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Case report

Artefact or hip prosthetic fracture on multislice CT? The importance of correct positioning when scanning metal implants

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Introduction

Fractures of total hip arthroplasty (THA) implants, are rare but not unknown.[1] Correct diagnosis is crucial in deciding whether implant replacement surgery is indicated. Loosening of femoral stem or acetabular components are far more common,[2] but cannot be differentiated without imaging. Conventional radiography of the hip is first-line modality, but when the diagnosis is unclear or inconsistent with clinical presentation, CT is the modality of choice.[3,4]

However metal implants impart artefacts on CT images. Beam hardening artefacts occur where x-rays are filtered by passage through radiodense material, increasing average energy of the x-ray spectrum.[5] The result is a dark streak- or star-like artefact radiating from the metal into adjacent tissue, and potentially obscuring pathology. Artefact reduction can be achieved by increasing kVp, metal artefact reduction (MAR) reconstruction algorithms, and reducing thickness of metal in the scanplane, through careful positioning of patient and/or tilting of the scanner gantry.[6] When these precautions are not observed, there is a risk of the artefacts simulating pathology.

Case report

A 67 year old man presented at the orthopedic surgery department 6 months after right THA, with increasing pain when walking, and no history of hip trauma. Paraclinical findings did not indicate infection. Standard hip radiographs were performed, showing normal postoperative status. The patient was then referred to CT of the hip prosthesis, to rule out component loosening. Scanning was on a Toshiba Aquilion PRIME 80-slice CT-scanner (Toshiba Medical Systems, The Netherlands) with a dedicated protocol as follows: mA: 300, kVp 135, Pitch: 0,684, rotation time: 1 sec. Images were reconstructed in 0,5 mm thickness and 0,3 mm interval at a medium sharp kernel, for MPR processing. Images were reconstructed with and without Single Energy Metal Artefact Reduction (SEMAR).

Images were then reviewed by a musculoskeletal (MSK) radiologist with more than 15 years of experience. Small cysts were found in the acetabulum/liner interface. At the neck of the femoral component, a dark streak raised suspicion of fractured prosthesis (Fig. 1), on both SEMAR and non-SEMAR images, especially on paracoronal MPR. Volume Rendering Technique (VRT) reconstructions were used for a global view. The irregular appearance and localization could indicate serrated edges of a material fracture.

The case was discussed with another MSK radiologist. A senior CT radiographer was consulted to see if artefacts could be resolved by reconstructions at different algorithms, which was not the case. Therefore the patient was recalled for renewed CT scan of the region, with identical parameters. This time the patient was positioned with the scan plane as perpendicular to the femoral neck as possible, reducing the amount of metal traversed by the beam. The patient was positioned as shown in Fig. 2, as THA patients are advised not to cross their legs (to minimize subluxation risk). A board was placed under the shoulder region, and feet immobilized in a vacuum bag, taped to the patient table but extending beyond it. The dark streak could not be reproduced, and it was concluded that no fracture was present (Fig. 3).

Discussion

This case highlights the importance of correct patient positioning in CT, when scanning metal implants, even though advanced MAR techniques are used. MAR algorithms are designed to reduce artefacts in tissue surrounding the metal, which may help to explain the failure to reduce the artefact within the metal.

SEMAR works by identifying projections in raw data space containing metal artefacts, subtracting these from the sinogram and interpolating missing projections from remaining data. Following this, new images are reconstructed from the resulting sinogram, with the metal data reinserted. Other vendors offer similar solutions: MAR (GE), O-MAR (Philips), I-MAR (Siemens).[7]

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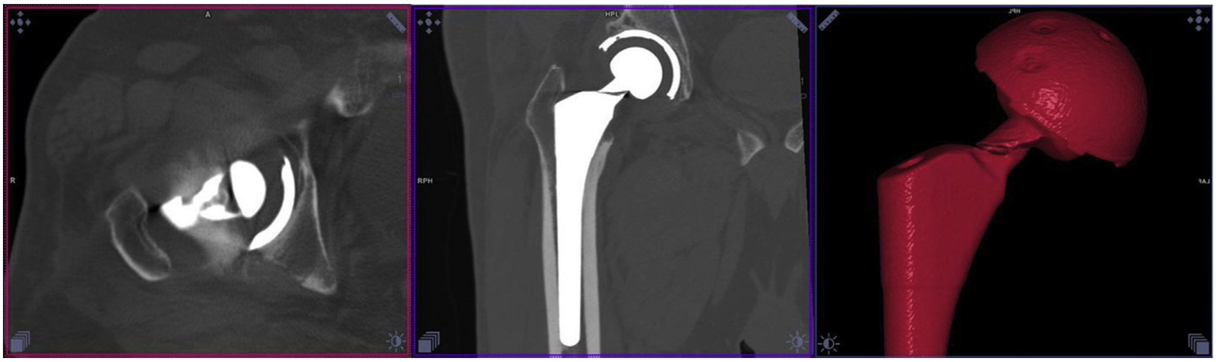

Figure 1. Primary scan (axial image at artefact site, paracoronal MPR and VRT) showing suspected fracture.

If scanning had been performed with Dual Energy (DE), it is possible that the artefact could have been resolved using mono-energetic reconstructions[8] However our experiences with this technique have been mixed, an experience supported by some studies.[9,10] One limitation is a 33 cm DE Field-Of-View, making positioning even more challenging for off-centre structures like THA.

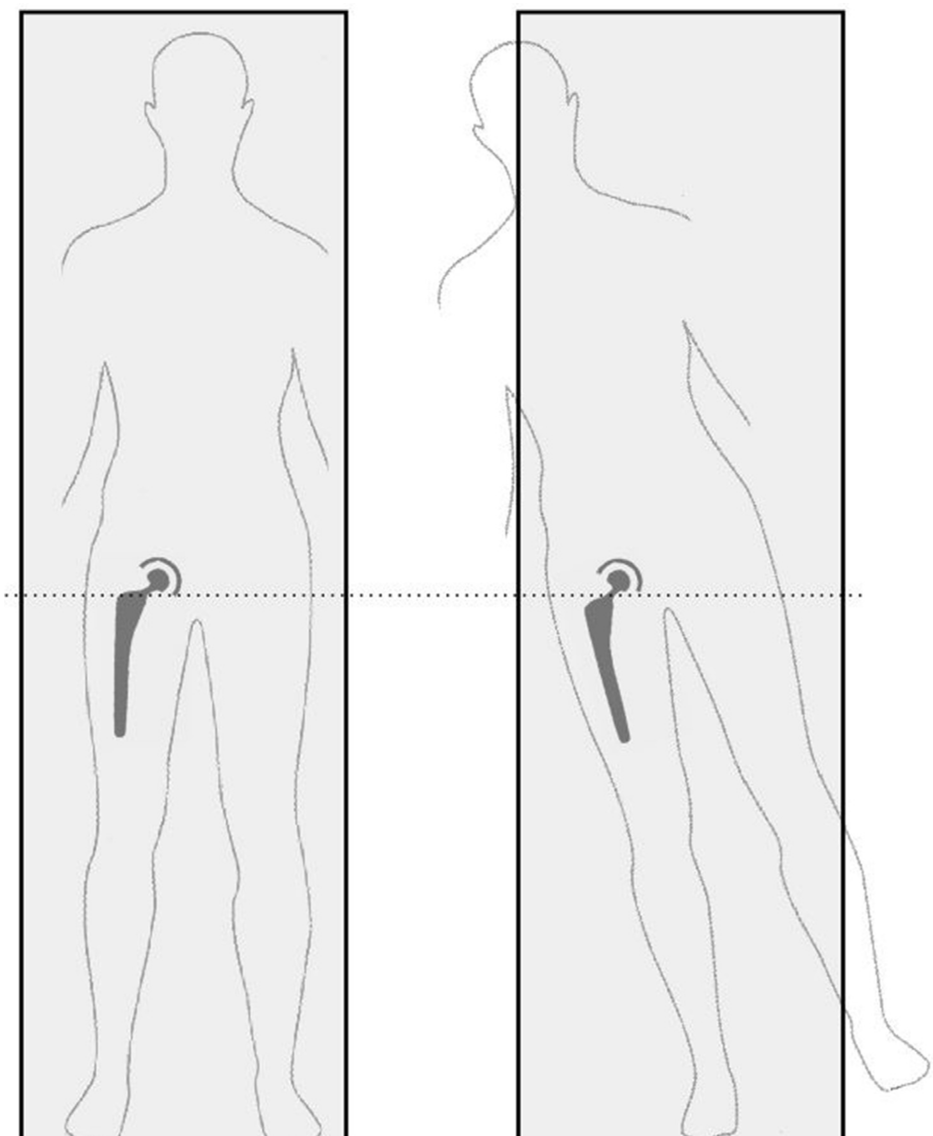

Figure 2. Patient positioning on the scanner table. Original scan on the left, new scan on the right. Dotted line represents scan plane at the level of artefact.

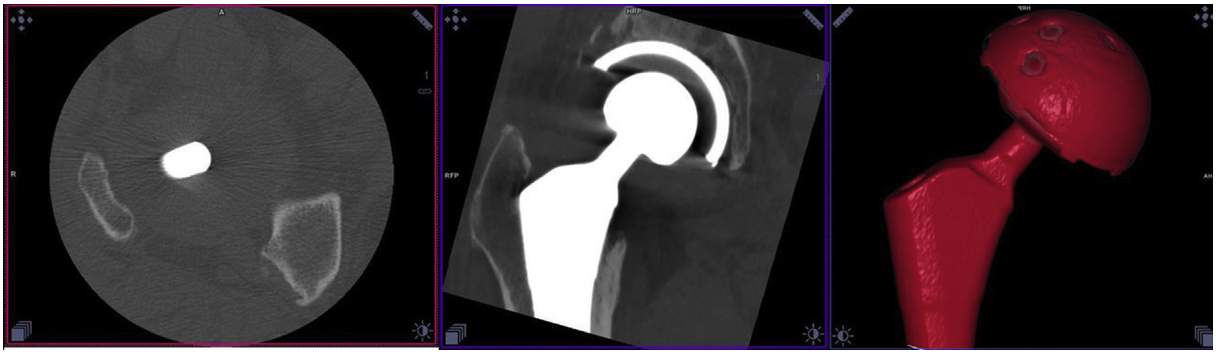

Figure 3. Renewed scan. Paracoronal images are rotated corresponding to the new scanplane.

Radiographers should review previous radiographs, to determine size and orientation of implants, and position patients with scanplane traversing the minimal volume of metal. The most optimal scanner in terms of positioning should be selected. 2 scout views should be acquired in perpendicular planes, checked, and patient position corrected if necessary, before acquiring the full helical scan. In this case, the extra radiation exposure was approximately 400 mGycm, which could have been avoided with proper radiographic technique.

Conflicts of interest

The author declares no conflict of interest and the study is funded exclusively by the Department of Radiology & Nuclear Medicine at the Hospital of Southwest Jutland.

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