

Rapid progression of a severe femoral bone loss in a stable revision hip prosthesis: causes and management

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ABSTRACT

We report a case of a severe bone loss of the proximal femur with a rapid progression, in a 72-year-old male patient with a stable total revision hip prosthesis. The patient had a persistent mechanical thigh pain. The blood laboratory values were normal. Infection disease and osteolytic bone tumor were excluded.

A surgical procedure was performed. The native bone of the proximal femur was resorbed and replaced by a dense fibrous tissue with some sclerotic bone fragments. A large amount of a brownish fluid and a red-brown and friable tissue were found in the pseudo-joint cavity. The proximal femur was reconstructed using a large amount of cryopreserved cancellous bone allograft, with retention of the femoral prosthesis.

The mechanism of the bone lesion can be related not only to the host response to the wear particles, but mainly to the fluid pressure in the effective joint space.

Femoral progressive osteolysis in a stable hip prosthesis is an indication for surgery in useful time, before adverse bone remodeling can begin and lead to major bone loss.

Keywords: Severe femoral bone loss; Osteolysis; Revision hip prosthesis.

INTRODUCTION

Bone loss has been reported in association with either loose or well-fixed total hip prostheses. Although in-

creased fluid pressure and implant motion may play a role, the final pathway seems to be related to the host response to the wear particles generated by the different friction systems of the prostheses: polyethylene-on-metal, metal-on-metal, polyethylene-on-ceramic, and ceramic-on-ceramic bearing surfaces^{1,2,3}.

The cellular response to particulate debris, a foreign body reaction, can produce periprosthetic osteolysis that leads to bone loss and consequently to aseptic loosening of the hip prostheses. Polyethylene particles seem to be the major culprit^{1,3}.

Aseptic loosening remains a dominant cause for implant failure requiring revision. Revision hip surgery with extensive bone loss is never an easy prospect for the patient or surgeon. It is technically challenging, involves higher costs, and often lower success rates.

Particles of polyethylene and other debris are dispersed through the joint fluid. Fluid flows according to pressure gradients, and any area of bone accessed by joint fluid is a potential site for deposition of wear debris. Schmalzried, Jasty and Harris described "the effective joint space" where debris and fluids migrate around the components of the prostheses and cause bone lysis out of the joint space. This concept explains the development of osteolysis at the tip of a well-fixed femoral component, or over the dome of an acetabular component with holes in the metal backing^{2,3}.

Pelvic and femoral osteolysis are generally progressive processes of particle-induced bone loss. The pattern of lysis depends on the implant design. Many patients with osteolytic lesions remain asymptomatic until catastrophic failure occurs from dislocation or periprosthetic fracture. Once the osteolysis is detected, more frequent follow-up is advisable. Radiographs should be made at 3- to 6-month intervals rather than yearly^{4,5,6}.

The purpose of this paper is to report an unusual case of a patient with a stable total revision hip pros-

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thesis who had a rapid and severe bone resorption of the proximal femur, like an osteolytic bone tumor. We suggest a possible explanation for the development of the impressive bone loss and we describe the surgical technique used for femur reconstruction.

CASE REPORT

A 72-year-old man was submitted in January 2006 to a total revision hip arthroplasty in the right side due to aseptic loosening of a primary cementless prosthesis CLS®, with 11-years follow-up. The aetiology of the primary prosthesis was a degenerative arthritis of the hip. In the revision surgery, an acetabular metallic support ring with a cemented polyethylene cup and a revision conical stem were implanted. The pelvic and femoral bone loss were reconstructed with morselized cancellous bone allograft (Fig. 1a). No complications were reported in the first three years of the postoperative course.

A dislocation of the revision prosthesis occurred in May 2009 by indirect traumatism. The dislocation was reduced under general anesthesia and signs of osteolysis in the proximal femur were detected. The patient

returned to his normal activity after 15 days.

In August 2010 the radiographic studies showed an aggravation of the femoral osteolysis in the stage II, according to the HUC Classification System⁶. Nevertheless the femoral stem was stable by the excellent fixation of the distal part and the acetabular component remained well-fixed (Fig. 1b). The patient had a thigh pain, that was aggravated by weight-bearing and relieved by analgesics (metamizole) and resting. The patient walked with support aids, two forearm crutches, and was medicated with warfarin to control atrial fibrillation.

Due to the constant mechanical pain and weakness, he visited our Department five months later. Plain radiographs revealed a severe expansive osteolytic lesion of the proximal femur. The bone was almost entirely resorbed (Fig. 2) and a surgical intervention was performed. The blood laboratory values were normal.

The hip was exposed through a standard posterior approach. The proximal femur bone was replaced by a pseudojoint cavity composed by a dense fibrous tissue with some sclerotic bone fragments. A capsular distension was detected. When the pseudojoint cavity was incised, a large amount of a brownish fluid (400 cc) escaped under great pressure (Fig. 3).

The inner surfaces of the pseudojoint cavity and the

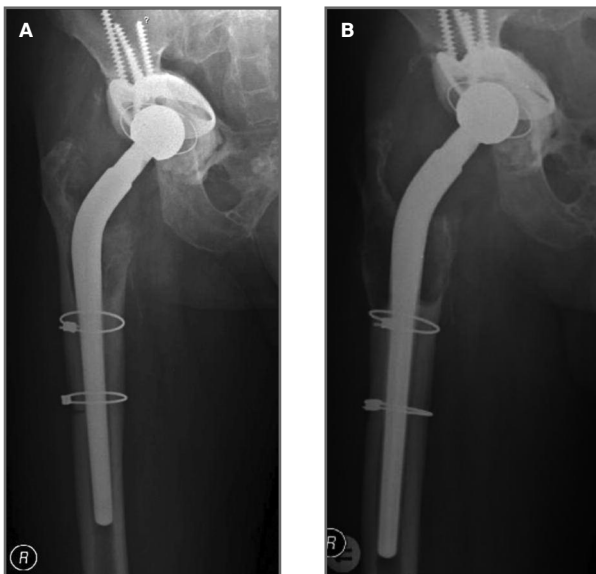


FIGURE 1. Periprosthetic osteolysis. a) Radiograph of a revision hip prosthesis at 1-year follow-up. The prosthesis was stable with absence of periprosthetic osteolysis. b) At 4-years follow-up the radiograph revealed moderate proximal femoral osteolysis, stage II according to the HUC Classification System



FIGURE 2. Five months later, painful and severe expansive osteolytic lesion of the proximal femur. The bone was almost entirely resorbed. The acetabular and femoral components remained mechanically stable

joint space were cleaned of a red-brown, uniform and friable tissue. At macroscopic examination it seemed like a chronic connective granulation tissue possibly derived from hematoma resorption, with no evidence of acute inflammation. The histopathologic examination of the specimens revealed fibrous and necrotic material, including some segments of granulation tissue with an exuberant angiomatous component.

The proximal femur was reconstructed using a large amount of cryopreserved cancellous bone allograft (300 cc) from HUC Tissue Bank, with retention of the femoral prosthesis. The morselized bone was impacted to fill the space of the pseudojoint cavity around the femoral implant (Figs. 4a and 4b).

Final culture results of fluid and soft-tissue specimens obtained at the time of surgery were negative for infection.

No complications were reported in the postoperative course. Immediately after surgery, the patient was mobilized with protected weight-bearing. Three weeks after surgery, the mechanical tight pain disappeared. At 7-months follow-up, the patient was clinically able to walk without external support; had a Trendelenburg sign and reported no groin or thigh pain. He was very pleased with the surgery result.

DISCUSSION

The current clinical case illustrates a rare example of an extensive and aggressive osteolysis of the proximal femur. Investigations have indicated that the cellular response to wear particles is central to the develop-

ment of osteolysis in total hip arthroplasties. Mechanical factors were also responsible for osteolysis. Whether the initiating factor is biologic or mechanical is a subject of debate^{2,3}.

In the current case, four years after the revision hip surgery plain radiographs showed a moderate osteolysis of the proximal femur. The primary factor in this instance seems to have been the biological reaction to the wear particles of polyethylene, cement and metal, either alone or in concert.

However, an unusual progression of the lytic bone loss was detected during a short period of five months that led to the femoral bone resorption. In this situation, it is vital to exclude the presence of infection or bone tumor, because periprosthetic osteolysis is usually a progressive and slow process that also leads to a progressive bone stock loss.

Infection must be suspected whenever resorption of bone is considerable, the endosteal surface of the bone is scalloped, periosteal elevation is present, and the erythrocyte sedimentation rate or C-reactive protein level are high. The clinical and laboratory studies eliminated an infection process in this clinical case, and the final culture results of fluid and soft-tissue specimens obtained at the time of surgery were negative for infection.

Although the incidence of malignant tumors in patients undergoing total hip arthroplasties is known to be lower than in the general population, there are several reports on the development of malignant tumors at

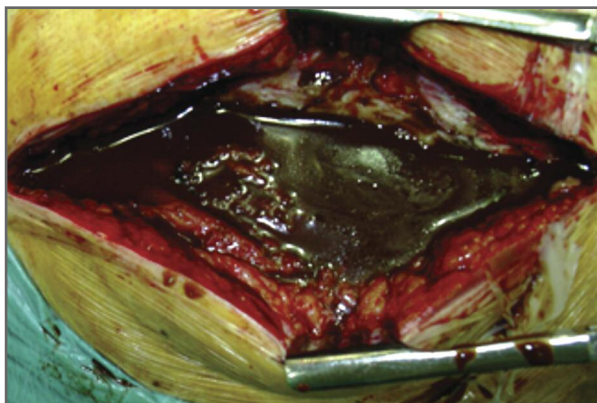


FIGURE 3. Intraoperative photograph showing a large amount of a brownish fluid under great pressure (400 cc) in the pseudojoint cavity and in the joint space

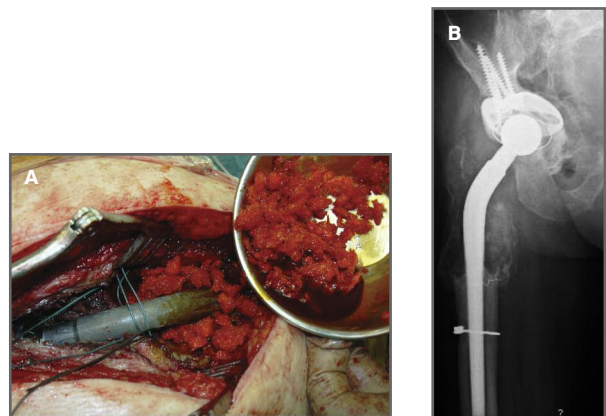


FIGURE 4. Management of the expansive bone loss. a) The proximal femur was reconstructed using cryopreserved cancellous bone allograft (HUC Tissue Bank), the prosthesis was not replaced b) Radiograph at 7 months of the postoperative period showing the process of the allograft bone incorporation

the site of total hip arthroplasties. Malignant fibrous histiocytoma at the site of an endoprosthesis of the hip constitutes a distinct rarity, and has been attributed to the implants or to their alloy constituents⁷. The histopathologic examination of the specimen from the surgical operation revealed fibrous and necrotic material and the absence of malignant lesions.

A mechanical instability of the femoral component may originate expansive bone loss⁸, nevertheless we can also eliminate this mechanism because in the current case the stem was stable.

We believe that the continued expansion of the osteolysis during a short time of five months can be mainly secondary to an intense fluid pressure, supported by a failure of venous and lymphatic drainage. In fact, a large volume of articular fluid under a high pressure was found in the pseudojoint cavity and in the joint space at the time of surgery. No granulomatous membranes suggestive of a biological reaction to wear particles were detected in periprosthetic tissues. Osteolysis can also occur in the absence of wear particles by fluid pressure in the effective joint space⁹.

Van der Vis and Aspenberg showed that fluctuating pressure applied to bone can result in the death of osteocytes near the implant and subsequent bone resorption. Thus, there is evidence that fluid pressure and ensuing flow could be a main cause of not only pain, but also osteolysis^{10,11}. It is also true that bone erosion by aneurisms can be caused by constant mechanical pressure, analogous to what happens between periprosthetic osteolytic lesions and arthrosis cysts.

The exact pathogenesis of the granulation tissue with exuberant angiomatous component present in the pseudojoint cavity and in the joint space is unclear. One hypothesis is the possibility that a hemorrhagic process may have contributed to its origin and also to the fluid pressure. This may be related to the fact that the patient was under oral anticoagulant therapy (warfarin) to control atrial fibrillation, and he had also described a constant and mechanical thigh pain during the preoperative time.

Severe bone loss of the proximal femur secondary to major osteolysis is a difficult situation to deal with, offering no ideal treatment option. The possible options include the implantation of a composite allograft/stem prosthesis, a modular type megaprosthesis, a custom-made megaprosthesis, the use of massive or cortical strut bone allografts, and impaction cancellous bone allografting^{12, 13, 14, 15, 16}.

In the current case the replacement of the femoral re-

vision prosthesis by a new femoral implant was not an acceptable option, because the stem was mechanically stable.

The proximal femur reconstruction with bone allografting seemed preferable because it is an attractive technique since it restores the bone stock around the implant^{17,18}, and it can be done without surgical dislocation of the stem. We used cancellous bone allografts. The morselized bone was impacted and filled the space between the femoral stem and the inner surfaces of the pseudojoint cavity.

Cryopreserved cancellous bone allografts showed clinical efficacy for the reconstruction of bone defects¹⁹. The validity of the impaction allografting technique has been demonstrated previously by histological and mechanical criteria. Histologically, grafted bone chips were shown to be replaced by host bone in human retrieval studies and animal experiments²¹.

Femoral progressive osteolysis in a stable hip prosthesis even in the absence of symptoms is clear indication for surgery, before adverse bone remodeling may begin and lead to major bone loss. If allowed to progress, femoral reconstruction becomes more complex or impossible.

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