Unusual presentation of more common disease/injury

Delayed sciatic nerve palsy following resurfacing hip arthroplasty caused by metal debris

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Summary

The rapid rise in the incidence of failed metal-on-metal hip articulations in recent years has led to many patients requiring complex revision surgery. These failed metal prostheses may produce local metallic debris, which promotes both local and systemic adverse effects. We report an unusual case of failed metal-on-metal resurfacing hip arthroplasty presenting with ipsilateral buttock pain and foot drop 6 months after surgery. After thorough investigations, the metal-on-metal bearing was revised to a metal-on-polyethylene total hip replacement. This resulted in marked improvement in the systemic symptoms, inflammatory markers and metal ion levels postoperatively. However, neither clinical nor neurophysiological sciatic nerve recovery followed. The patient eventually required tendon transfer surgery for her persistent foot drop.

BACKGROUND

Bone-conserving resurfacing arthroplasty in the hip is a very attractive articulation choice in younger patients requiring total hip arthroplasty.^{1 2} It provides improved range of motion, reduces the risk of dislocation and theoretically has lower wear rates compared to metal-on-polyethylene bearings.³ In addition, hip resurfacing also preserves femoral bone stock and reduces stress shielding in the proximal femur.⁴ These properties make hip resurfacing particularly favourable in young and active patients.

Despite these benefits, there have been a number of recent concerns regarding the use of metal-on-metal bearing surfaces. Metallic wear debris, namely chromium and cobalt, are released from the articulating surface^{5 6} and may reach up to 13 500 times the number of particles produced by metal-on-polyethylene articulations.⁵ The particles released by these metal-on-metal articulations are significantly smaller and can promote localised hypersensitivity and immune reactions leading to prosthetic failure.⁷ Increased circulatory metal ion levels may promote osteolysis, immune suppression, chromosomal mutations and carcinogenicity.^{8–10}

Localised reversible sciatic nerve injury following total hip replacement has been reported in cases related to nerve compression from wear debris,¹¹ subfascial haematoma¹² and iatrogenic intraoperative pressure on an anatomical variant of the nerve through piriformis muscle.¹³ In this article, we present an unusual case of irreversible sciatic nerve palsy secondary to metal debris accumulation following hip resurfacing arthroplasty. Despite revision surgery, the patient's neurological function did not recover and she required a tendon transfer to improve mobility.

CASE PRESENTATION

A 56-year-old woman presented to her general practitioner with 2-year history of steadily increasing dull pain in her right hip. The pain was worse after standing or at the end of the day, associated with reduced range of movement in

the right hip, and was no longer responding to regular paracetamol, naproxen and tramadol. The patient's mobility had also significantly decreased over the last year and she was able to walk only 50 metres on flat ground with a stick in her right hand. She had no history of trauma, rheumatoid arthritis, gout, pseudogout, obesity, steroid use, vitamin C or D deficiency, metabolic diseases or congenital musculoskeletal problems. The patient lived with her husband in a house, without any regular carers and was independent with all her activities of daily living. Radiographic films confirmed the presence of osteoarthritis and the patient underwent a right Birmingham hip resurfacing procedure (figure 1) at her local secondary

Figure 1 Pre-operative anteroposterior radiograph of right Birmingham hip resurfacing.

referral centre. This was performed through the posterior approach with identification and preservation of the sciatic nerve intraoperatively. The inclination angle of the cup was approximately 50°. The patient made an uneventful postoperative recovery and was discharged home 6 days after surgery. After 4 months, the patient's pain had resolved, range of motion significantly improved and she was mobilising without the use of a stick.

Six months following surgery, the patient developed mild dull, gradual onset right buttock pain, which radiated into the groin. On examination, the wound was clean and well healed, leg-lengths were equal, and the patient had satisfactory range of movement in the right hip. There was no other discernible neurovascular compromise.

INVESTIGATIONS

Blood tests showed raised inflammatory markers: Erythrocyte sedimentation rate (ESR)=92 mm/h (normal ESR <20 mm/h) and C reactive protein (CRP)=107 (normal CRP<5). Plain radiographic films of the pelvis were unremarkable. CT scans revealed small quantities of fluid around the right greater trochanter and adductor magnus tendon. Aspiration under general anaesthetic revealed serous fluid, which was negative after Gram stain, culture and sensitivity testing. MRI did not show any abnormality. Following this, the patient developed a painless, sudden onset right-sided foot drop. This was associated with paraesthesia over the L4-S1 dermatomes in the right leg. There were no local or systemic features of infection or any other neurological deficit on clinical examination. Inflammatory markers remained persistently elevated and repeat plain radiographic films showed peri-acetabular osteopenia.

At this stage, the patient was referred to a tertiary referral centre, Royal National Orthopaedic Hospital for further management. Repeat right hip aspiration was negative for Gram stain, culture and sensitivity testing. A Technetium-99 bone scan was performed and did not show any evidence of malignancy, osteomyelitis or avascular necrosis. Electromyography study showed widespread acute denervation in the territories of common peroneal and obturator nerves on the right side but with preservation of the peroneal division to the short head of biceps femoris. The patient was scheduled for an exploration/revision of the right hip resurfacing.

DIFFERENTIAL DIAGNOSIS

Ipsilateral foot drop following hip surgery is most commonly related to sciatic nerve palsy from iatrogenic injury or nerve compression secondary to postoperative haematoma. Differential diagnosis of unilateral foot drop not related to surgery includes: prolapsed vertebral disc producing L5 nerve root compression, stroke and peripheral isolated neuropathy secondary to diabetes mellitus or alcohol.

TREATMENT

At exploratory/revision surgery, the bulk of the hip abductors, external rotators and a significant part of gluteus maximus were found denuded from the bone and appeared to be dead and fibrotic. The sciatic nerve was fibrotic and extremely hard on palpation for approximately 10 cm in length corresponding to the posterior

aspect of the right hip prosthesis. The nerve above and below this localised fibrotic area appeared intact. Multiple soft tissue samples were retrieved and the area thoroughly washed out. Owing to the risk of infection, it was decided to perform the revision procedure in two-stages, with the first stage involving the insertion of a spacer G. This temporary hip spacing device consists of gentamycin-impregnated bone cement moulded onto a stainless-steel reinforcing core. The spacer G maintains joint space, allows the patient to mobilise between the first-stage and second-stage procedures, and also ensures predictable, consistent antibiotic release locally.

Histological analysis of the soft tissue samples revealed extensive lymphocyte and macrophage invasion with multiple areas of soft tissue necrosis (figure 2). Microbiological testing did not reveal any organisms. Serum chromium and cobalt levels were elevated and allergy testing confirmed sensitisation to cobalt, nickel and palladium.

Three weeks later, the patient underwent the second-stage procedure and had a metal-on-polyethylene prosthesis implanted. A 60 mm porous acetabular shell with a polyethylene liner (Biomet; Warsaw, Indiana, USA), a

Figure 2 High-power photomicrographs show (A) completely necrotic periprosthetic fibrous tissue (H&E, original magnification $\times 200$) and (B) necrotic cancellous bone trabeculae with an intervening necrotic fibrous tissue (H&E, original magnification $\times 100$).

32 mm modular head (Biomet) and a size 2 standard cemented femoral Stanmore stem were used to reconstruct the hip (figure 3).

Six weeks after revision surgery, the patient's hip pain had significantly improved and she was not taking any regular medication for pain. However, the patient continued to have difficulty mobilising due to weakness of the hip abductors and persistent right-sided foot drop. Examination revealed significant muscle wasting of the right gluteal and thigh region with grade 3 power (table 1) of the hip abductors and Trendelenberg sign was positive on the right. A positive Trendelenberg sign occurs when the patient stands on one leg and the pelvis drops down on the other side to reduce the load by decreasing the lever arm. It is indicative of congenital dislocation, hip pain or weakness of the hip abductors (gluteus medius and minimus) on the stance side of the pelvis when the patient stands on one leg. Grade 2 power was recorded in dorsiflexion and plantarflexion of the right hallux and ankle. Paraesthesia over L4-S1 dermatomes of the right leg was still present over the right leg but reflexes were intact. The patient continued to mobilise with a high stepping gait on the right side. Repeat neurophysiological testing showed no evidence of regeneration of tibialis/peroneus longus.

The patient underwent tendon transfer with right tibialis posterior to extensor hallucis longus, extensor digitorum longus and peroneus tertius, and lengthening of the Tendo-Achilles. The operation was uneventful and the patient enrolled into an intensive rehabilitation programme postoperatively. One year following the tendon-transfer procedure, the patient was pain free with good

Figure 3 Post-revision anteroposterior radiograph.

Table 1 Power was assessed using the following grading system

Scale	Description
0	No muscle contraction is visible
1	Muscle contraction is visible but there is no movement of the joint
2	Active joint movement is possible with gravity eliminated
3	Movement can overcome gravity but not resistance from the examiner
4	The muscle group can overcome gravity and move against some resistance from the examiner
5	Full and normal power against resistance

range of movement in the ankle. The right hip abductors had improved significantly but the patient still had a Trendelenberg-positive gait on the right. She had residual sensory deficit over L4-S1 dermatomes of the right leg but was able to actively dorsiflex the right foot and clear the floor while walking. Repeat chromium and cobalt levels were within the normal range. She was discharged back to the referring hospital to continue treatment.

DISCUSSION

To our knowledge, this is the first report of a failed metal-on-metal hip arthroplasty presenting as localised, irreversible sciatic nerve palsy. Clinical examination and neurophysiological studies confirmed persisting sciatic nerve deficit despite revision surgery, and the patient required a tendon transfer procedure to address her foot drop.

Metal-on-metal bearings can release metal ions into the systemic circulation leading to immune suppression, carcinogenesis and chromosomal abnormalities.^{8 9 10} Peri-prosthetic tissue sampling during revision surgery on metal-on-metal articulations has shown the presence of adverse reaction to metallic debris and aseptic lymphocytic vasculitic-associated lesions, which includes type IV hypersensitivity reactions and immunological response to metal wear debris.^{7 14} There is dense infiltration of lymphocytes, plasma cells, macrophages with drop-like inclusions, eosinophilic granulocytes, with extensive fibrin exudation and necrosis.⁷ In our patient, the sciatic nerve was fibrosed and the surrounding tissues were inflamed and necrotic. A combination of inflammatory cell infiltration and occlusion of the sacral vasa nervorum from the localised metal ion release is likely to have compromised perfusion and induced fibrosis. The nerve above and below the articular surfaces appeared intact intraoperatively suggesting nerve destruction was primarily peri-articular.

Several studies have shown elevated serum chromium and cobalt levels in patients with metal-on-metal total hip replacements.^{4 15} Our patient also had raised chromium and cobalt levels, which resolved following revision surgery. Systemically elevated chromium and cobalt levels have been shown to produce widespread polyneuropathy and also localised visual, auditory and sensory defects.¹⁶ Our patient did not have any other systemic neurological defects but the persistent malaise and raised inflammatory markers suggest an associated generalised systemic response to the metallosis. Local peri-prosthetic inflammation may also have contributed to these raised inflammatory markers. Failed metal-on-metal prosthesis may present with pain, bursal swelling and reduced range of

movement following surgery. Our patient had an atypical presentation with 6-month delay in the development of symptoms following surgery suggesting progressive wear of the metal implants produced localised metallic debris and sensitisation to the metal ions. This sensitisation reaction then instigated and propagated the local and systemic symptoms experienced by the patient.

Allergy testing is commonly performed in patients with systemic symptoms or failure of the prostheses. In our patient, allergy testing confirmed the presence of both nickel and chromium sensitisation, despite no history of allergic reactions or intolerance to metals. Elves *et al* showed that in patients with metal-on-metal hip replacements, up to 38% of patients were sensitive to one or more of the metals and in those with non-traumatic loosening, up to 65% were sensitive to the metal ions.¹¹ It is unclear as to whether sensitisation to the metal ions causes soft tissue destruction or vice versa. Large prospective controlled trials will need to address which phenomenon arises first.

Metal ions are released from prosthesis due to the combined effects of corrosion and wear debris. Chromium and cobalt levels are significantly greater over the first 2 years in hip resurfacing than in metal-on-metal total hip replacement.⁴ This may be attributed to resurfacing implants having greater surface area and thus increased corrosion, variations in diametric clearance and surface roughness. De Haan *et al*¹⁷ demonstrated that serum chromium and cobalt levels are increased with steeper inclination angles of the acetabular component. Acetabular abduction angles of greater than 50–55°^{17 18} combined with small size components increase risk of edge-loading, which promotes localised wear and increased serum metal ions. In our patient, the abduction angle was 50° and the prosthesis were appropriately sized for the patients skeletal framework, and so are unlikely to have contributed to excess wear of the articular surfaces. It has been reported that other factors such as level of activity, the arc of cover and type of hip resurfacing prosthesis used may also influence metal ion levels.¹⁷

In the UK, all cases of unsuccessful metal-on-metal hip replacements are referred to the London Implant Retrieval centre.¹⁹ Removed prostheses, peri-prosthetic tissues, clinical information and radiological data are analysed to provide guidance for surgeons on choice of prosthesis, surgical techniques and patient selection.

Learning points

- ▶ Resurfacing arthroplasty of the hip offers improved long-term outcomes in young and active patients.
- ▶ However, there remains a risk of developing a reaction to metal wear debris producing both local and systemic adverse effects.
- ▶ Delayed onset sciatic nerve palsy following implantation of a metal-on-metal bearing should raise the suspicion of adverse reaction to metallic debris/aseptic lymphocytic vasculitic-associated lesions.
- ▶ Early surgical intervention with revision surgery offers the best treatment for metal wear debris secondary to metal-on-metal bearing surfaces.

Competing interests None.

Patient consent Obtained.

REFERENCES

1. Daniel J, Pynsent PB, McMinn DJ. Metal-on-metal resurfacing of the hip in patients under the age of 55 years with osteoarthritis. *J Bone Joint Surg (Br)* 2004;**86-B**:177–84.
2. Amstutz HC, Su EP, Le Duff MJ. Surface arthroplasty in young patients with hip arthritis secondary to childhood disorders. *Orthop Clin North Am* 2005;**36**:223–30.
3. McMinn D, Treacy R, Lin K, *et al*. Metal on metal surface replacement of the hip: experience of the McMinn prosthesis. *Clin Orthop* 1996;**329** (Suppl):89–98.
4. Witzleb WC, Ziegler J, Krummenauer F, *et al*. Exposure to chromium, cobalt and molybdenum from metal-on-metal total hip replacement and hip resurfacing arthroplasty. *Acta Orthop* 2006;**77**:697–705.
5. Doorn PF, Campbell PA, Worrall J, *et al*. Metal wear particle characterization from metal on metal total hip replacements: transmission electron microscopy study of periprosthetic tissues and isolated particles. *J Biomed Mater Res* 1998;**42**:103–11.
6. Daniel J, Ziaee H, Pradhan C, *et al*. Blood and urine metal ion levels in young and active patients after Birmingham hip resurfacing arthroplasty: four-year results of prospective longitudinal study. *J Bone Joint Surg (Br)* 2007;**89-B**:169–73.
7. Willert HG, Buchhorn GH, Fayyazi A, *et al*. Metal-on-metal bearings and hypersensitivity in patients with artificial hip joints. A clinical and histomorphological study. *J Bone Joint Surg Am* 2005;**87**:28–36.
8. MacDonald SJ. Metal-on-metal total hip arthroplasty: the concerns. *Clin Orthop* 2004;**429**:86–93.
9. Visuri T, Pukkala E, Paavolainen P, *et al*. Cancer risk after metal on metal and polyethylene on metal total hip arthroplasty. *Clin Orthop Relat Res* 1996;**329** (Suppl):280–9.
10. Hart AJ, Hester T, Sinclair K, *et al*. The association between metal ions from hip resurfacing and reduced T-cell counts. *J Bone Joint Surg (Br)* 2006;**88**:449–54.
11. Crawford JR, Van Rensburg L, Marx C. Compression of the sciatic nerve by wear debris following total hip replacement. A report of three cases. *J Bone Joint Surg (Br)* 2003;**85-B**:1178–80.
12. Austin MS, Klein GR, Sharkey PF, *et al*. Late sciatic nerve palsy caused by hematoma after primary total hip arthroplasty. *J Arthroplasty* 2004;**19**:790–2.
13. Sosna A, Pokorny D, Jahoda D. Sciatic nerve palsy after total hip replacement. *J Bone Joint Surg (Br)* 2005;**87**:1140–1.
14. Molvik H, Hanna SA, de Roock NJ. Failed metal-on-metal total hip arthroplasty presenting as painful groin mass with associated weight loss and night sweats. *Am J Orthop* 2010;**39**:E46–9.
15. Vendittoli PA, Mottard S, Roy AG, *et al*. Chromium and cobalt ion release following the Durom high carbon content, forged metal-on-metal surface replacement of the hip. *J Bone Joint Surg Br* 2007;**89**:441–8.
16. Oldenburg M, Wegner R, Baur X. Severe cobalt intoxication due to prosthesis wear in repeated total hip arthroplasty. *J Arthroplasty* 2009;**24**:e815–20.
17. De Haan R, Pattyn C, Gill HS, *et al*. Correlation between inclination of the acetabular component and metal ion levels in metal-on-metal hip resurfacing replacement. *J Bone Joint Surg (Br)* 2008;**90-B**:1291–7.
18. Hart AJ, Buddhdev P, Winship P, *et al*. Cup inclination angle of greater than 50° increases whole blood concentrations of cobalt and chromium ions after metal-on-metal hip resurfacing. *Hip Int* 2008;**18**:212–19.
19. Website: http://www1.imperial.ac.uk/surgeryandcancer/divisionofsurgery/clinical_themes/musculo/retrieval. (accessed 15 Aug 2012).

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