

CLINICAL CASES OF PATIENTS WITH ARTHROPLASTY AND HEIGHTENED BLOOD CONCENTRATION OF METAL IONS

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We report on several clinical cases of different appearance and complications of patients after THR with metal-on-metal (MoM) couplings or a revision knee system. There may be skin irritation mainly due to chromium hypersensitivity or systemic effects and even cobalt intoxication can appear. We recommend clinical control to patients with MoM and a head size of 36 mm or larger or with knee revision systems. Patients who have problems such as pain or mal positioning should have measured the metal ion levels of cobalt. A serum cobalt level of $>7 \mu\text{g/L}$ indicates possible periprosthetic metallosis and may cause trouble. A normal serum cobalt level is below $1 \mu\text{g/L}$. We also need an MRI with Metal-Artifact-Reduced-Sequences or if not possible an ultrasound investigation to detect pseudotumors around the hip joint. For the clinical investigation you should look and ask for general hypersensitivity reaction (skin rash), cardiomyopathy, neurological changes including sensory changes, renal function impairment or thyroid dysfunction which may occur in cobalt intoxication. To optimize the diagnostic histological investigations using the Krenn classification are extremely helpful.

Key words: arthroplasty, metal-on-metal couplings, cobalt intoxication.

Introduction

Implant-related metal hypersensitivity is a rare complication in total joint replacement [4, 8, 10, 12, 19]. In a representative survey among members of the working group for joint replacement (AE) in Germany we showed that 0.6% of patients with total hip arthroplasty and 1,13% with total knee arthroplasty (TKA) may have a problem due to hypersensitivity to nickel or cobalt after implantation and one third of them may need revision surgery [21].

Several case reports have indicated a connection between early TJA failure or problems and metal sensitivity recently [1, 2, 19]. Due to the latest problems in patients with MOM couplings some reports are on cobalt intoxication [13–16, 23] or other systemic effects.

We report on several clinical cases of different appearance and complications in patients after THR with metal-on-metal (MoM) couplings [20] or a revision knee systems.

Cases

One patient had a MoM-coupling with an ASR XL acetabular head system (Depuy) just having problems after excessive cycling. An MRI with Metal-Artifact-Reduced-Sequences (MARS) detected a small pseudotumor but without damaging of the muscles. The metal ion levels decreased to $9,5 \mu\text{g/L}$ from $20 \mu\text{g/L}$ for chromium and to $19,0 \mu\text{g/L}$ from $30,0 \mu\text{g/L}$ for cobalt. The patient remains under control because he had no bigger problems [20].

The next patient had a “Cormet” surface replacement with a swelling at the major trochanter level (fig. 1). The x-rays detected a high inclination angle of the cup and an “edge loading” with high contact stresses (fig. 2). The negative influence of high cup inclination angles and the edge loading is shown by Morlock and coworkers [11]. The MRI with MARS showed a big pseudotumor. The chromium blood concentration raised from $5 \mu\text{g/L}$ to $9,5 \mu\text{g/L}$ and for cobalt from $7,3 \mu\text{g/L}$ to $14,0 \mu\text{g/L}$. A revision was recommended.

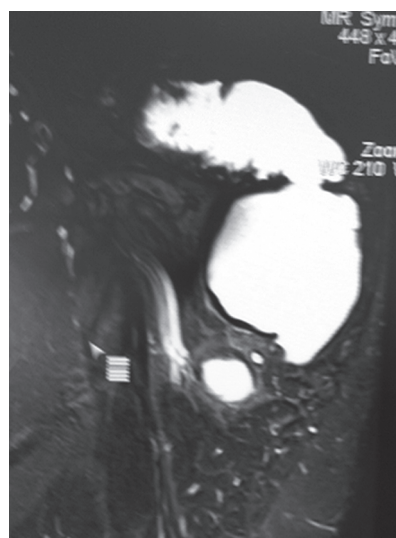


Fig. 1. Big “pseudotumor” with muscle damage in the gluteal area

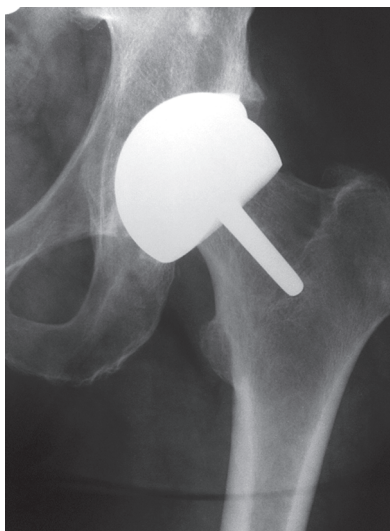


Fig. 2. Surface replacement with high inclination of the cup, causing “edge loading” with wear

Another patient had a “BHR” on the left side and an “Adapt” surface replacement on the right side (fig. 3) without any problems. Systems with a good (high) radial clearance (BHR 105 μm and Adapt 85 μm) do not have so much wear. The metal ion levels decreased from 3,16 $\mu\text{g/l}$ to 0,36 $\mu\text{g/l}$ cobalt and from 6,11 $\mu\text{g/l}$ to 0,42 $\mu\text{g/l}$ for chromium. The only problem is a dermatitis mainly of the hands.

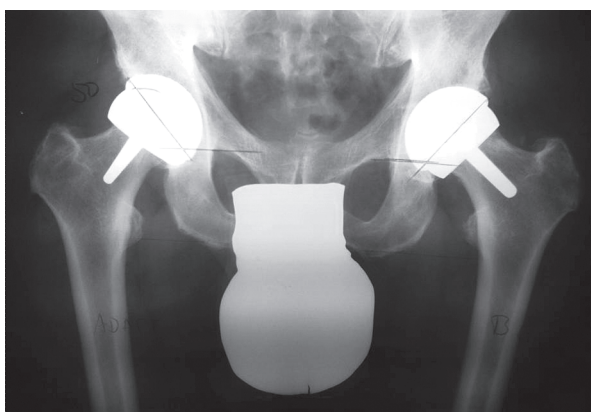


Fig. 3. Comparison of two different systems, both with acceptable inclination angles

X. Gao et al. [2] described a severe case of dermatitis associated with chromium following total knee arthroplasty. Also the retroversion of the cup can lead to high ion levels as 21 $\mu\text{g/l}$ for chromium and 37,6 $\mu\text{g/l}$ for cobalt, which lead to a revision in another patient. A.J. Hart et al. [5] recommended a CT-scan to detect such retroversions.

Recently we had a patient with symptoms of a cobalt intoxication with cobalt levels (17,9 $\mu\text{g/l}$) in blood and in the joint fluid (445 $\mu\text{g/l}$) after several

knee operations and revisions and a swollen knee (fig. 4). The microbiological investigation showed no infection but the histological findings of Prof. V. Krenn showed massive necrosis due to metal toxic reactions (SLIM) and little CD3 positive lymphocytes seen in metal sensitivity reactions [7].



Fig. 4. Massive constant knee swelling after several THR revisions due to metal hypersensitivity and cobalt metal ion “overloading”

Comparable to our experience with patients with MoM couplings we discussed that it seems to be an overloading or intoxication with cobalt, also called cobaltism as described by S.S. Tower in 2012 [23].

Discussion

In total hip replacement the problem of local tissue reactions associated with metal ions from MoM couplings is known since 1975 [6].

Although there is more metallic particles in MoM, J.P. Thyssen et al. [22] and K. Gustavson et al. [3] did not see an association between metal allergy, total hip arthroplasty and revision. They even saw a reduction of positive patch tested patients after hip surgery.

In the Australian register they saw in 2011 already 5 implants with higher complications (table). The ASR and the Cormet 2000 were stopped, but Bionik, Recap and Durom are still running. Due to the fact that we see more and more problems with the resurfacing in Germany these kinds of implants are only implanted by a small group of surgeons.

Several case reports have indicated a connection between early TJR failure or problems and metal sensitivity. They found skin reactions around the scar and pain [19] or generalised dermatitis to chromium [2].

Table

Cumulative Percent Revision of Primary Total Resurfacing Hip Replacement by Prosthesis Type*

Prosthesis type	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	13 Yrs
ASR	284	1167	3.4 (2.5, 4.6)	7.2 (5.9, 8.8)	15.3 (13.3, 17.5)	23.9 (21.4, 26.6)	–	–
Adept	16	655	1.1 (0.5, 2.3)	1.8 (0.9, 3.3)	2.3 (1.3, 4.1)	3.6 (2.1, 6.2)	–	–
BHR	581	10750	1.4 (1.2, 1.6)	2.4 (2.2, 2.8)	3.6 (3.2, 3.9)	5.0 (4.6, 5.4)	6.9 (6.3, 7.5)	8.4 (7.4, 9.5)
Bionik	34	200	3.5 (1.7, 7.2)	12.0 (8.2, 17.4)	16.7 (12.1, 22.9)	–	–	–
Cormet	88	626	2.1 (1.2, 3.6)	5.7 (4.1, 7.8)	10.1 (7.9, 12.8)	14.2 (11.4, 17.6)	18.7 (14.9, 23.4)	–
Durom	77	847	3.2 (2.2, 4.6)	5.4 (4.1, 7.2)	7.6 (6.0, 9.6)	8.9 (7.1, 11.1)	10.3 (8.2, 12.9)	–
Icon	8	118	1.7 (0.4, 6.6)	2.6 (0.8, 7.8)	4.5 (1.9, 10.4)	6.8 (3.3, 13.7)	–	–
Mitch TRH	30	1024	1.2 (0.7, 2.1)	2.2 (1.4, 3.3)	2.8 (2.0, 4.1)	3.6 (2.4, 5.2)	–	–
Recap	22	195	5.1 (2.8, 9.3)	8.7 (5.5, 13.7)	10.4 (6.8, 15.7)	11.7 (7.6, 17.8)	–	–
Other (8)	30	188	5.3 (2.9, 9.7)	7.5 (4.5, 12.4)	9.8 (6.3, 15.1)	12.2 (8.2, 18.0)	17.5 (12.4, 24.4)	–
TOTAL	1170	15770						

Note: Only combinations with over 100 procedures have been listed.

* Australian national joint replacement registry annual report 2014. <https://aoanjrr.dmac.adelaide.edu.au/documents/10180/172286/Annual%20Report%202014>

P. Thomas et al. [18] found in their study of 200 arthroplasty patients with complaints involving the prosthesis (130 female, 187 knee and 13 hip prostheses) and in parallel 100 symptom-free patients (75 female, 47 knee and 53 hip prostheses) were investigated. In the knee arthroplasty patients with complaints 9.1% showed dental material intolerance, 23.5% atopy, 25.7% CMI, 18.2% metal allergies, 7.4% gentamicin allergy and 27.8% positive metal LTT (mostly to Ni). In symptom-free patients 0% showed dental material intolerance, 19.1% atopy, 12.8% CMI, 12.8% metal allergy, 0% gentamicin allergy and 17% positive metal LTT.

We demonstrated in 2013 the different symptoms and complications in patients fitted with prostheses with metal-on-metal (MoM) bearings. In patients who have problems tests should be carried out to measure the metal ion levels of cobalt and chromium.

G. Mahendra et al. [9] already speaks about necrosis and inflammation in peri-implant soft tissues have been described in failed second-generation

metal-on-metal (MoM) resurfacing hip arthroplasties and in the pseudotumors associated with these implants.

Now we also see some problems in patients with MOM couplings – were some reports are on cobalt intoxication [13–16] or other systemic effects but our case with the knee problem is new.

V. Krenn et al. [7] said that by means of histopathology different pathogenetic synovial-like interface membrane (SLIM) patterns that lead to reduction of implant durability could be discerned, such as periprosthetic particles, bacterial infections and arthrofibrosis. Subsequently, SLIM types have been determined in a revised consensus classification including particle-induced type (type I) so-called non-septic loosening, infection type (type II) so-called septic loosening, combination type (type III) of bacterial and particle-induced types, indifferent type with mechanical and functional disorders (type IV), osseous pathologies (type V), arthrofibrotic type (type VI, endoprosthesis-associated arthrofibrosis) and allergic/immunological/toxic reactions to prosthesis material (type VII).

Particles are characterized histopathologically according to the Krenn particle algorithm. In cases of severe lymphocyte/macrophage infiltration, necrosis, abrasion particle detection and granuloma formation, a toxic or allergic reaction to implant material should be considered.

We recommended the clinical investigations should specifically target asymptomatic or symptomatic local swellings after total hip or knee replacement and patients should be questioned on problems with general hypersensitivity reactions (skin rash), cardiomyopathy, and neurological changes including sensory changes, renal function impairment and thyroid dysfunction.

In trouble arthroscopy and histological classifications can help as well as blood ion measurements and microbiological investigation.

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ПОВЫШЕНИЕ УРОВНЯ ИОНОВ МЕТАЛЛА В КРОВИ ПАЦИЕНТОВ ПОСЛЕ ЭНДОПРОТЕЗИРОВАНИЯ: КЛИНИЧЕСКИЕ СЛУЧАИ

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Описано несколько клинических наблюдений пациентов с различными проявлениями и осложнениями после эндопротезирования тазобедренного сустава парой трения металл-металл или ревизионной артропластики коленного сустава. У таких больных может появиться раздражение кожи, в основном вследствие гиперчувствительности к хрому, и даже интоксикация кобальтом. Авторы рекомендуют проводить клиническое наблюдение за пациентами, которым установлены эндопротезы тазобедренного сустава с парой трения металл-металл и головками диаметром 36 и более мм, а также за больными после ревизионного эндопротезирования коленного сустава. У пациентов с болевым синдромом и неправильным положением компонентов эндопротеза необходимо определить уровень металлических ионов кобальта. Уровень кобальта в сыворотке крови свыше 7 мкг/л свидетельствует о наличии перипротезного металлоза, так как в норме этот показатель составляет менее 1 мкг/л. Для выявления псевдоопухолей в области тазобедренного сустава следует применять МРТ с использованием программы MARS (metal artifact reduction sequences), направленной на устранение искажений изображений и артефактов, возникающих из-за присутствия в магнитном поле металлических имплантатов. При отсутствии такой возможности можно выполнять ультразвуковое исследование. Во время клинического исследования необходимо определить наличие у пациента общей реакции гиперчувствительности (кожная сыпь), кардиомиопатии, неврологических нарушений, включая нарушения чувствительности, ухудшения функции почек или щитовидной железы, которые могут произойти вследствие интоксикации кобальтом. Оптимизировать гистологические исследования помогает использование классификации Кренна, которая приводится в тексте статьи.

Ключевые слова: эндопротезирование, металл-металлические пары трения, гиперчувствительность к металлам, интоксикация кобальтом.

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