CASE REPORT

Arthroprosthetic cobaltism and pseudotumour also occur in patients with small diameter femoral ball head metal-on-metal total hip arthroplasties

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SUMMARY

Metal-on-metal implants have been widely discredited in public during the past few months. At the same time patients' awareness has risen leading to an increased number of consultations regarding the topic. As hip resurfacings and total hip arthroplasties with large diameter femoral ball heads are already known for excessive metal wear, even small diameter ball heads with low friction get into focus now. We report a case of a 75-year-old man with recurrent hip pain almost 14 years after low friction metal-on-metal total hip arthroplasty. In addition to elevated serum cobalt levels, a type IV sensitivity reaction to cobalt could be noted. Explantation of a highly worn small diameter femoral ball head as well as development of the so-called pseudotumour indicate that all patients should be screened for signs of metal wear regardless of their specific risk factors or the type of metal-on-metal implant.

BACKGROUND

Metal-on-metal (MoM) implants have been one of the hottest topics in orthopaedics for the past few months.¹ It has been reported that mostly hip resurfacings (HRs) and total hip arthroplasties (THAs) with large diameter femoral ball heads (≥ 36 mm) can cause increased metal wear and therefore local as well as systemic reactions.^{2,3}

Rationale for the development of modern MoM pairings was their favourable tribological behaviour. High correlations between polyethylene (UHMWPE) wear and aseptic loosening of THAs, one of the main causes for revision surgery, accelerated the search for alternatives in terms of wear reduction.⁴

The introduction of the second-generation Metasul, a high-carbon wrought-forged cobalt–chromium (Co–Cr) alloy, by Sulzer Medica AG in 1988 was a revolution in this field. Its promise of limited volumetric wear (0.003 – 0.009 mm³/year) due to low friction led to an MoM revival.⁵ Since then plenty of reports on elevated metal ion levels, delayed type hypersensitivity reaction and formation of pseudotumours emerged mainly in conjunction with high-friction implants such as HRs (eg, BHR and ASR) but lately also with THAs using femoral ball heads larger than 36 mm. Combination of these symptom constellations and their serious side effects lately created the term arthroprosthetic cobaltism.³

The present case reports of a patient with a small diameter femoral ball head (28 mm) and basically all early symptoms of arthroprosthetic cobaltism. This highlights the implications that may also arise from the more favourable low-friction MoM THAs.

CASE PRESENTATION

A 75-year-old man was admitted to our outpatient clinic with recurrent movement-specific pain in his right hip since several weeks. In 1999 he received a THA of his right hip with a 28 mm M/O 12/14 Metasul ball head (Sulzer Medica AG, Winterthur, Switzerland) on a conventional medium sized 12/14 Marburg stem (Sulzer Medica AG, Winterthur, Switzerland) and a 52/28 Marburg Metasul UHMWPE sandwich liner (Sulzer Medica AG, Winterthur, Switzerland). Additionally, a history of chronic instability of the right hip with up to 4

Figure 1 (A) Plain radiograph (AP) of the pelvis 14 years after metal-on-metal total hip arthroplasties on the right side. No significant changes to prior radiographs could be noted. (B) Plain radiographs (AP/axial) of the right hip taken 6 weeks after revision surgery.

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Figure 2 (A) Explanted 50/28 mm Marburg Metasul cup and 28 mm M/O 12/14 Metasul ball head. (B) Close up of the head cone showing slight signs of fretting. However, volumetric wear was negligible compared with that of the head and the metal liner.

subluxations has to be noted since implantation of the prosthesis. In 2004, the patient also received a metal-on-UHMWPE THA of his left hip without further complication until today.

INVESTIGATIONS

Clinical examination revealed tenderness over the right groin as well as pain on maximum passive internal and external rotation. Plain radiographs (AP) of the pelvis did not show any specific abnormalities (figure 1A). Owing to a history of lately occurred concomitant atopic eczema he also attended the dermatological outpatient clinic where an allergy test was conducted which revealed a delayed-type hypersensitivity (type IV) to cobalt and potassium dichromate. Serological analyses showed elevated cobalt levels of 9.90 µg/L (reference ≤2.00 µg/L), while C reactive protein was 18 mg/L (reference ≤5 mg/L) without accompanying leucocytosis. All other laboratory parameters were within normal range.

DIFFERENTIAL DIAGNOSIS

Aseptic loosening or low-grade infection was discussed as differential diagnoses. Aseptic loosening was ruled out, as there was no evidence for this on plain radiographs of the hip. Low-grade infection was regarded as the most likely cause for the patient's problem. However, this is normally not seen in connection with pseudotumours of any kind.

TREATMENT

Based on the severity of the patient's clinical problems, diagnostic hip arthroscopy was performed suspecting wear-induced synovitis or metallosis. However, during surgery a general hypertrophy of the capsule could be noted with an absence of

inflammation, metallosis or relevant synovitis. Histopathological processing of intraoperative specimens revealed neosynovia of indeterminate type (type IV) according to the consensus classification.⁶ Morphologically there were no signs of infection, wear particles, hypersensitivity reaction or especially vasculitis. Additional diagnostic metal-artefact reducing sequence (MARS-MRI) scans revealed a pseudotumour (50×30×32 mm) ventral of the acetabulum with direct contact to the adjacent hip neocapsule. No signs of loosening, osteolytic lesions or cysts could be identified. Given the fact that no clear reasons for the patient's symptoms could be found it was decided to change the existing cup as well as the ball head. A 32 mm L BioloX Option Ceramic ball head (CeramTec GmbH, Plochingen, Germany) and a cemented 58/32 Mueller II UHMWPE liner (Smith & Nephew GmbH, Marl, Germany) were implanted instead. Within the same operation the ventral pseudotumour was removed for further histopathological processing. Changing the insert only would not have been an option in this case as the implanted Marburg sandwich liner was a monoblock system.

OUTCOME AND FOLLOW-UP

Explants were processed for further material science analyses. Skid marks could be detected on the surface of the ball head as well as signs of fretting in its head-cone (figure 2). Surface geometry was assessed with a coordinate measurement machine as described earlier⁷ revealing distinct wear of ball head and metal liner. The calculated volumetric wear was 15.6 mm³ for the ball head and 5.7 mm³ for the metal liner (figure 3). It is noted that the metal liner lost its sphericity in its outermost parts which may be caused by deformations of the polyethylene sandwich part. This deformed liner yielded to a higher

Figure 3 (A) Deviation of a perfect sphere: explanted Marburg Metasul cup. (B) Deviation of a perfect sphere: explanted Metasul ball head.

Figure 4 (A) Histopathology of the pseudotumour showing disseminated lymphocytic infiltration without vasculitis; H&E, 10-fold. (B) Magnification of a representative lymphocyte accumulation also showing a bunch of small vessels without signs of inflammatory reaction; H&E, 40-fold.

calculated wear volume compared with an undeformed liner. Calculated volumetric wear of the head-cone being 0.4 mm^3 seemed to be negligible. Taken together, a total volumetric wear of $>1.5 \text{ mm}^3/\text{year}$ could be noted which is around 250 times more than expected for a regular Metasul bearing.

Histopathological processing of the pseudotumour revealed a subtotal necrotic periprosthetic tissue mass with predominant fibrosis and disseminated lymphocytic infiltration (figure 4). It was graded again as indeterminate type (type IV) according to the consensus classification. Furthermore, it has to be regarded as an inflammatory type pseudotumour.⁶ Nanoparticle wear, as it is typically seen within Metasul bearings, may be responsible for the vast tissue necrosis. Additional immunohistochemical studies were performed to rule out low-grade infection. A CD15 antibody staining showed a moderate diffuse granulocytosis without reaching the threshold of 23 CD15 cells/10 high power field. A CD3 antibody staining did not yield specific reactivity with some isolated CD3 perivascular cells.

Twelve weeks after revision surgery and accompanying physiotherapy the patient felt fine with strongly reduced pain and a good active and passive range of motion in his right hip. Plain radiographs (AP/axial) of the right hip showed good post-operative results with no hint to further complications (figure 1B).

After a follow-up period of 1 year the patient was still satisfied with the result although reporting recurrent episodes of gait instability due to an insufficiency of the gluteus medius muscle. In summary this has to be related to the expanded surgical approach that was needed to remove the whole pseudotumour during revision.

DISCUSSION

We demonstrated the implications that may arise even from small diameter femoral ball heads in MoM bearings. Not only persistent hip pain but also elevated serum levels of metal ions and their potential systemic impact are causes for hip revision surgery today. Common guidelines for the management of MoM problems however put their focus mainly on high-risk implants like HRs and THAs with large diameter femoral ball heads.¹ THA with small diameter femoral ball heads have been largely disregarded due to their low-friction principle. However, even the least volumetric wear of MoM implants may cause severe joint reactions up to necrosis due to a reduced grain size.⁸ This may explain the similar prevalence of pseudotumours in patients regardless of the diameter of the femoral ball head used in THA. For this reason previous studies have advocated the use of a regular metal ion monitoring in all MoM patients

already.⁹ In addition, hip arthroscopy has already been described as a valuable instrument in the treatment and diagnosis of painful THAs.¹⁰ Signs of impingement and subsequent material wear as well as metallosis can be detected and partial synovectomy can be performed if necessary. Synovial sample taking may also be useful to confirm the diagnosis of arthroprosthetic cobaltism, for example, by methods like plasma mass spectrometry. Recent implant retrieval studies support this approach, as metal ion monitoring alone seems to be a too weak predictor of implant failure.¹¹

Learning points

- ▶ All patients with recurrent hip pain following metal-on-metal (MoM) total hip arthroplasty should be screened for elevated metal ion levels regardless of individual risk factors or implant type.
- ▶ Hip arthroscopy may be an option to obtain specimens for histopathological processing in cases of suspected arthroprosthetic cobaltism.
- ▶ Guidelines of professional societies regarding MoM implants have to be rethought and risk factors re-evaluated to generate special algorithms to assure that every patient is treated according to his individual needs regardless of the MoM implant type.

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Competing interests None.

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