

# Cobalt-chromium toxicity following revision of total hip replacement

Ramy Samargandi, MD, Louis-Romée Le Nail, MD, PhD, Bandar Hetaimish, MD, Maxime Saad, MD.

### ABSTRACT

تعتبر سمية الكوبالت والكروم الجهازية بعد استبدال مفصل الورك من المضاعفات النادرة التي قد تؤدي في بعض الأحيان إلى عواقب مميتة. يشير هذا التقرير عن حالة امرأة تبلغ من العمر 64 عاماً أصيبت بتسمم الكروم والكوبالت بعد تبديل مفصل الورك لحدوث مضاعفات بكسر في مكونات المفصل السيراميكي استدعى استبداله بمفصل لديه سطح احتكاك مكون من معدن الكوبالت والكروم مع بولي إيثيلين. حدثت السمية الجهازية بعد عام من الجراحة مع ظهور أعراض عصبية مركزية مصاحبة بأعراض أخرى. سمحت عملياته جراحة تغيير المفصل والتنضير بالتحسن السريع لجميع الأعراض المرضية. يجب تجنب تغيير المفصل بسطح احتكاك معدني بعد حدوث كسر بسطح احتكاك مفصل مكون من السيراميك لتجنب السمية بسبب الكوبالت والكروم. يجب أن يكون جراحو العظام والتخصصات الطبية المختلفة على دراية بهذه المضاعفات النادرة والخطيرة للسماح بالعلاج المبكر. قبل كل شيء، تعتبر الرعاية متعددة التخصصات أساسية للسماح بالتشخيص الصحيح والعلاج المناسب.

Systemic cobalt-chromium (Co-Cr) toxicity following a total hip replacement is a rare complication that may sometimes lead to fatal consequences. We report a case of a 64-year-old woman, who presented with Co-Cr toxicity after revision of fractured ceramic components with metal-on-polyethylene. Systemic toxicity occurred a year after surgery and was expressed brutally with mostly central neurological symptoms. Revision surgery allowed rapid regression of all symptoms. Prosthetic revision with a metal bearing surface after a history of fracture of the ceramic bearing component should be avoided. Orthopedic surgeons and the different medical actors should be aware of this rare but serious complication to allow earlier management. Above all, multidisciplinary management is primordial to allow correct diagnosis and appropriate treatment.

**Keywords:** case report, cobalt-chromium toxicity, total hip replacement, complications after surgery

*Saudi Med J* 2024; Vol. 45 (2): 194-198  
doi: 10.15537/smj.2024.45.2.20230334

From the Department of Orthopedic Surgery and Traumatology (Samargandi, Le Nail, Saad), The Regional University Hospital Centre of Tours, Tours, France, and from the Department of Orthopedic Surgery (Samargandi, Hetaimish), College of Medicine, University of Jeddah, Jeddah, Kingdom of Saudi Arabia.

Received 12th July 2023. Accepted 14th December 2023.

Address correspondence and reprint request to: Dr. Ramy Samargandi, Department of Orthopedic Surgery and Traumatology, The Regional University Hospital Centre of Tours, Tours, France.  
E-mail: ramy.samargandi@hotmail.com  
ORCID ID: <https://orcid.org/0000-0001-5912-9667>

Systemic cobalt-chromium (Co-Cr) toxicity after total hip replacement (THR) is a rare complication that may have fatal consequences and is well-described in the medical literature.<sup>1,2</sup> This complication may occur after prosthetic revision with a metal bearing surface following a fracture of the ceramic component.<sup>2-5</sup>

The fracture of the ceramic bearing component may lead to debris (third body), which after revision with a Co-Cr component, can lead to premature wear of the polyethylene, especially of the metal head. This debris releases cobalt ions into the body, leading to systemic manifestations. Cobalt toxicity can manifest as systemic damage, fatigue, anorexia, auditory or ophthalmological damage, simulating an autoimmune disease, and cardiac toxicity, which can be fatal.<sup>1-3,6-8</sup>

Due to these multisystemic clinical presentations, diagnosing Co-Cr toxicity remains difficult. Therefore, physicians should have a high index of suspicion. This should be considered in the differential diagnosis if patients who have undergone prosthetic joint replacement with a Co-Cr bearing component, especially in cases of revision after a history of a fractured ceramic component, develop symptoms, and conditions described above.

The medical literature recommends extended synovectomy and revision using a ceramic bearing surface following the fracture of one of the ceramic components. All metal bearing surfaces should be avoided to prevent the wear of metal components.<sup>9</sup> Unfortunately, these recommendations are not always followed, and catastrophic complications arise because of surgeons' lack of awareness regarding these recommendations.

This case report aims to raise awareness of the potential risk of Co-Cr toxicity after total hip replacement and its importance as a differential diagnosis, highlighting the need for early recognition and management to prevent fatal consequences.

**Case Report.** The patient was a 64-year-old woman who underwent THR surgery with a ceramic-on-ceramic bearing surface at another center in 2015 at the age of 58 years for primary hip osteoarthritis. Six months post-operatively, after a fracture of the ceramic component, prosthetic revision, including a large synovectomy, lavage of the ceramic debris, and revision with a metal-on-polyethylene bearing surface, was carried out at the same center. The post-operative course was favorable for one year.

**Clinical findings.** In July 2017, she developed sudden deafness in the left ear. In October 2017, she developed progressive and fluctuating deafness in the right ear. Various complementary examinations, including magnetic resonance imaging (MRI) and computed tomography (CT), revealed no etiology for this deafness, particularly no cerebral causes. Subsequently, she was fitted with a hearing aid.

Furthermore, she also developed ophthalmological symptoms with a decrease in visual acuity during 2017. Multiple etiologies were proposed, including cataracts and Cogan syndrome. Finally, the diagnosis was determined as idiopathic neuropathy with bilateral optic nerve atrophy, according to abnormalities revealed by a visual evoked potential test and the normal results of brain MRI.

In 2018, she was diagnosed with hypothyroidism and underwent medical management, which resulted in the normalization of thyroid function.

Hematological symptoms appeared in 2018, with polycythemia and a hematocrit value of 59%. Complementary examinations favored a secondary origin with signs of neurological deceleration, including fatigue, weakness, and upper and lower limb paresthesia. She underwent 5 phlebotomies that improved these symptoms, but neuropathy of the lower limbs persisted. In 2019, cardiomyopathy with left ventricular hypertrophy and an ejection fraction of 53% was diagnosed.

Orthopedic follow-up was initially favorable. The patient could walk without a walking aid until April 2021. She began experiencing disabling hip

pain, which made walking almost impossible, and was confined to a wheelchair. No history of trauma was present. Therefore, she was referred to our center for the first time in May 2021.

**Diagnostic assessment.** A CT scan carried out in May 2021 revealed a granuloma on the roof of the acetabulum without any signs of loosening (Figure 1A). In addition, there was significant polyethylene wear, with numerous pieces of debris in the surrounding soft tissues, especially in the gluteus medius, hamstring, and piriformis muscles. The MRI revealed multiple ceramic fragments and soft tissue infiltration were observed up to the distal third of the femur, encircling the sciatic nerve (Figure 1B). A hip aspiration was carried out, eliminating an associated periprosthetic infection.

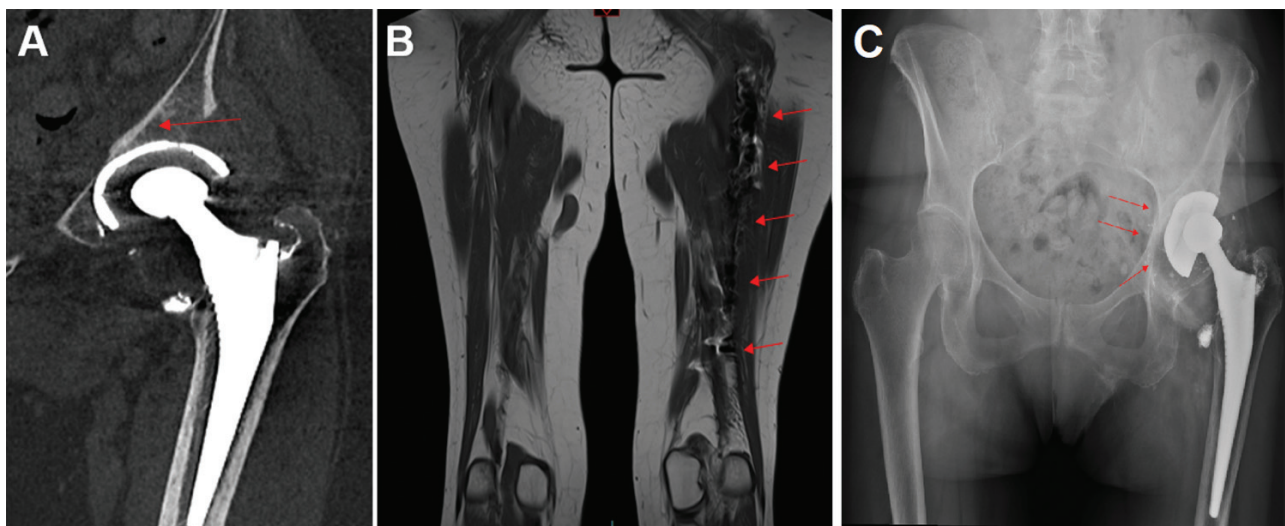
The presence of severe metal toxicity was suggested by the patient's relative based on an episode of the television show Dr. House, which she watched. Thus, the patient consulted the Internal Medicine Department in June 2021. The serum cobalt level was 86.3 µg/L (normal range: 0-0.5 µg/L), and the urinary cobalt level was 411.3 µg/L (normal level: <2.0 µg/L). The serum chromium level was 234.4 µg/L (normal range: 0-0.5 µg/L), and the urinary chromium level was 357.4 µg/L (normal level: <2.0 µg/L).

The clinical and biological features favored a diagnosis of severe Co-Cr toxicity in which surgical revision was indicated. Before surgery, the patient presented with severe pain in the hip and radiography was carried out to assess the cause of the increasing pain, and it revealed rapid loosening of the acetabulum (Figure 1C), which was not present on the CT scan obtained in May 2021.

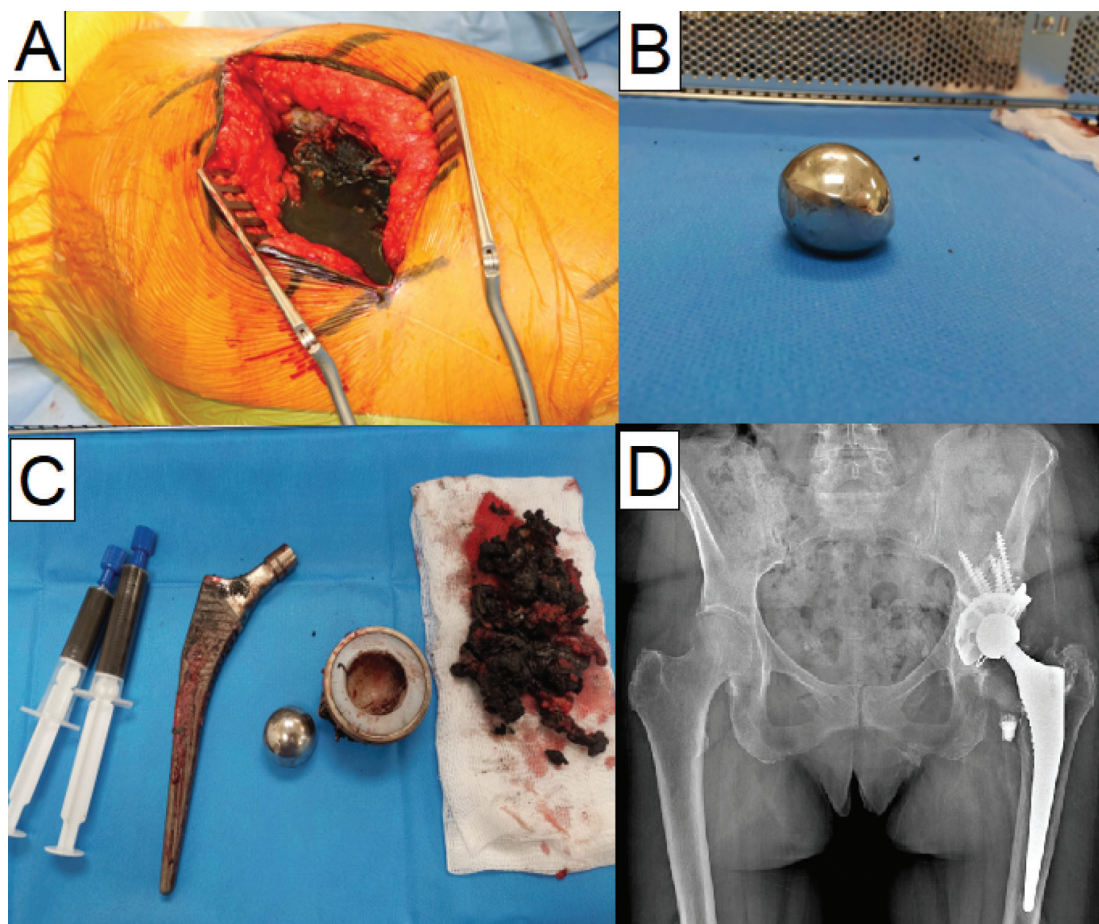
**Therapeutic intervention.** Owing to significant acetabular bone damage, replacement with a first-line ceramic-ceramic bearing surface prosthesis was no longer possible. A one-stage bipolar prosthetic replacement with an acetabular cage made of titanium, a cemented polyethylene acetabular cup with a liner, and a new stem with a ceramic head was carried out in September 2021.

Intra-operatively, a large quantity of thick and black-colored fluid was observed, with extensive black discoloration of the surrounding muscles. Large synovectomy and extensive debridement of the infiltrated soft tissue were carried out. The head and acetabular cup were then removed. Massive wear was observed on the metal head surface, which revealed a loss of sphericity and became oval at its upper part. Moreover, all observed pieces of ceramic debris were removed (Figure 2A-C). The hip was then reconstructed using an acetabular cage made of titanium, a cemented polyethylene acetabular cup with a liner, and a new stem with a ceramic head.

**Disclosure.** Authors have no conflict of interests, and the work was not supported or funded by any drug company.



**Figure 1** - Pre-operative imaging. A) Computed tomography demonstrating a large granuloma of the left acetabular roof (red arrow). B) Magnetic resonance imaging highlights numerous ceramic debris descending to the distal third of the femur and encompassing the sciatic nerve (red arrows). C) Pelvic AP view radiograph before surgery, which reveals loosening and verticalization of the acetabular cup (as indicated by red arrows).



**Figure 2** - Depicts the intra-operative findings. A) A black-colored fluid collection indicating metallosis. B) A metallic head exhibiting loss of sphericity and wear. C) Removal of the prosthesis with a damaged taper neck, metallosis fluid, and debried soft tissues. D) Post-operative pelvic AP radiograph.

**Follow-up and outcomes.** Post-operatively, the patient described an immediate improvement in neurological symptoms. She was able to walk with crutches on the first post-operative day. She was discharged on day 5 post-operatively.

Six months post-operatively, the neuropathy of the lower limbs resolved completely, and auditory symptoms improved, but ophthalmological symptoms did not. The hip pain disappeared, and the patient was able to resume walking without assistance. Radiological

follow-up at 6 months revealed no signs of prosthetic loosening (Figure 2D).

At one-year follow-up visit, the patient's condition showed marked improvement. Improvements in visual acuity and neurological symptoms were noted. She was able to resume unlimited walking. Biologically, the serum levels of cobalt and chromium reduce slowly. The evolution of the blood and urine metal assays is summarized in Table 1 and the case timeline is summarized in Figure 3.

**Table 1** - Summary of cobalt-chromium concentration levels.

Co-Cr levels	Duration				
	One month pre-operative	One month post-operative	3 months post-operative	6 months post-operative	One year post-operative
Cobalt S	86,35 µg/L	63,6 µg/L	38,6 µg/L	27,95 µg/L	24.8 µg/L
Cobalt U	411,40 µmol/L	91,2 µg/L	89.8 µg/L	NA	33.7 µg/L
Chrome S	234,46 µg/L	NA	196.64 µg/L	104,56 µg/L	96.62 µg/L

S: blood, U: urine, NA: not available



**Figure 3** - Case presentation timeline.

**Discussion.** Herein, we reported a case of Co-Cr toxicity following a revision of THR for the fracture of a ceramic-ceramic bearing surface and replacement with a metal-polyethylene component. In this case, the patient's symptoms and signs persisted for several years. Different specialist doctors managed the patient without diagnosing Co-Cr toxicity.

The patient presented with obvious symptoms of toxicity that have been well-described in the literature.<sup>2-5</sup> One of the problems encountered in the management of this patient was that all symptoms were treated independently without recognizing the etiology. A multidisciplinary approach and communication between different specialties would have enabled an early diagnosis and avoided the development of complications. Considering the patient's perspective is essential and can help practitioners reach a diagnosis. Because of multimedia use, patients are becoming increasingly aware of the existence of this complication. In the present case, the diagnosis was suggested by the patient's niece, similar to other cases where multimedia played an important role in the diagnosis.<sup>3,10</sup> Furthermore, the present case was characterized by metallosis, which infiltrated the sciatic nerve down to the knee, and especially acetabular bone loss. The degree of bone loss did not allow us to carry out the revision with ceramic-ceramic components, and cemented ceramic cups were not available in France. Currently, clinical and biological evolutions of the patient's condition seem favorable.

The fracture of one of the ceramic components is a complication encountered during prosthetic joint surgery, and its management must be known to all surgeons.<sup>10</sup> Prosthetic revision with a metal bearing surface after a fracture of the ceramic bearing component should be avoided, and the revision should be carried out with another ceramic bearing surface to avoid erosion of the metal component. A diagnosis of Co-Cr toxicity should be considered in any patient who develops multisystemic symptoms after a recent hip replacement prosthetic revision surgery with a metal bearing surface for a ceramic component fracture.

In conclusion, although Co-Cr toxicity following prosthetic revision of THR using a metal bearing surface

is rare, orthopedic surgeons and healthcare providers should be aware of this serious complication to allow early management. In particular, multidisciplinary management is primordial to avoid the management of symptoms independently, which prevents physicians from missing the actual diagnosis.

**Acknowledgment.** *The authors gratefully acknowledge Dr. Bouilleau Loic for his invaluable contributions to the radiological interpretation in this study. The authors also would like to thank Editage (www.editage.com) for English language editing.*

## References

1. Peters RM, Willemse P, Rijk PC, Hoogendoorn M, Zijlstra WP. Fatal cobalt toxicity after a non-metal-on-metal total hip arthroplasty. *Case Rep Orthop* 2017; 2017: 9123684.
2. Gautam D, Pande A, Malhotra R. Fatal cobalt cardiomyopathy following revision total hip arthroplasty - a brief report with review of literature. *Arch Bone Jt Surg* 2019; 7: 379-383.
3. Garcia MD, Hur M, Chen JJ, Bhatti MT. Cobalt toxic optic neuropathy and retinopathy: case report and review of the literature. *Am J Ophthalmol Case Rep* 2020; 17: 100606.
4. Lecoanet P, Blangis M, Garcia M, Legallois Y, Fabre T. Chromium-cobalt intoxication with intense systemic complications following total hip revision after per-operative ceramic fracture. *Case Rep Orthop* 2019; 2019: 4209796.
5. Gessner BD, Steck T, Woelber E, Tower SS. A systematic review of systemic cobaltism after wear or corrosion of chrome-cobalt hip implants. *J Patient Saf* 2019; 15: 97-104.
6. Rizzetti MC, Liberini P, Zarattini G, Catalani S, Pazzaglia U, Apostoli P, et al. Loss of sight and sound. Could it be the hip? *Lancet* 2009; 373: 1052.
7. Biglia A, Morandi V, Monti S, Delvino P, Cavagna L, Montecucco C. [Cobalt hip prosthesis intoxication mimicking an autoimmune disease]. *Revue du Rhumatisme* 2021; 88: 65-67. [In France]
8. Sanz Pérez MI, Rico Villoras AM, Moreno Velasco A, Bartolomé García S, Campo Loarte J. Heart transplant secondary to cobalt toxicity after hip arthroplasty revision. *Hip Int* 2019; 29: NP1-NP5.
9. Rambani R, Kepecs DM, Mäkinen TJ, Safir OA, Gross AE, Kuzyk PR. Revision total hip arthroplasty for fractured ceramic bearings: a review of best practices for revision cases. *J Arthroplasty* 2017; 32: 1959-1964.
10. Dahms K, Sharkova Y, Heitland P, Pankuweit S, Schaefer JR. Cobalt intoxication diagnosed with the help of Dr House. *Lancet* 2014; 383: 574.