

# The imaging spectrum of peri-articular inflammatory masses following metal-on-metal hip resurfacing

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## Abstract

**Introduction** Resurfacing metal-on-metal hip arthroplasty is increasing in popularity, especially in younger patients. To date, studies indicate that the procedure is associated with a good outcome in the medium-term. Formation of a peri-articular mass is a rarely reported complication. In this study we analyse the imaging findings in patients with resurfacing implants presenting to our institution with peri-articular masses identified on cross sectional imaging.

**Materials and methods** All patients with documented peri-articular masses following resurfacing arthroplasty were included. The available imaging related to the masses was reviewed and the findings documented along with the patient's demographics.

**Results** There were 10 patients (13 joints). All patients were female. Patients presented with periprosthetic anterior or posterolateral solid and cystic masses. The anterior masses involved psoas muscle and were predominately solid. The posterolateral masses were predominately cystic. In the three cases with bilateral arthroplasties, masses were detected in both hips. Histology in six cases showed features compatible with a type IV hypersensitivity reaction.

**Conclusions** The preponderance of females, the bilateral nature of the masses and the histological features suggest that peri-articular masses following resurfacing arthroplasty is due to the metal hypersensitivity.

**Keywords** Resurfacing hip arthroplasty · Mass · Hypersensitivity reaction · Solid · Cystic

## Introduction

Hip resurfacing arthroplasty (RSA) is an increasingly used alternative to conventional total hip arthroplasty, especially in younger patients. In a younger population the survival rates of conventional implants are less than in a less active elderly population, with 80% of implants surviving at 10 years, compared to 90% survival at 10 years in the elderly population [1]. The advantages of resurfacing include the preservation of bone stock, optimisation of stress transfer to the proximal femur, an increased level of inherent stability and optimal range of movement. Various series from the originators of these prostheses have proven good short- to medium-term implant survivorship [2, 3].

Unexpected complications related to new design features may be encountered in novel implants. With resurfacing implants, there is a well-documented risk of femoral neck fracture. The implant consists of a metal-on-metal articulation (in comparison with the conventional polyethylene/metal articulation), made from cast cobalt–chromium alloys. Although these implants produce smaller wear particles than conventional total hip replacement, the wear particles are an order of magnitude more numerous [4, 5]. There is release of metal ions both locally and systemically. There is concern that raised levels of cobalt and chromium metal ions may raise the risk of development of haemato-

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logical and musculoskeletal malignancy, although it has been shown that the total cancer risk in a group of patients who had undergone metal-on-metal hip arthroplasty was no higher than that of the general population at 15 years [6]. There have been recent reports of marked perivascular lymphocyte and plasma cell infiltrates around certain metal-on-metal articulations thought to be secondary to high local concentrations of metal ions [7]. These have been termed aseptic lymphocytic vasculitis-associated lesions (ALVALs). These have been postulated to represent an immunological response to metal wear debris [7, 8]. Over the past few years, attention has focused on hypersensitivity reactions related to these prostheses, although proving cause and effect has been difficult.

There has been one report in the literature of an iliopsoas mass occurring as a complication of such an implant [9]. At our institution we have seen a series of masses and cysts arising in close proximity to the new generation of metal-on-metal implants. Initially, many of the patients with these masses were referred to our tumour service. The masses described in this paper appear to be distinct from previously reported osteolytic phenomena, although they may be driven by the same immunological processes. None of these masses demonstrated infection or were neoplastic, and we have called them ‘pseudotumours’. With increasing popularity of this type of implant, radiologists should be aware that tumours can present around these implants and that they represent neither infection nor a neoplastic phenomenon. The aims of this paper are to present the magnetic resonance imaging (MRI), computed tomography (CT) and ultrasound findings from a series of cases presenting at our institution. Details regarding clinical presentation, operative findings and management options will be described elsewhere and are currently being prepared for submission to the surgical literature.

### Spectrum of imaging findings

All the patients were female, with a mean age of 52.9 years (range 35–73 years). A total of 17 patients, with 20 affected joints (three bilateral cases), who had undergone RSA presented to our tumour service with cysts or masses around the hip. Of this group, ten patients (13 joints in total) underwent imaging other than plain radiography, including arthrography, ultrasound, MRI and CT. Histological analysis of biopsied tissue or tissue recovered at surgery was available from 12 of the patients. In six of the imaged joints, we had histological tissue for correlation.

Twelve patients had undergone the primary procedure at our institution, and a further five had been referred from other centres for management of suspected tumour. The Birmingham Hip Resurfacing system (Smith and Nephew,

Memphis, TN, USA) accounted for the 14 joints. Four had Conserve Plus systems (Wright Medical, Memphis, TN, USA), and, in two joints, a Cormet type arthroplasty had been used (Corin Group PLC, Cirencester, UK). Patients presented with symptoms at a mean (of) time of 22 months following the procedure (range 0–60 months). All patients presented with non-specific hip-related pain. Other clinical features included a palpable mass and symptoms related to femoral nerve irritation.

Infection was excluded in all cases on the basis of aspiration, intraoperative frozen sections and culture of tissue recovered at operation. Because these cases presented as a new complication of metal-on-metal resurfacing, metal ion levels were not tested.

The majority of masses were diagnosed on ultrasound or MRI. A standard MRI protocol at our institution consists of axial T1-weighted and T2-weighted fast spin echo (FSE) and coronal T1-weighted sequences and short-tau inversion recovery (STIR) sequences. A minority was detected with CT. Most cases had been subjected to more than one of these investigations. Common findings were a solid or cystic mass arising from the anterior aspect of the joint in the region of the psoas bursa, or cysts arising from the lateral or posterior aspect of the joint. Cysts always appear to communicate with the joint. The anterior masses can extend proximally, beyond the inguinal ligament and into the iliac fossa. The imaging findings are summarised in Table 1.

Six of the 20 presenting joints have been revised. All three of the predominantly solid masses required revision, in contrast to two out of the nine purely cystic lesions. Of the mixed solid and cystic lesions, one of the two has been revised. All joints were revised with conventional metal-

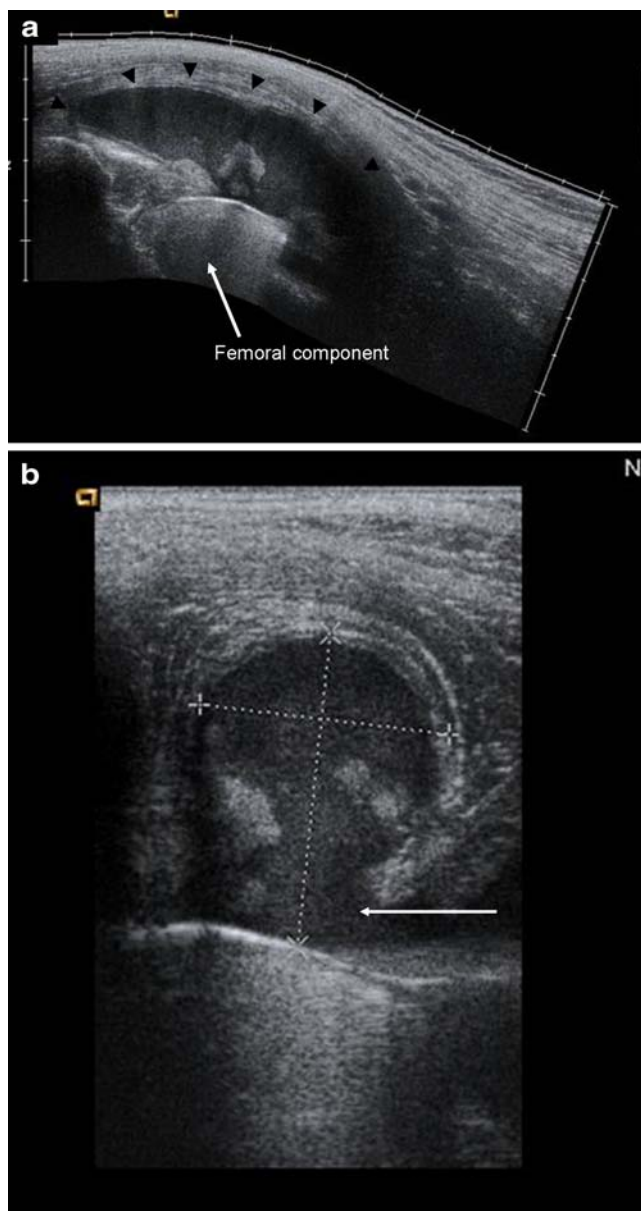
**Table 1** Summary of imaging findings (US ultrasound, ARTHRO arthrography, C cystic with minor solid component, S solid with minor cystic component, C/S substantial cystic and solid elements)

Case number	Investigations	Anterior mass	Posterior/lateral mass
1	US	C	
2 (right)	MR, CT, US	S	
2 (left)	MR, CT, US	S	
3	MR, CT, US	S	
4	MR US	S	C
5	CT, US		C
6	US		C
7 (right)	MR		C
7 (left)	MR, US		C
8	MR, CT, US		C
9	US, ARTHRO		C
10 (right)	MR, US		C
10 (left)	MR, ARTHRO		C/S

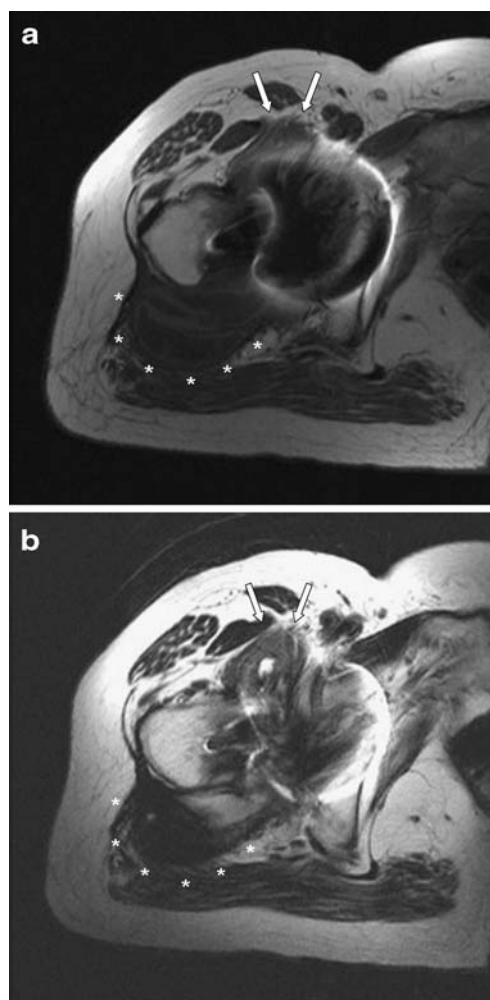
on-polyethylene total hip replacements. Following revision, there has been no recurrence of masses or cysts.

#### Anterior masses

A total of five joints, in four patients, presented with anterior masses. The typical imaging characteristics of an anterior pseudotumour are a mass involving the psoas bursa and the adjacent psoas muscle. The masses contain both solid and cystic elements. In one case the mass was



**Fig. 1** **a** Extended field of view sagittal ultrasound image of a well-defined cyst (*arrowheads*) arising from the anterior aspect of the hip joint (case 1). The anterior anatomical relationship of the cyst to the prosthesis can be readily appreciated. **b** Transverse ultrasound image from the same patient showing direct communication of the cyst with the joint (*arrow*)

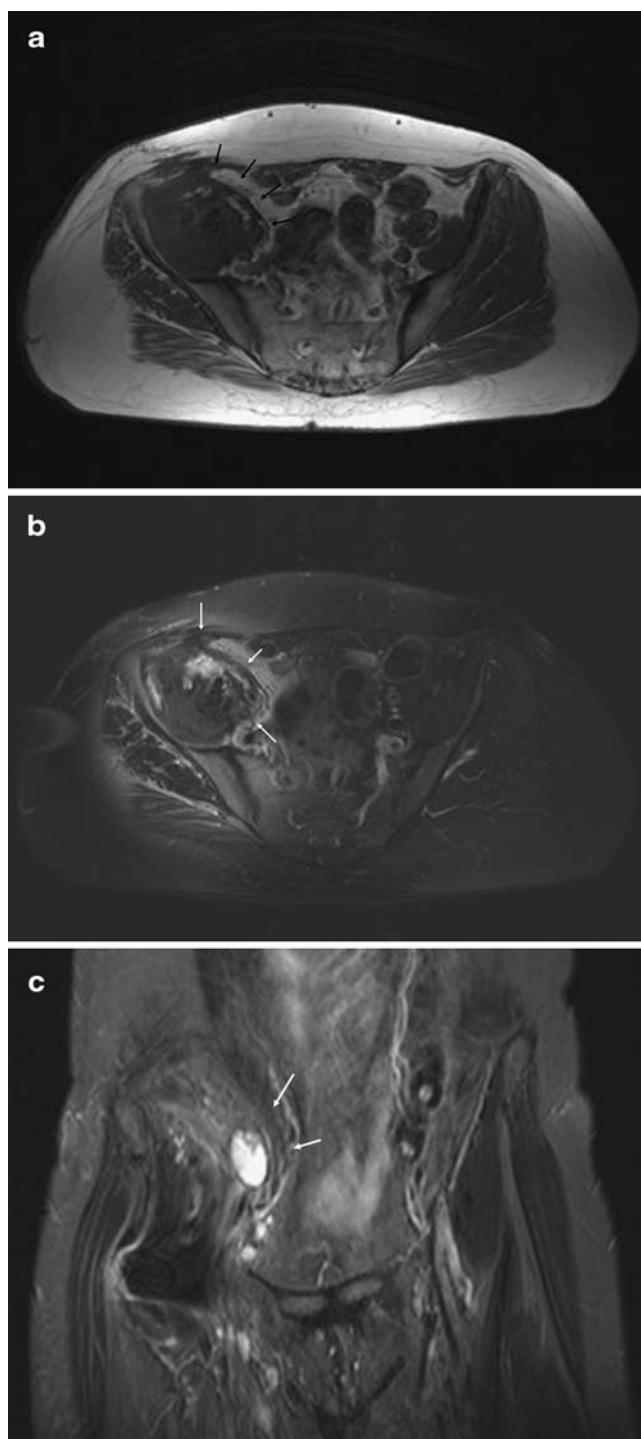


**Fig. 2** Axial **(a)** T1-weighted and **(b)** T2-weighted fat saturation images from case 4 showing a thick walled anterior cyst (*arrows*). Allowing for poor fat saturation due to the presence of the metallic implant, the abnormality demonstrates fluid signal characteristics. In this case there is a coexisting posterior cystic mass (*asterisks*)

predominately cystic (Fig. 1). In four joints the mass consisted of predominantly solid components (Figs. 2 and 3). The mass may extend above the inguinal ligament into the iliac fossa (as in Fig. 3).

#### Posterior and lateral cysts

A total of seven patients, with nine affected joints, presented with cysts in a posterior or lateral position. Within this group, six patients, with eight joints, presented with posterior or lateral cysts that appeared to arise from the joint. The sizes of the cysts were variable. The largest cysts we encountered measured up to 21 cm in maximum dimension (Fig. 5). Cysts are visible on CT as low-attenuation masses with a well-defined wall (Fig. 4). On MRI the cyst walls often showed some low signal intensity on both T1- and T2-weighted images (Fig. 5). This is likely to represent susceptibility from



**Fig. 3** Axial (a) T1-weighted and (b) T2-weighted fat saturation MRI images. These images from case 3 demonstrate a complex heterogeneous anterior mass composed of solid and cystic components (arrowed). The bulk of the mass lies superior to the inguinal ligament in the right iliac fossa, within the iliacus and psoas muscles. c Coronal STIR image from case 3, demonstrating the craniocaudal extent of the mass (arrowed), which is seen to contain both cystic and solid components

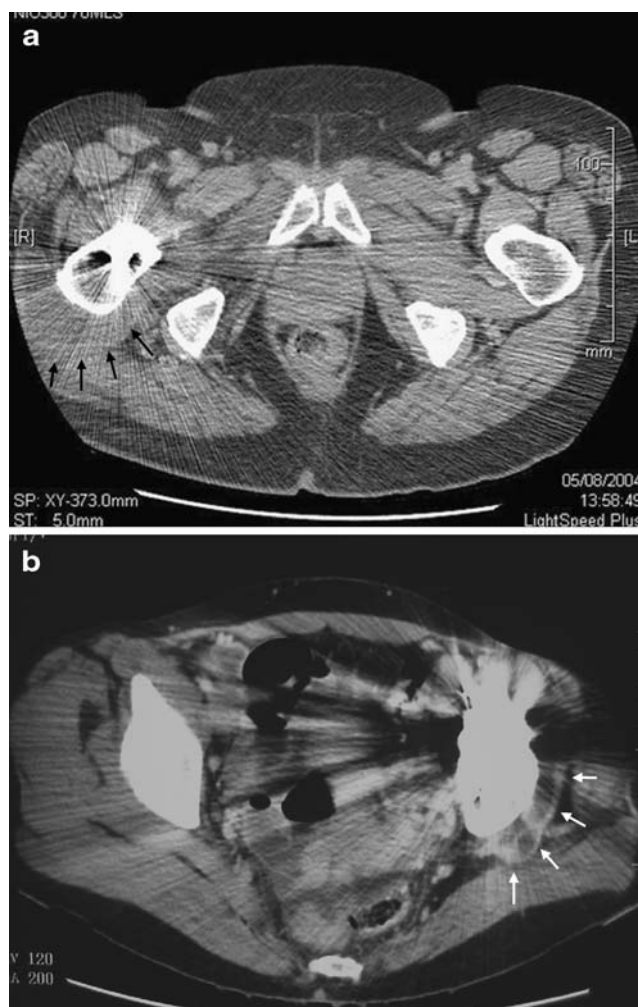
metal particles, sequestered in the cyst wall. One patient had both an anterior and posterolateral mass (Fig. 2).

#### Communication with the joint

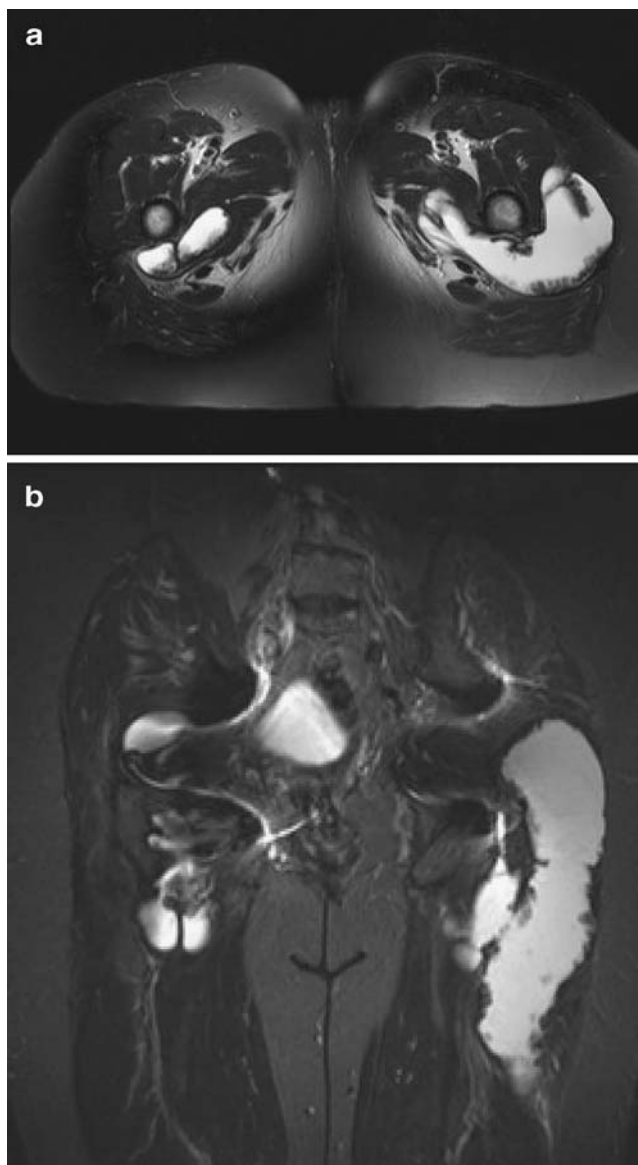
Ten cases presented with predominantly cystic masses, and these cysts were intimately related to the joint capsule. It is, therefore, probable that all the cysts communicated with the joint. Communication was proven directly in two cases at arthrography (Fig. 6).

#### Muscle inflammatory changes

In one hip there was extensive oedema in the surrounding soft tissues (Fig. 7a). In this case, there was an anterior



**Fig. 4** a Case 5. Axial unenhanced CT showing a posterior cystic mass (arrows). The image is a lower slice from an abdominal CT, with accidental findings of pseudotumour. The mass is of low attenuation, in keeping with a fluid-filled cystic mass. b Case 8. Axial enhanced CT image showing CT features of a cystic pseudotumour. Posterolateral to the left hip, there is an enhancing multiseptated cystic mass (arrows)



**Fig. 5** **a** Case 7. T2-weighted fat-suppressed image, showing an extensive posterior and lateral cystic pseudomass around the left femur. In this case there is a contralateral implant, also complicated by a cystic mass. **b** Coronal STIR image (case 7) depicting the craniocaudal extent of the mass

mass involving the psoas muscle. Extensive oedema was seen in the peri-articular muscles and the subcutaneous fat.

In another case with a posterior cyst there was a more localised pattern of oedema within the adjacent gluteus maximus (Fig. 7b).

#### Bilateral findings

Three of the patients had undergone bilateral resurfacing arthroplasties. In all these cases the abnormalities were bilateral. One case had bilateral anterior masses and two cases bilateral posterior and lateral masses (Fig. 8).

#### Histological analysis

All the lesions were characterised by extensive coagulative necrosis of cellular and collagenous connective tissue and muscle in which there was a heavy macrophage infiltrate. Scattered small metallic wear particles were noted. Around many of the larger areas of necrosis, there was an inflammatory cell infiltrate in which there were numerous macrophages and scattered lymphocytes, mainly T cell (CD3, CD4) in type. Three cases also showed evidence of macrophage and giant cell granulomas around the areas of necrosis; scattered eosinophil polymorphs were also noted in some cases.

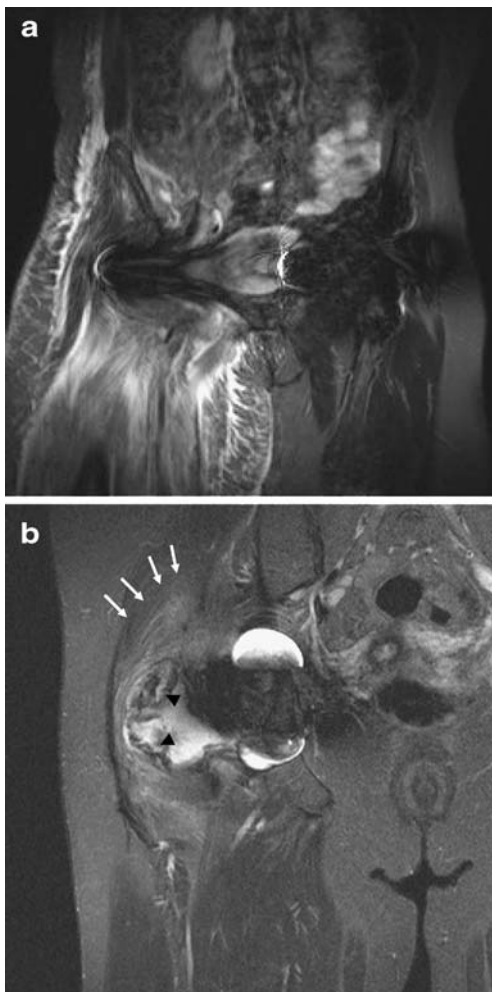
#### Discussion

With the increasing use of RSA implants in a young population, radiologists need to recognise that masses and cysts can develop around metal-on-metal implants. Several case reports describe bone or soft tissue malignancy in association with total hip replacement [10, 11], raising concerns that metal particles can predispose to sarcoma formation. In our experience, however, the cystic and solid masses we describe in this series do not represent malignancy or infection.

The patients in our series presented in with variety of conditions, including pain, spontaneous dislocation, palpable mass and femoral nerve palsy. The masses could be detected on ultrasound, CT or MRI. Despite the hip being a



**Fig. 6** Case 9. Arthrogram demonstrating communication between posterolateral cyst and the joint



**Fig. 7** **a** Coronal STIR image (case 2) with a predominantly solid pseudotumour in the iliopsoas. In this case there was extensive oedema in the surrounding muscles of the thigh. **b** Case 4. Coronal STIR image, showing a more localised inflammatory reaction within adjacent muscle (*arrows*), secondary to a posterior cystic pseudotumour. Deposition of metallic particles is seen as focal low signal intensity within the cyst wall (*arrowheads*)

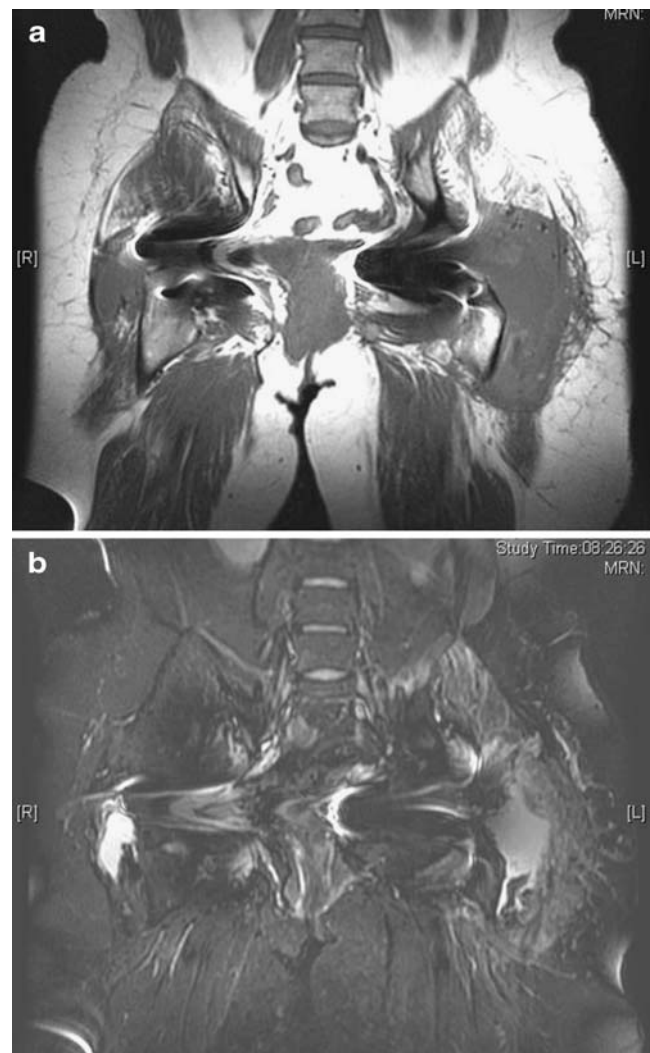
deep structure, ultrasound is our preferred initial investigative tool, as CT scans and MR images may be degraded by metal artefact. The anterior, lateral and posterior aspects of the joint should all be carefully examined.

In larger lesions the extent of the abnormality may be best appreciated on MRI.

Communication between the joint and cystic pseudotumours may be appreciated on cross-sectional imaging but is more reliably demonstrated by arthrography. Anterior cysts probably represent distension of the iliopsoas bursa. We postulate that a hypersensitivity reaction results in the formation of cysts that follow the path of least resistance, either anteriorly or through defects in the capsule laterally and posteriorly. Routine surgical approaches for the placement of such implants are either posterior or antero-

lateral, which could account for the anatomical sites of the posterior and lateral pseudotumours.

There has been one previous case report demonstrating an iliopsoas soft tissue mass in relation to an RSA implant on CT [9]. In this case, the histology showed dense lymphocytic infiltrate and areas of necrosis. A possible hypersensitivity reaction has been described in association with soft tissue masses developing around other implants, including a Vitallium (an alloy composed of 60% cobalt, 20% chromium, 5% molybdenum and other trace elements) plate used to fix a forearm fracture internally [12]. In this case the mass was initially thought to represent neoplasia, but the presence of a heavy inflammatory cell infiltrate, that included numerous lymphocytes, plasma cells, eosinophils and macrophages, as well as endarteritis, suggested an



**Fig. 8** Coronal **(a)** T1-weighted and **(b)** STIR images from case 10 showing cystic masses lateral to both hips. Coronal STIR image shows bilateral laterally placed pseudotumours. The pseudotumours are of high signal intensity, confirming a cyst. Oedema is again present in the adjacent muscles

immune pathogenesis. Similarly, in our patients, histological analysis demonstrated a pronounced T lymphocyte and macrophage response, with granuloma formation and eosinophil polymorph infiltration in some cases; there was also extensive tissue necrosis in which there was a macrophage infiltrate and scattered metal wear particles. Granulomatous foreign body macrophage response is frequently seen in all arthroplasty tissues, but the degree of necrosis, the presence of numerous well-defined sarcoid-like granulomas and the heavy lymphocytic infiltrate was a unique feature in our patients. The cytological and histological features of our cases are commonly seen in local hypersensitivity reactions, particularly type IV delayed hypersensitivity type reactions [13], where sensitised T cells recognise an antigen together with HLA-D2 on antigen presenting cells. This would accord with the ALVAL response seen in periprosthetic tissues of metal-on-metal arthroplasties [7].

Two important clinical features in our patients also led us to postulate that a hypersensitivity reaction underlay the observed phenomena. It was noted that all patients with pseudotumours presenting in our institution were female. Although this could be explained by differences between the genders in biomechanics, resulting in increased wear, we also observed that, in cases where both hips have been replaced, if one hip develops a pseudotumour, then the contralateral hip does too. These observations led us to postulate that a hypersensitivity reaction to the cobalt and chromium particles released from implant wear best explains these observations. Nickel, chromate and cobalt have been known for some time to be important contact allergens. Nickel allergy is more frequent in the female population, due to sensitisation from inexpensive jewellery [14], with ear piercing (and other body piercing) being a particularly potent cause of hypersensitivity. Furthermore, 13% of patients presenting with contact dermatitis from nickel have been shown to be sensitised to both nickel and chromium [15]. Owing to the novel presentation of our cases, we did not routinely collect data regarding metal allergy or screen the patients prior to surgery. Metal allergies are relatively common, but pseudotumours remain, thus far, an unusual complication of resurfacing arthroplasty. It may be that many patients deemed ‘allergic’ would not develop this complication. As such, there is currently no consensus on the role of screening

There have been concerns regarding systemic hypersensitivity reactions in patients with metal-on-metal prostheses. Thirty years ago, Benson et al. [16], in a study of the McKee metal-on-metal prosthesis, noticed that levels of hypersensitivity to metal was higher in a group where failure of the prosthesis had occurred. Another paper from this era demonstrated a higher incidence of metal sensitivity in patients with total joint replacements [17]. At that time it

was also postulated that metal sensitivity was a cause of bone necrosis and loosening of the prosthesis in total joint replacements [18].

More recently, hypersensitivity reactions have been postulated as the root cause of osteolysis in metal-on-metal bearings, resulting in failure [19]. Based on the female dominance in our cases, the bilateral nature of the pathological condition, and the histological features, we postulate that a delayed-type hypersensitivity reaction, primarily related to previous exposure to jewellery, is the underlying cause of metal-on-metal hip resurfacing-related pseudotumours.

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