Complications after modular-neck total hip arthroplasty: the poor clinical impact of imaging follow-up

Poster No.: C-0876
Congress: ECR 2018
Type: Scientific Exhibit
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Keywords: Prostheses, Complications, CT, Conventional radiography, Musculoskeletal bone, Bones
DOI: 10.1594/ecr2018/C-0876

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Aims and objectives

Background

Total hip arthroplasty (THA) has become increasingly used to correct advanced joint diseases in the elderly, but also in a younger population for post-traumatic fractures and secondary arthritis. The goal of THA is to not only remedy a painful hip, but also to achieve an anatomic reconstruction; therefore, implant manufacturers have developed modular femoral components to provide greater options for intra-operative correction of version, offset and leg length in THA. (1; 2)

Younger and more active patients have a higher rate of revision, because the longevity of the prosthesis is usually a function of usage. Data reported from national registries suggest revision risks of 5 to 20% ten years following primary THA. (3) A more recent development in modular femoral components was the introduction of a modular neck-stem taper, which has become widespread in orthopedic surgery and has provided important benefits to both surgeons and patients. (4) However, in recent years, modularity has come under scrutiny due to failure of dual modular femoral components and corrosion at the modular neck-stem taper. (5)

Metal corrosion is a relevant problem in modular hip systems; this mechanism induces high levels of metal debris and metal ions in the body, which trigger allergic reactions and promote severe peri-articular adverse local tissue reaction as large inflammatory masses (pseudotumor), fluid collections and localized soft tissue necrosis. (6) Some modular hip implants consist of Cobalt-Chromium (Co-Cr) components. Several studies have documented a strong correlation between elevated serum Co and Cr concentrations and elevated Co and Cr concentrations in the joint aspirate of patients undergoing revision arthroplasty for failed Co-Cr hip implants. (7) In response to these concerns, recommendations for monitoring patients with Metal-on-Metal (MoM) prostheses were published. (8; 9). Follow up should consist of a history, clinical examination, functional scoring, blood metal ions measurement and X-ray; in case of clinical/radiographic abnormality, additional imaging (ultrasound, CT-scan and/or MARS-MRI) would be indicated. (8; 9; 10)

Imaging techniques are applied to determine structure and function of implants, peri-articular tissues and/or internal organs, which may be affected by metal products. The first mainstay of imaging evaluation is an appropriately performed conventional radiograph (antero-posterior pelvic radiograph and lateral view) to obtain information on the implant (e.g. type of the implant, bony fixation, position, potential wear) and the quality of peri-articular bone (e.g. lucency, osteolysis, osteoporosis) on the femoral as well as acetabular side. Several investigators have shown that ultrasound is capable of detecting pseudotumours associated with MoM implants. Computed tomography (CT) can detect and quantify peri-prosthetic osteolytic lesions, delineate solid or cystic masses adjacent to
a MoM THA and allow more accurate assessment of component alignment; metal artifact reduction softwares are capable of improving visibility of the capsule. Magnetic resonance imaging (MRI) is the current gold standard for the identification and detailed description of soft tissue abnormalities in MoM implants, however, special MRI techniques are necessary to reduce metal artifacts. (11; 12; 13; 14; 15)

Purpose

Modular-neck total hip arthroplasty (MN-THA) has been associated with an increased rate of post-operative complications. We aimed to assess imaging findings of complicated MN-THA.
Methods and materials

We retrospectively analyzed clinical history and imaging exams of 70 consecutive patients (51 women and 19 men) who received a dual modular total hip system in the period November 2008 - May 2012. All the prostheses were of cementless hydroxyapatite (HA) coated design, with acetabular and stem components made of titanium and an exchangeable Co-Cr neck.

Patients were reviewed every year during the post-operative follow-up (until July 2017). At each follow-up visit, patients were examined clinically and plain radiograph (antero-posterior and lateral view of the hip) and measurement of blood serum Co and Cr levels were obtained. In case of clinical/radiographic abnormality, additional ultrasound and/or Dual-Energy CT imaging were performed. CT acquisition parameters are shown in Table 1 (Table 1 on page 5).

One of three radiologists (15-years experience) reviewed radiographic (antero-posterior and lateral view of the hip) and CT examinations, recording all imaging abnormalities suspicious for complications. We then calculated the prevalence of imaging findings and association with increased serum Co and Cr ion levels (>2 µg/L, chi-square test).
**Table 1**: Protocol for Dual-Energy CT scan of the pelvis in our Institution, with a 64-slice multidetector CT scanner (single source rapid kV switching system).

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Results

The mean duration of follow-up for all patients was 66.7 months (range 27 - 104 months). Patients underwent a total of 265 radiographic examinations (mean 3.8, median 4), with CT ordered as a further test in 7 cases.

Revision arthroplasty was performed in fifteen patients because of infection (5 cases, 33.3%), painful prosthesis (4 cases, 26.7%), mobilization (3 cases, 20%) and elevated serum ion levels (3 cases, 20%). Age, mean duration of follow-up and causes of revision are shown in Table 2 (Table 2 on page 7).

Among imaging findings, erosion was the most frequent one on both plain radiography (2.9%) (Fig. 1 on page 7) and CT (1.4%) (Fig. 2 on page 8), with no significant (p=0.624) association with serum ion levels, which were increased in 10/15 patients. One patient developed an arthro-cutaneous fistula, pre-operatively evaluated by ultrasound (Fig. 3 on page 9).
Table 2: Age, mean duration of follow-up and causes of revision.

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Fig. 1: Osteolysis in a 73-year-old female patient. X-ray images on antero-posterior (A) and lateral (B) view of the hip show antero-lateral calcar erosion (arrows), arising from a local inflammatory reaction.

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Fig. 2: Focal erosion in a 70-year-old female patient. X-ray image on antero-posterior view (A) of the hip shows focal calcar erosion (arrowhead) between medial acetabular rim and ischiopubic ramus, arising from a local inflammatory reaction. Pre-operative CT image on the axial plane (B) shows the magnitude of osteolysis; CT image reformatted on the coronal plane (C) better depicts this finding (arrows).

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Fig. 3: Pre-operative evaluation of arthro-cutaneous fistula by ultrasound in a 76-year-old female patient. US image (A), obtained with a convex probe, represents, subcutaneously, a non-homogeneous hypoechogenic periarticular collection (star) that continues with the fistular tract (arrow). X-ray image on antero-posterior view (B) of the hip is negative for erosion.

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Conclusion

Erosion is the only imaging sign associated with complicated MN-THA, showing low prevalence. Imaging is an unreliable diagnostic modality in patients with such a frequent disease; however, imaging remains an important component in the pre-operative assessment of patients before revision arthroplasty.


