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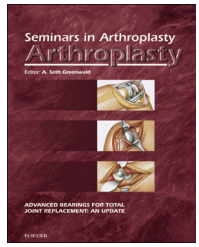

Ultrasound: Optimal screening test for pseudotumor detection

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ABSTRACT

Since 1990, metal-on-metal (MOM) hip arthroplasties have been increasingly used. However, there have been concerns lately regarding adverse local tissue reaction to metal ions leading to aseptic masses called pseudotumors. Ultrasound (US), computerized tomography (CT), and magnetic resonance imaging (MRI) have all been suggested to investigate this problem. We have reviewed the use of ultrasound in the detection of pseudotumors and have found it to be equally sensitive and specific, easily accessible, and not as affected by metal artifacts compared to MRI. We recommend that ultrasound be considered as the first line of investigation to rule out a pseudotumor formation in MOM hip arthroplasties.

1. Introduction

Since 1990, metal-on-metal (MOM) hip arthroplasty had been widely used with over a million units implanted worldwide in an effort to improve survivability, range of motion, and stability of hips in younger patients [1]. The two main varieties of MOM hip arthroplasty are large- and small-diameter-head MOM total hip arthroplasty (THA) and hip resurfacing arthroplasty (HRA).

However since 2010, there have been reports of early failure and revision of some designs [2,3] (large-diameter ASR and ASR). These are commonly due to reactions, which have been reported under different headings such as "metallosis," "pseudotumor," and "aseptic lymphocytic-vasculitis-associated lesions (ALVAL)," collectively described as "adverse reaction to metal debris (ARMD)" [4]. All of the above are an abnormal reaction of local tissues around an implant due to increased metal ions released either from the primary bearing articulation or from other modular junctions such as the head-neck or neck-stem junctions, also called adverse local tissue reaction (ALTR) [5]. For the purpose of this review, we have referred to adverse soft tissue lesion around MOM hip replacements as a pseudotumor.

There have been recent reports of similar reactions occurring in metal-on-highly cross-linked polyethylene-bearing hip replacements (HXLPE). This is due to the abnormal corrosion at the trunnion-head junction [5,6]. Since this bearing couple is being commonly used, we are faced with a potentially increased burden of this problem in the future.

Pseudotumors are non-malignant, non-infective masses around a prosthesis, which can be solid, cystic, or mixed. These lesions can cause osteolysis, soft tissue damage, and pressure symptoms on neurovascular structures [7]. It is important to detect them early, as they can cause major complications and poor outcomes after revision surgery [8,9]. Previous reports have confirmed the incidence of these pseudotumors in asymptomatic patients and hence the need for surveillance and monitoring their progress [10–12].

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The European orthopaedic consensus, in 2012, agreed on following up patients with MOM hip replacements by at least an annual clinical assessment, blood metal ions, and a plain radiograph. They have suggested use of cross-sectional imaging in addition to the above tests in certain implants and symptomatic patients [13]. They suggest using ultrasound (US), computerized tomography (CT) scan, or modified magnetic resonance imaging (MRI), but it is unclear as to which is the best first line of investigation. Numerous reports suggest that metal artifact reduction sequence (MARS) MRI is the gold standard. However they are costly, not easily accessible, and contraindicated in patients with ferromagnetic clips, cardiac pacemakers, and claustrophobia [14].

Clearly there is a need to examine the advantages of using an alternative investigation that is cost-effective, equally reliable, and readily available even in smaller health units.

We present a detailed review of the reliability and accuracy of ultrasound in the investigation of pseudotumors and an evaluation of its role in the screening of MOM and painful HXLPE hip arthroplasties.

2. Clinical evidence of using ultrasound in evaluation of MOM hip arthroplasty

There have been reports of the successful use of ultrasound in the investigation of MOM hip arthroplasty in English literature.

Pandit et al. in their study used ultrasound as part of their investigation for symptomatic hip resurfacings [6]. They investigated 17 patients (20 hips) with a Birmingham hip resurfacing who had varied symptoms including pain. Apart from plain radiographs, they used US, CT, and MRI to investigate 10 patients (13 hips). They found two main types of imaging abnormality, namely, a predominantly cystic mass lateral to or behind the joint, or a mainly solid mass lying anteriorly and involving psoas and its bursa. One of their observations was that ultrasound helped to differentiate solid from cystic lesions and could also be used as a guide for biopsy and aspiration. They coined the term “pseudotumor” for this soft tissue mass around MOM prostheses.

Kwon et al. [15] reported the incidence of ALTR in a total of 201 asymptomatic Birmingham hip resurfacings in 158 patients. Using ultrasound as a screening tool, they found pseudotumors in seven patients (4%). US not only allowed them to investigate a large number of patients efficiently but also assisted with aspiration and core biopsy to confirm the diagnosis.

Williams et al. also used US to define the prevalence of pseudotumor formation in asymptomatic patients with a MOM hip arthroplasty. They found 10 patients (32%) in MOM THA, five (25%) in the HRA group and one patient in the metal-on-polyethylene THA group. Hence they concluded that high-resolution US was effective in surveillance of MOM hip implants [10]. Almousa et al. [16] demonstrated that US could be used effectively in monitoring these pseudotumors over time.

Nisshi et al. explored the potential for US in the screening for ALTR around MOM implants. In their study they used US to investigate 79 patients (88 hips) with either a MOM HRA or THA. They categorized their patients into four groups: 69 with normal hips, 11 with joint expansion, five with cystic lesions, and three with a mass. The hips with a mass had a higher frequency of symptoms. Their conclusion was that US provided sensitive screening of soft tissue reaction around metal-on-metal bearings and may be used to monitor their progress [14]. In a later study from the same group, they compared US with the results of MRI in 105 patients (131 hips). Using MRI results as reference the sensitivity, specificity, and accuracy of US for detection of an ALTR were 74%, 92%, and 84% around MOM bearings while in HXLPE bearings it was 90%, 83%, and 85%, respectively [17].

We did a study in our institution comparing MRI and US on 40 patients (28 men and 12 women) with a large-head MOM THA [18]. Patients underwent MRI and US on the same day. If both US and MRI results agreed for a pseudotumor, the result was considered accurate. We found that results of MRI and US agreed in 37 of 40 patients (93%). The use of ultrasound to detect pseudotumors showed a sensitivity of 100% and specificity of 96% while SEMAC MRI had a sensitivity of 92% and specificity of 100%. There was no significant difference between the two modalities in terms of sensitivity or specificity ($p = 0.32$).

Results from the above two studies are difficult to compare as the metal artifact reduction techniques used in these studies were not similar and different standards of accuracy were used. Both studies concluded that US is an effective way to investigate MOM hip arthroplasties in asymptomatic patients for the presence of pseudotumor.

A study that showed poor sensitivity of US for detection of a pseudotumor is by Siddique et al. [19]. They compared the findings of US versus MARS MRI in 19 consecutive patients with asymptomatic unilateral MOM THA. The prevalence of pseudotumors on MARS MRI was 68% and on US was 53%. Using MRI findings as gold standard, sensitivity of US was 69% and specificity was 83%. Sensitivity and specificity of US for pseudotumor detection were inferior when compared to MARS MRI. They concluded that ultrasound should be used when MARS MRI is poorly tolerated, contraindicated, or unavailable. The study had a number of limitations such as small number of patients and there was a time lag between the ultrasound and MRI investigations, which could have been a cause for lack of agreement between the two investigations.

All of the above studies, however, lacked correlation of US and MRI findings with histological diagnosis either by biopsy or at revision except a recent study by Lainiala et al. [20]. They correlated preoperative US findings with perioperative surgical findings during revision of MOM hip arthroplasties. They found that US had a sensitivity of 83% and specificity of 92% for detecting per-trochanteric pseudotumors and 79% and 94%, respectively, in the iliopsoas region. They concluded that the presence of pseudotumor was predicted well with an ultrasound.

To summarize, there is good evidence to suggest that US is a reliable and reasonably accurate test to screen asymptomatic MOM hip arthroplasties. It also seems to correlate well with revision findings in symptomatic patients as seen above.