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CASE REPORT

Fracture of the femoral alignment stem of a hip resurfacing arthroplasty A case report

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Metal-on-metal hip resurfacing arthroplasty has become increasingly popular for the treatment of osteoarthritis in a younger patient population. While the initial complication of femoral neck fracture is being addressed, we describe a fracture of the femoral alignment stem in a component two years from the primary procedure.

Keywords : hip resurfacing ; stem fracture.

INTRODUCTION

Contemporary hip resurfacing arthroplasty (HRA) has emerged as an attractive option for the treatment of symptomatic hip osteoarthritis in young patients. Its proponents highlight the restoration of anatomy and biomechanics with preservation of the proximal femoral bone stock and reduced local stress shielding (*10,11*). However, there are continuing concerns regarding complications of HRA that include femoral neck fracture (*8*), avascular necrosis (AVN) (*12*) and production of metal-on-metal wear debris (*7,11*). These may cause systemic complications and local tissue reactions.

Several implant manufacturers have a design of HRA on the marketplace, from which there is only one previous report of a metal-on-metal resurfacing implant fracturing the femoral alignment stem in a Cormet (Corin Medical Ltd., Cirencester, U.K.). This is the first report of a femoral alignment stem fracture of the ReCap HRA (Biomet, Warsaw, IN, USA) which has a shorter and fluted stem compared to other HRAs, in a patient with a diagnosis of osteoarthritis two years from primary surgery, without gross evidence of AVN at revision surgery.

CASE REPORT

A 58-year-old medically fit male with bilateral hip osteoarthritis underwent staged HRA starting with the right hip. This was performed under spinal anaesthesia in the lateral position using the standard posterior approach. The acetabulum was reamed to 60 mm and a 62 mm cup was inserted with a press fit. The femoral head was reamed with no evidence of any cystic lesion or notching of the femoral neck. A 56 mm femoral head was cemented while the stem remained uncemented. The patient made an uneventful recovery and at 6 months was asymptomatic with a complete range of movement and so proceeded to HRA on the left. The post-operative course again was unremarkable (Fig. 1a).

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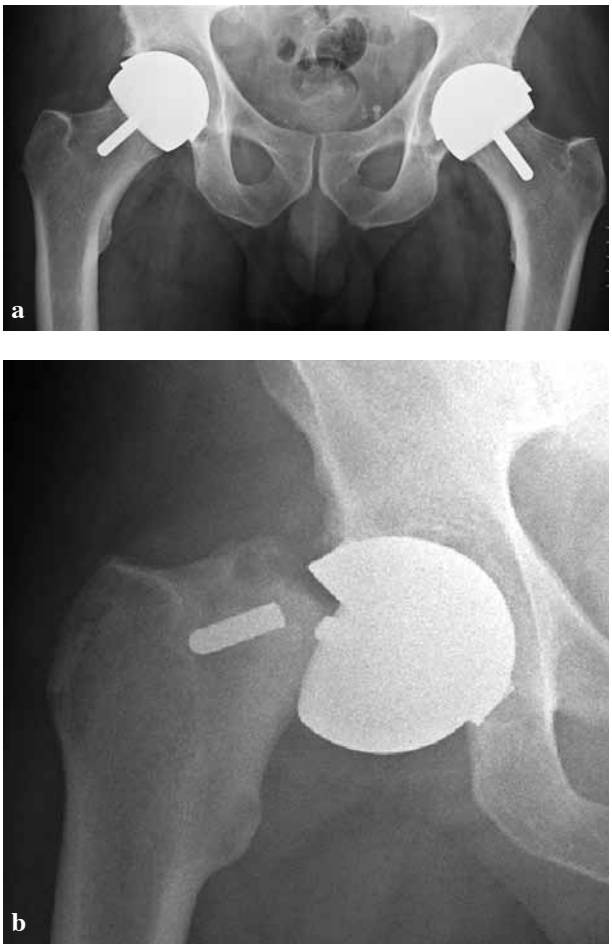

Fig. 1. — a) AP Pelvis radiograph. Demonstrating femoral stem in neutral alignment (lateral view not shown also confirms neutral alignment), b) Radiograph of femoral alignment stem fracture.

Twenty four months after the right HRA, the patient described a twisting episode with acute onset of groin pain and an inability to bear weight. Plain radiographs confirmed a fracture of the right femoral neck and stem of the femoral resurfacing component (Fig. 1b). The patient denied any hip/groin pain prior to this or of any precipitating traumatic event.

He underwent revision arthroplasty by the original surgeon (VBS) seven days later. Intra-operatively, no gross cysts or macroscopic signs of avascular necrosis were visible at the fracture site ; there was no evidence of infection ; all cultures and tissue samples sent for microbiology were negative. It was noted intra-operatively that the fracture extended beneath the superior rim of the femoral component. The distal femoral stem was well fixed within the femoral neck and was centrally located ; it could be removed only after the femoral neck cut. The femoral resurfacing component was replaced with a Biometric (Biomet, Warsaw, USA) uncemented femoral stem and a Magnum 56 mm metal femoral head. The patient made a complete recovery and at the two year follow-up remains asymptomatic with a full range of movement.

The retrieved femoral component was analysed by the manufacturer who confirmed the component met the specifications of manufacture with no defects of the material. Analysis of the fracture surface further suggested that the stem failed under fatigue loading with evidence of progression 'beach' marks inferring crack initiation from a flute on the stem, indicating cyclic bending forces from a more rigidly fixed distal stem compared to the rest of the stem and femoral head (Fig. 2a-c).

DISCUSSION

Current design and surgical technique of hip resurfacing have decreased the frequency of revision surgery. However, femoral neck fracture still occurs with a reported incidence between 0% and 4%, and occurs on average between 6 weeks if the femoral neck is notched (*7*) to 16 months from other stress risers (*8*). These stress risers may play a role in the occurrence of femoral alignment stem fractures when the distal stem is well fixed.

The cause of such fractures is multi-factorial. One variable is patient selection. Older females with high body mass index are at a greater risk of fracture (*8*) perhaps representing a group with lower bone mineral density and/or difficult surgical exposure (*2*). From the technical perspective, an increased incidence has been described for surgeons in the early stage of the learning curve for this demanding procedure (*8*). This incorporates the avoidance of notching of the femoral neck (*2,4,7*), or leaving reamed femoral bone uncovered to act as a stress riser where histologically such fractures occur (*4,7,8*). In this case, the senior author had

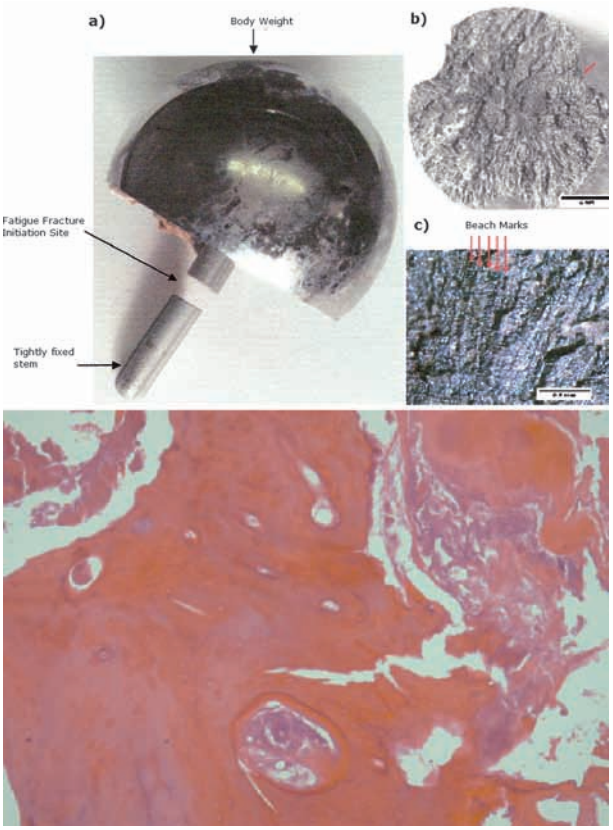

Fig. 2. — a) Possible forces causing fatigue failure of femoral stem, stereomicroscope composite images with b) inferred crack initiation point (red arrow), and c) close up image of beach marks (red arrows), d) histological view of subcapital bone fragments.

performed over 100 procedures and so overcoming the reported learning curve.

When positioning the femoral component, the alignment stem should be at a minimum neutral to the original neck-shaft angle, but it is desirable to achieve 5-10° of valgus. This can increase femoral neck load tolerance by 28% for bone with normal bone mineral density (*2,9*), by reducing the peak maximum principal stress in the cement by approximately two-thirds (*7*). The components should also be fully seated to prevent circumferential stress risers (*4,8*). Upon analysis of the neck-shaft angle from pre and post-operative radiographs in this case, the alignment stem was placed in neutral position in the anteroposterior and lateral plane and was fully seated.

A complication unique to hip resurfacing hip arthroplasty is avascular necrosis (AVN) which may have an increased incidence with the use of the posterior approach (*12*). AVN of the entire femoral head can lead to femoral neck fracture or, if localized to the superolateral corner, produce initial component loosening (*5*). Alternatively, loosening of the femoral implant may occur as a consequence of bone resorption, from the reduction of femoral loading by one-third which increases for bonded implants (*7*). This lower bone density underneath the resurfacing cup and subsequent loosening then results in bone hypertrophy around the alignment stem. This has been corroborated with finite element analysis demonstrating stress shielding in the anterosuperior region of the femoral neck directly beneath the prosthesis and stress concentration around the peg in the inferior cross-section of the femoral neck at midstance (*13*). The alignment stem was not designed for load transfer (*5*), although it has been demonstrated to resist nine times body weight and fatigue testing showed no failure after 5 million cycles (*3*) with peak maximum principal stresses in the implant stem well below the fatigue limit of cobalt-chromium (*7*). To address this potential loading of the femoral stem it has been suggested that cementation of the femoral stem reduces the incidence of aseptic femoral lucency in patients with femoral components less than 48 mm in diameter. However, this benefit is not present for femoral components larger than 48 mm and does not translate into a decrease in femoral neck fractures (*1*).

The histological analysis of the bone tissue is complicated by the delay to revision surgery, such that bone could appear degenerate from either fracture or AVN (Fig. 2b). However, the lack of reparative fibrous and granulation tissue and loss of osteocyte nuclei from lacunae in cancellous bone and formation of appositional new bone may suggest that AVN was not the primary diagnosis and may represent bone resorption (*5*). Nevertheless, a gradual process of load transfer to the alignment stem induced local bone changes around the distal stem fragment for it to become well fixed distally without cement.

The only other case report in the literature of a metal-on-metal resurfacing femoral alignment stem

fracturing is in a Cormet resurfacing hip (Corin Medical Ltd., Cirencester, United Kingdom) in a 69-year-old male with a history of ankylosing spondylitis. This stem fractured 3 years following surgery with no macroscopic evidence of avascular necrosis but it was postulated that AVN had led to stem fatigue (*3*).

Our case describes the first report of a fracture of the femoral alignment stem in a ReCap (Biomet Inc.), neutrally aligned femoral component two years from the initial procedure. This may represent an argument to improve the load tolerance of the alignment stem and possibly removing flutes to support the femoral component while bone adaptation occurs possibly preventing a delayed femoral neck fracture. This complication may increase in frequency as the use of the technique expands.

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