complication of arthroplasty failure. Degeneration of the polyethylene and metal arthroplasty components can lead to metallosis, which can cause a combination of direct cytotoxic effects and an inflammatory response within the synovial and periarticular tissues. This can result in bone resorption and secondary arthroplasty component loosening as well as a metal containing joint effusion and metal-induced synovitis. Little literature exists as to the ultrasonographic findings of metal-induced synovitis and polyethylene component displacement. As the use of musculoskeletal ultrasound significantly increases, being aware of these findings is important. The following is a case report that demonstrates the ultrasonographic findings of metallosis, metal-induced synovitis and polyethylene component displacement. We will also demonstrate the ultrasound guided aspiration findings as well as radiographic and gross pathologic correlations.

Case Report

A 62-year-old man presented for evaluation of a painful right total knee arthroplasty 6 years after surgery. The patient described chronic pain in his knee for 3 years, which was present with movement and at rest and not relieved by oral pain medications. The patient denied constitutional symptoms and did not recall any trauma after surgery. Initial laboratory studies demonstrated the white blood cell count and C-reactive protein to be within normal limits. The erythrocyte sedimentation rate was elevated at 79 mm/hr (normal ≤20 mm/hr). The patient was then referred for a diagnostic US of the right knee. Ultrasonographic imaging with a 10-MHz transducer using a MYT-90 (General Electric Company, Chatsworth, CA) with a rapid-flow pulsed Doppler and color Doppler, and an incomplete compressible area of the suprapatellar recess consistent with severe metal-induced synovitis in combination with a complex joint effusion (Fig. 1). US imaging also demonstrated the anteriorly placed polyethylene component as an oblong area of echogenicity expanding anteriorly into Hoffa’s fat pad, inferior to the patella and adjacent to the patellar tendon (Fig. 1). Color Doppler imaging failed to demonstrate hyperemia confirming the diagnosis of the polyethylene component. Radiographs were obtained which demonstrated significant dense deposition of the suprapatellar recess with anterior displacement of the polyethylene component resulting in metal-on-metal articulation (Fig. 2). An US-guided aspiration of the right knee joint was requested to evaluate for an underlying infection. The US-guided aspiration yielded approximately 250 mL of completely dark black synovial fluid (Fig. 3).

Discussion

Total knee arthroplasty is one of the most common surgeries performed in the United States with a lifetime likelihood of 7% in men and 9.5% in women. [1] Breakdown and loosening of components is inevitable and in the absence of infection, the most common complication is from degradation of arthroplasty components, both metal and polyethylene, and their resultant effects on the surrounding tissues. [12] Early degeneration of the polyethylene component can lead to deposition of small particles of polyethylene into the joint space and surrounding tissues, which is referred to as plasticosis. Further wear can result in metal-on-metal contact and subsequent deposition of metal particles, which are predominantly oxides consistent with metallosis. This can cause local cytotoxic effects as well as an innate, adaptive, and cytokine mediated inflammatory response [12-15]. These effects can result in a larger and sometimes painful joint effusion as well as erosion of adjacent bone with secondary loosening of prosthetic joint components [13, 16].

Radiographs are the first-line imaging modality when there is concern for complications after arthroplasty and they can be used to assess for the positioning and integrity of the arthroplasty components as well as the adjacent bone. Metallosis has both specific and nonspecific radiographic findings that have been described in the literature. Specific findings refer to the appearance of metallic density in the joint effusion or extravasal collection and include the ‘bubble sign’, the ‘metal–tissue’ sign, and the ‘cloud sign’ (Fig. 2). The ‘bubble sign’ describes the deposition of metal debris into the joint space with metallic debris, giving a bubble-like appearance [5]. Similarly, a linear and less complete outlining of the joint capsule with metallic density has been described as the ‘metal–tissue’ sign [17]. The ‘cloud sign’ refers to amorphous cloudy metallic densities in the joint space. [18] Periprosthetic oedema is a more sensitive but nonspecific finding that may be seen with metallosis. Computed tomography can also detect the metallic densities and is more sensitive at detecting subtle osteolysis and characterizing the full extent of bone loss for surgical planning [13]. Magnetic resonance imaging can demonstrate susceptibility artifact that would suggest metallic deposition around the joint space; however, the artifact from the arthroplasty limits its usefulness [6]. Though arthroscopic evaluation may be considered and is ultimately described in the literature, knowledge of the ultrasonographic findings of metallosis, metal-induced synovitis and displacement of the polyethylene component is important. This is especially true given the significantly increasing use of musculoskeletal US in the evaluation of knee pain and the postoperative knee as well as its use in US-guided aspirations [8]. On many occasions US of the knee may precede radiograph imaging. A joint effusion or extravasal fluid collection associated with a knee arthroplasty with metallosis is readily imaged by US. A recent study by Lainala et al. demonstrated a high sensitivity and specificity for identification of pseudotumors around metal-on-metal hip prostheses. [19] The use of dynamic compressibility during US of a distended suprapatellar pouch allows advantage to both radiographs and magnetic resonance imaging in differentiating between a joint effusion and synovitis. Synovitis will not be compressible while simple joint fluid will completely compress and a complex joint effusion will partially compress or demonstrate mechanical debris [8]. US also allows the real-time use of color Doppler to evaluate for hyperemia without the need for intravenous contrast administration. A heterogeneous echogenic effusion, with or without a well-defined margin and associated with the fluid collection as well as plastic debris. Metal deposition around the fluid collection demonstrates echogenic shadowing, as seen in our imaging, and would be the correlate to the ‘metal–tissue’ sign and ‘bubble sign’ [6]. Our case is unique in that it also demonstrates ultrasonographic visualization of the displaced polyethylene component (Fig. 1). The osseous cortical contour can also be assessed on US and can identify osteoclastic changes. US and CT may play a crucial role in the diagnosis of metal-induced synovitis and displaced polyethylene component. Knowledge of the ultrasonographic findings is important as the use of US increases for the evaluation of knee pain and the postoperative knee. The prompt recognition of both the clinical and the ultrasound appearance of metallosis or loosening in delay can lead to an increased amount of inflammatory and cytotoxic changes in the periarticular tissues as well as continued osteoclastic changes. The progression of the effects of metallosis can lead to a more complicated surgical repair.