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MUSCULOSKELETAL

Metal-on-metal hip resurfacings—a radiological perspective

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Abstract It is important to be aware of the various complications related to resurfacing arthroplasty of the hip (RSA) and the spectrum of findings that may be encountered on imaging. The bone conserving metal-on-metal (MOM) hip resurfacing has become increasingly popular over the last ten years, especially in young and active patients. Initial reports have been encouraging, but long-term outcome is still unknown. Early post operative complications are rare and have been well documented in the literature. Medium and long term complications are less well understood. A rare but important problem seen at this stage is the appearance of a cystic or solid periarticular reactive mass, which occurs predominately in women and usually affects both hips when seen in patients with bilateral RSAs. The following imaging findings are illustrated and their significance discussed; Uncomplicated hip resurfacing arthroplasty, radiolucency around the femoral peg, femoral neck fracture, loosening and infection, suboptimal component position, femoral notching, dislocation, heterotopic ossification, femoral neck thinning and reactive masses. The radiologist should be aware of the normal radiographic appearances and the variety of complications that may occur following RSA and should recommend ultrasound or MRI in patients with an unexplained symptomatic hip and normal radiographs.

Keywords Hip · Resurfacing · Arthroplasty · Complications · MRI

Introduction

Current designs of hip resurfacing arthroplasty consist of cobalt chrome acetabular and femoral components. The acetabular component is a thin shell and the femoral component is a shell with a narrow stem which is placed in the femoral neck. The prosthesis is mainly used in men under the age of 65 and women under 60 with good bone stock. Resurfacing arthroplasty has the advantage of improved stability when compared to conventional total hip replacement and, because the native femoral neck is preserved, revision with a conventional primary hip prosthesis is possible in the event of failure. The design of resurfacing prostheses has evolved over the years, from Charnley's Teflon-on-Teflon bearing in the 1950s to the variety of currently available metal on metal devices, which include the Cormet 2000 (Corin Medical), the Birmingham Hip (Midland Medical Technologies), the Conserve Plus (Wright Cremascoli) and Recap (Biomet). In order to prevent excessive wear, the prosthesis needs to be made from a hard material and with precision engineering to ensure a perfect fit between the components. Approximately 45% of patients under 55 years of age undergoing primary hip replacement received resurfacing in the UK in 2004 [1].

The current literature indicates that resurfacing arthroplasty is an effective intervention in the short to medium

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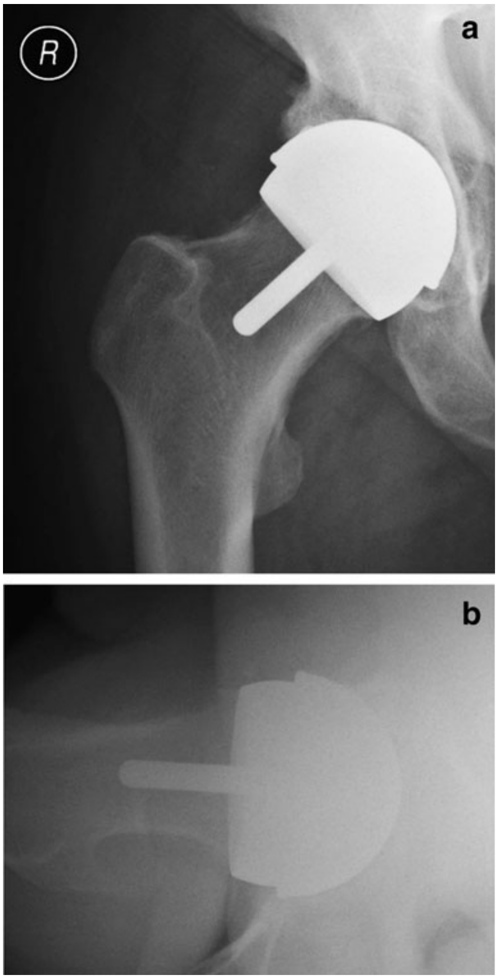

Fig. 1 **a** frontal and **b** lateral radiograph of RSA showing optimum position of the components

term. There are a number of recognised complications with which surgeons and radiologists should be familiar. Plain radiography is the primary method of monitoring progress following surgery, but further imaging techniques including

Fig. 2 Radiolucency is seen around the femoral peg. This is a normal finding

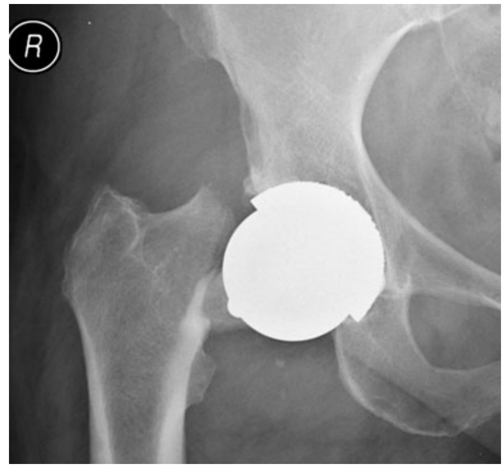

Fig. 3 Fracture of the neck of femur

magnetic resonance imaging (MRI) and ultrasound may be required to assess purely soft tissue abnormalities.

In this article, the normal post-operative radiographic appearances and the imaging of complications of resurfacing arthroplasty are illustrated.

Uncomplicated resurfacing arthroplasty

Routine follow-up radiographs of resurfacing arthroplasty consist of a frontal view (Fig. 1) which may be supplemented by a lateral view. The acetabular component should have an abduction angle of about 40° and anteversion of about 20°. The femoral component should be in a neutral or slightly valgus position relative to the neck. The position of the stem of the femoral component within the femoral neck and the degree of overhang of the femoral prosthesis on the native femoral neck are not thought to be critical. However,

Fig. 4 Loose acetabular component, which has migrated to a horizontal position

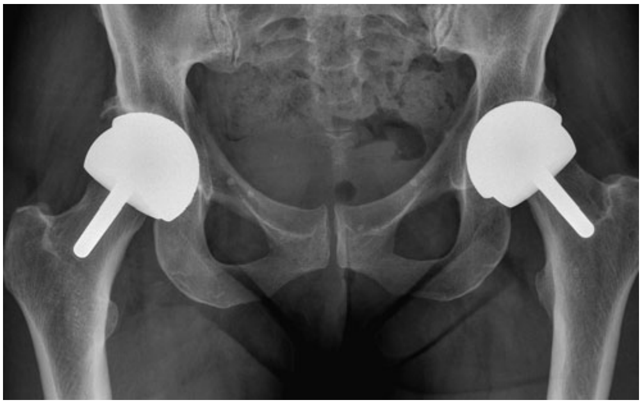

Fig. 5 The acetabular component on the right is positioned too vertically

the neck should not be notched. Minor radiolucency around the femoral stem is a normal finding (Fig. 2).

Femoral neck fracture

This is an important early complication with a reported incidence of around 1.5% and has a higher incidence in women [2] (Fig. 3). There are both mechanical and biological risk factors. The mechanical factors include notching, over-lengthening, varus neck alignment, heavy impaction and large cysts in the head and neck. Biological factors include osteoporosis, and other factors that weaken the bone as well as osteonecrosis of the femoral head [3]. The risk of weakening the neck and compromising the

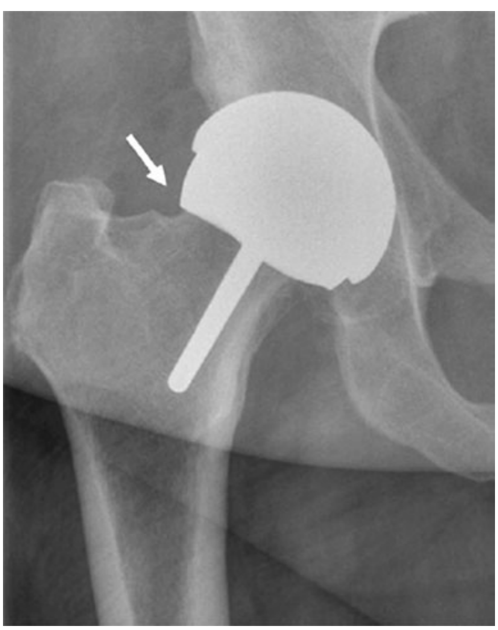

Fig. 6 Superolateral notching of the femoral neck (*arrow*)

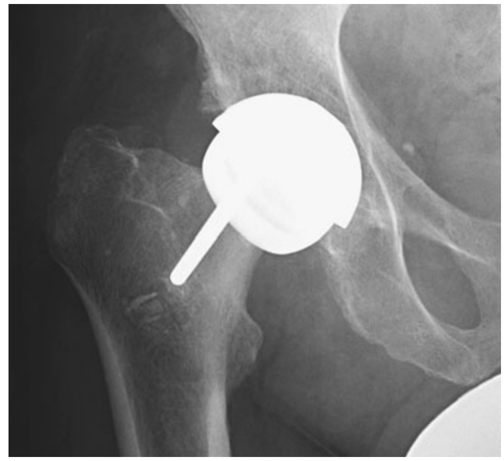

Fig. 7 The femoral stem lies in an eccentric position due to fracture at its proximal end

Fig. 8 Dislocation of the hip secondary to reactive mass

Fig. 9 Bilateral heterotopic ossification

Fig. 10 Femoral neck thinning secondary to a reactive mass

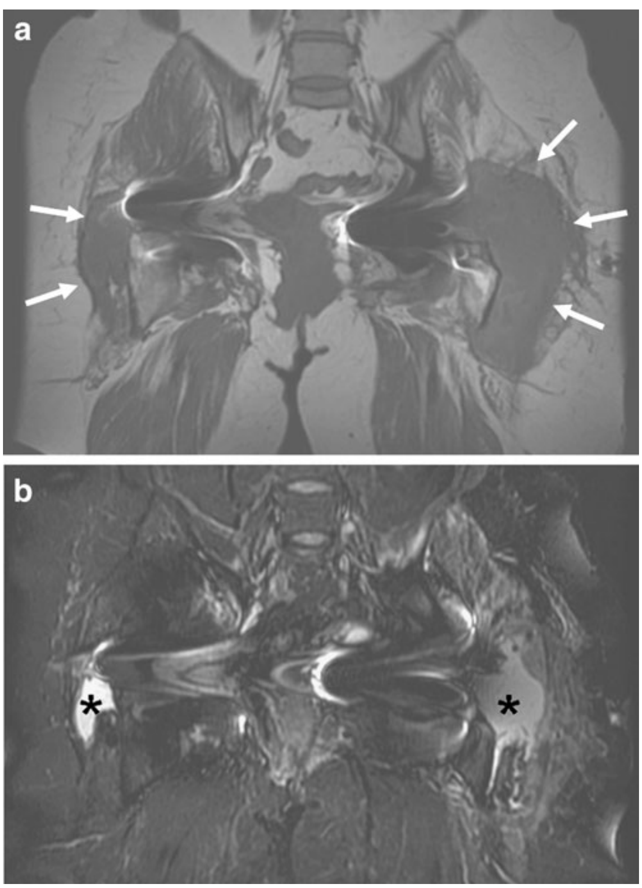

Fig. 11 Bilateral reactive masses in a female patient. **a** T1 and **b** STIR coronal image showing bilateral periarticular masses (*arrows*) with central cystic component (*asterisk*)

blood supply can be reduced by careful surgical technique. The use of an anterolateral, Ganz approach or a modified posterior approach has been shown to reduce disruption of the blood supply [2, 4, 5].

Loosening and infection

As with conventional total hip replacements, infections occur in the early post-operative period and may result in loosening of the prosthesis. To date, the incidence of aseptic loosening is low, and more commonly involves the acetabular component (Fig. 4). [6].

Suboptimal component position

Suboptimal component position without loosening may lead to impingement, pain and increase metal wear. The

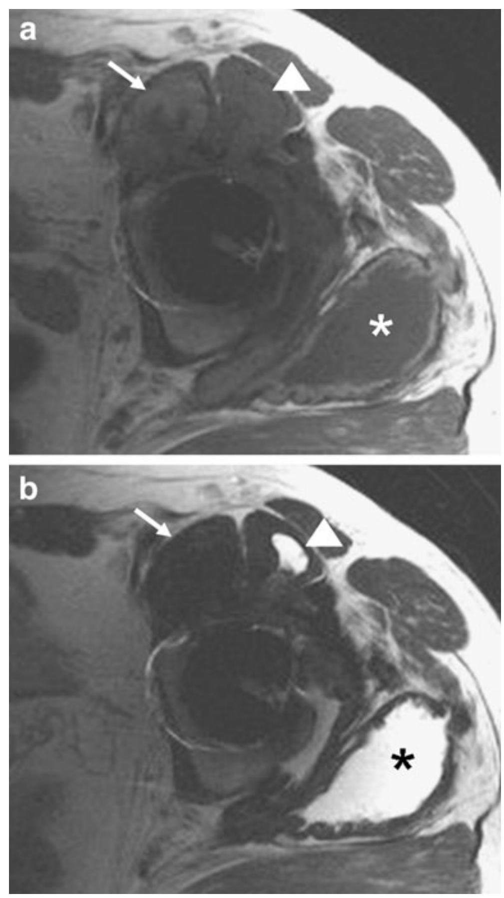

Fig. 12 **a** T1-weighted and **b** T2-weighted MRI showing reactive masses. Anteriorly there is a solid mass (*arrow*) and a mixed cystic-solid mass (*arrowhead*). Posteriorly there is thick-walled cyst (*asterisk*). All the solid components show low signal on the T2-weighted images and signal that is slightly higher than muscle on the T1-weighted images

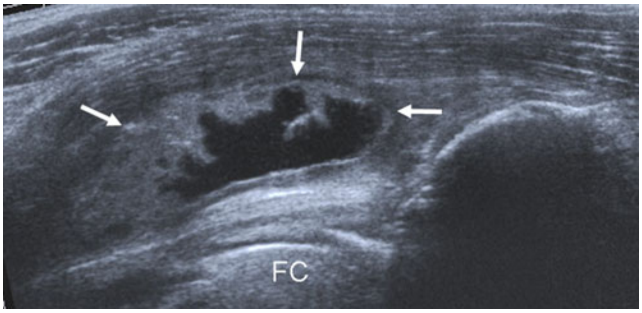

Fig. 13 Ultrasound showing a thick-walled reactive mass anterior to the joint (*arrows*). FC = Femoral component

commonest fault is excessive or inadequate inclination or anteversion of the acetabular component (Fig. 5) leading to impingement and pain [7]. Excessive inclination and or anteversion of the acetabular cup may lead to edge-loading resulting in metal wear with an increase in serum and articular ions levels. On the femoral side an excessively valgus position may result in neck notching and an excessively varus position an increase risk of fracture.

Femoral notching

Notching of the superolateral femoral neck (Fig. 6) immediately adjacent to the femoral component may be due to inaccurate reaming of the femoral head prior to application of the prosthesis. The resulting radiograph may show the femoral component to lying in an excessively valgus position. Although notching should be avoided, a slight valgus position of the femoral component is desirable as this in itself reduces the risk of fracture. Notching may weaken the neck and can also lead to a reduction in blood flow to the femoral head through damage to the extraosseous vessels leading to osteonecrosis both of which increase risk of fracture [8].

Femoral stem fracture

A single case of this phenomenon in total resurfacing arthroplasty has been described in the literature [9]. Two further case have been reported in hemiresurfacing arthroplasty [10, 11]. The stem fracture is associated with loosening of the prosthesis or femoral neck fracture. A further case is illustrated here (Fig. 7). At the time of revision surgery, the femoral component was found to be loose.

Dislocation

Dislocation is very rare [12] (Fig. 8) and may be due to underlying problems such as infection or reactive mass formation [13].

Heterotopic ossification

Heterotopic ossification (Fig. 9) is unwanted bone growth around an implant that is usually asymptomatic but may cause pain and a reduced range of motion. Some degree of heterotopic ossification may be seen in over half of all cases, and is more commonly seen in male patients with osteoarthritis [14].

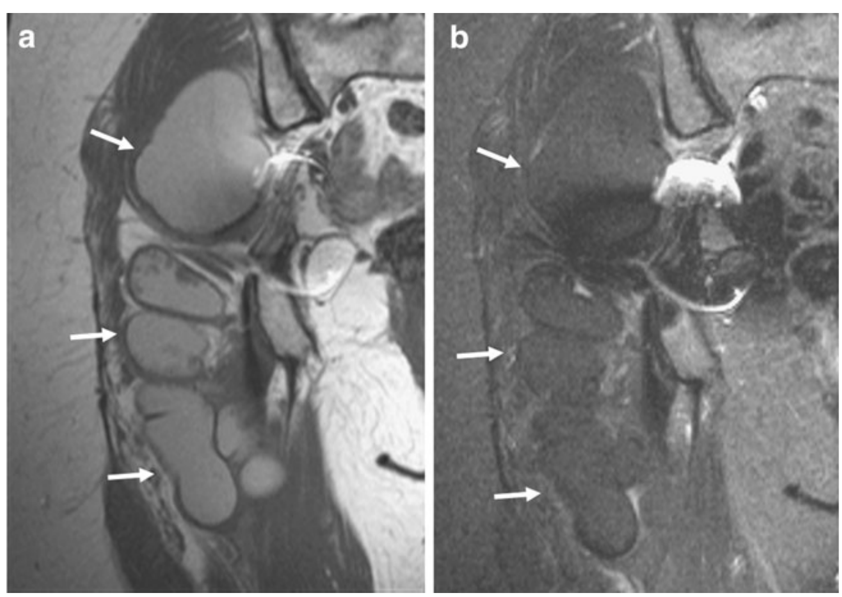

Fig. 14 **a** T1-weighted and **b** STIR coronal images showing a massive cystic reactive mass (*arrows*). The signal intensity of the fluid is high on the T1-weighted sequence and low on the STIR sequence

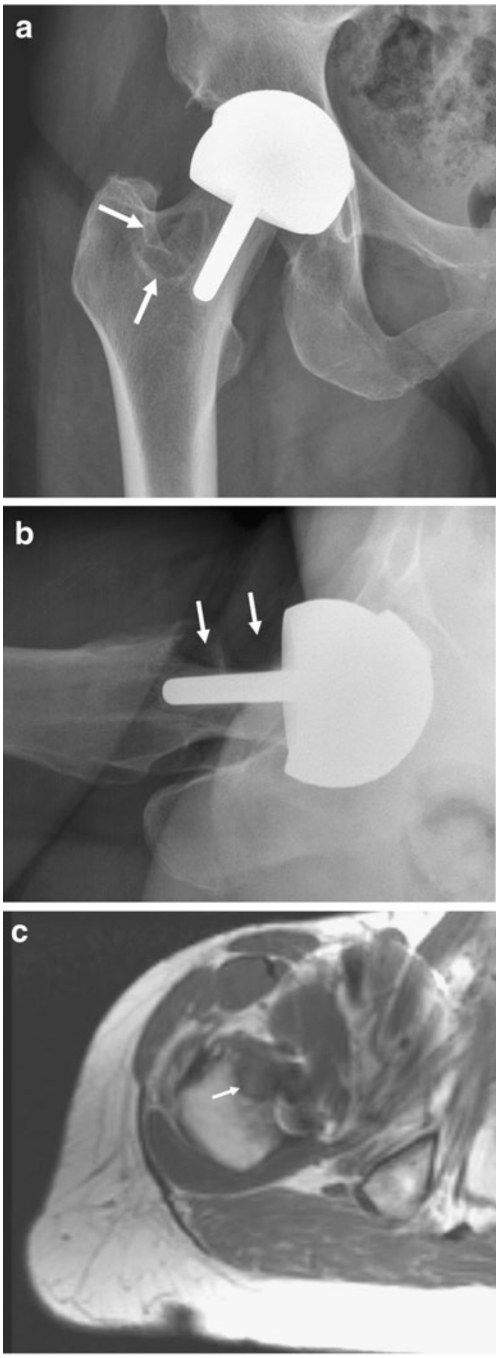

Fig. 15 Reactive mass and bone destruction. **a** Frontal radiograph shows a well-defined lytic lesion in the femoral neck (*arrows*). **b** The lateral view shows destruction of the anterior femoral neck (*arrows*). **c** T1-weighted MRI showing a defect in the anterior part of the right femoral neck (*arrow*)

Femoral neck thinning

Femoral neck thinning adjacent to the femoral prosthesis is a common finding. Some narrowing is seen in 70% patients [15]. 15–25% of patients have narrowing of the neck that is greater than 10% [15, 16]. The significance of femoral neck narrowing is not yet known. Marked thinning may be seen in patients with reactive masses (see below) but an association has not been proven (Fig. 10).

Reactive masses

A rare but important problem is the formation of a periarticular reactive mass, which may present months or years after surgery. These masses can be invasive and destructive. They have been called various names by different groups, such as, pseudotumour, aseptic lyphocytic vasculitis-associated lesion (ALVAL). This complication is much more common in female patients and involves both hips in the majority of patients with bilateral resurfacings (Fig. 11). The incidence is around 1%. Patients present with pain with or without swelling, occasionally femoral nerve symptoms or dislocation [13]. The masses may be solid, cystic or a combination of the two (Fig. 12). In general

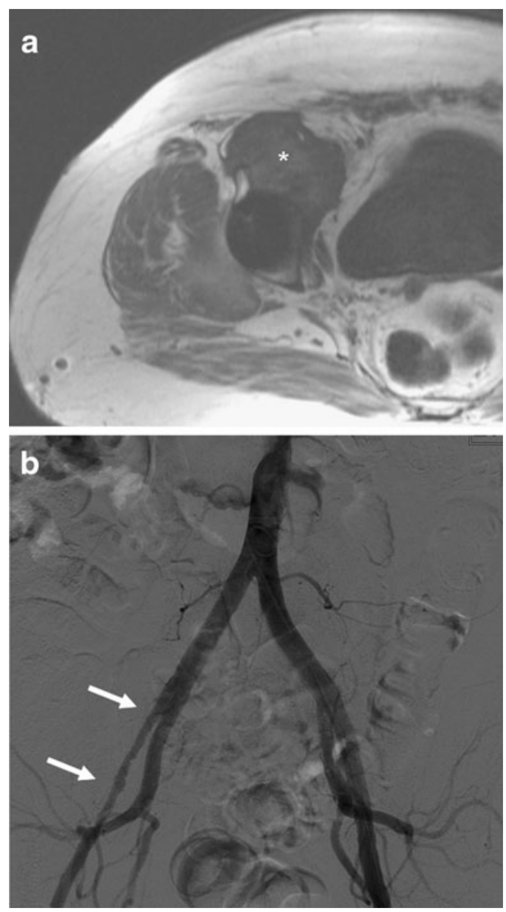

Fig. 16 This patient initially presented with symptoms of femoral nerve compression and developed vascular insufficiency. **a** T1-weighted MRI showing reactive mass encasing the femoral neurovascular bundle (*asterisk*). **b** Arteriogram showing a stenotic segment of the right external iliac artery (*arrows*)

anterior masses lying within the psoas muscle are predominately solid and posterior masses predominately cystic [17]. The formation of these reactive massis are thought to be due to excessive metal wear rather than a type IV hypersensitivity response. The masses can be demonstrated on ultrasound or MRI, the former having the advantage of not being affected by metal artefact (Fig. 13). The solid masses are hypoechoic with little internal vascularity. On MRI the solid masses typically show low signal intensity on T2-weighted images and signal intensity a little higher than normal muscle on T1-weighted images. Similar signal intensities are seen in the wall of the cystic lesions. The signal intensity of fluid is usually similar to water on T2-weighted and STIR images but occasionally has much lower signal intensity. On T1-weighted images the signal intensity is usually higher than water (Fig. 14). These signal characteristics presumably reflect the metal content of the reactive lesions. Occasionally bone erosion (Fig. 15) may be demonstrated. In severe cases the reactive process may involve the major arteries or the femoral nerve [18] (Fig. 16). Ultrasound or MRI is recommended in patients with unexplained pain following resurfacing arthroplasty. The treatment is revision to a conventional total hip replacement. Outcome following revision is often disappointing and recurrence of the reactive mass may occur [19].

Conclusion

Complications following resurfacing arthroplasty are rare and are mainly related to suboptimal surgical technique resulting in impingement or femoral neck fracture. Infection and aseptic loosening are unusual. Reactive masses, occurring predominately in women, are increasingly being recognised as a cause of symptoms.

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