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Original research

Proximal tibial resorption in a modern total knee prosthesis

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ABSTRACT

Background: In an effort to minimize backside polyethylene wear and osteolysis associated with titanium tibial baseplates, many manufacturers have transitioned to cobalt chromium alloys. Recent literature has implicated thicker cobalt chromium designs as a potential source of increased stress shielding and resorption. We report the incidence of proximal tibial bone resorption in a large consecutive series of patients undergoing total knee arthroplasty, with a modern total knee design.

Methods: Four hundred thirty-two consecutive primary total knee arthroplasties, performed by 2 fellowship-trained arthroplasty surgeons were identified over a 24-month period. In addition to review of the medical records, analysis of preoperative and postoperative radiographs was performed. Utilizing a novel classification system, the severity of resorption was quantified and correlated with patient and implant characteristics.

Results: After exclusions, 339 knees were evaluated in 292 patients. Mean follow-up was 13.2 months (range 6-41). Resorption was present in 119 knees (35.1%). Average time to diagnosis of bone loss was 6.9 months (range 2-32) postoperatively. There was a statistically significant difference between resorption and nonresorption groups with regards to gender and preoperative alignment. Most cases were classified as Grade 1. During the study period, 2 patients required revision for aseptic tibial loosening.

Conclusions: Our findings suggest that proximal tibial resorption is common with this particular implant, particularly in men and patients with preoperative varus deformity. Although this typically occurs relatively early in postoperative period and in most cases appears to remodel and stabilize, its ultimate clinical significance and effect on implant survivorship remains unclear.

Introduction

Total knee arthroplasty (TKA) is a historically successful operation with excellent outcomes [1-3]. However, despite advances in modern implant manufacturing and design, issues with polyethylene (PE) wear still plague long-term survivorship [4,5]. Long-term PE particles can be associated with osteolysis, implant loosening, and fracture. In addition to the primary bearing surface, the articulation between the tibial baseplate and PE liner, or so-called "backside wear," has also been cited as a source of wear particles that induce osteolysis [6-8].

In an effort to address issues with backside wear in total knee implants, many manufacturers have transitioned from titanium baseplates to more scratch-resistant, highly polished cobalt chromium (CoCr) designs. However, with different metallurgy comes different mechanical properties. CoCr designs are inherently more rigid and are often thicker than their titanium counterparts. Stress shielding is a well-recognized phenomenon following TKA, with most previous studies using computed tomography or dual X-ray absorptiometry data to describe more subtle preferential loss of cancellous bone [9-11]. However, 2 recent studies have implicated these designs in more dramatic proximal tibial bone loss [12,13].

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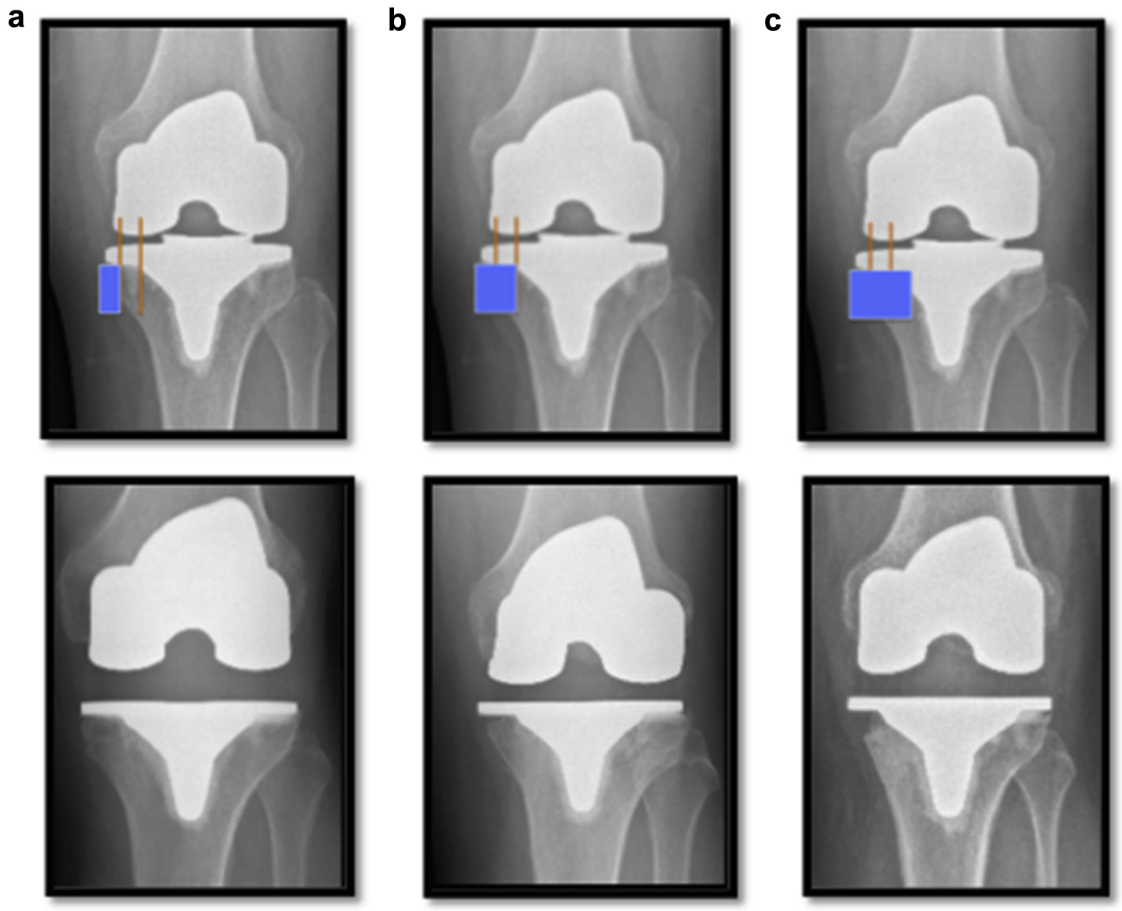

Figure 1. Classification system. (a) Grade 1: Resorption to the level of the baseplate (including any prior uncovered bone) up to 50% of the width of the tray. (b) Grade 2: Resorption beyond 50% but not to the keel. (c) Grade 3: Resorption to/beyond the level of the keel.

With anecdotal concerns from the senior authors, and recent questions about the effect of CoCr designs on proximal tibial bone loss, we sought to evaluate our institutional experience with a single modern total knee implant that utilizes CoCr tibial baseplate. Our primary goal is to calculate an overall incidence of proximal tibial bone loss, classify such bone loss in a way that could be easily reproducible, and identify any patient or implant characteristics that are associated with its occurrence. To our knowledge, this is the first large radiographic study to investigate the incidence of proximal tibial bone loss in a specific implant, and the first to attempt to classify its severity.

Material and methods

Following Institutional Review Board approval, the surgical cases of 2 experienced, fellowship-trained arthroplasty surgeons were reviewed from October 2013 to October 2015. Four hundred thirty-two consecutive primary TKAs were identified. Patients were then limited to those receiving a cemented DePuy Attune (Warsaw, IN) total knee prosthesis. This system utilizes a 4-mm thick cobalt-chromium-molybdenum alloy tibial baseplate with a rounded stem design. Those patients with fewer than 6 months of radiographic follow-up were excluded. Other exclusions included prior surgery altering the patient's lower extremity alignment (ie, high tibial osteotomy, open reduction internal fixation, etc.) and those with postoperative infection. Operative reports and clinical notes were then reviewed to obtain patient demographic data and body mass index (BMI), as well as implant sizes, bearing platform, complications, and/or reoperations.

Formal radiographic analysis was then performed. Per our institutional protocol, standing anteroposterior and lateral radiographs of the knee were obtained at the patients' preoperative visit, as well as their 6-week, 6-month, and 12-month postoperative visits. If there was additional follow-up, these radiographs were reviewed as well. All radiographs were identified and reviewed by a single observer independent of the surgeons. Quality of the anteroposterior image was considered acceptable if the posterior femoral condyles were not visible and there was approximately 45%-55% overlap between the lateral tibia and fibular head.

For each radiograph, lower extremity alignment was calculated by measuring the angle formed by the anatomic axes of the femur and tibia. Patients were then stratified into 3 groups: varus (any degree of varus alignment), neutral (0°-7° of valgus), and valgus (>7° of valgus). In addition, the anatomic lateral distal femoral angles and medial proximal tibial angles were calculated for each patient.

If present, proximal tibial bone loss was identified and quantified/classified based on a novel system as shown in Figure 1. Grade 1 resorption was defined as bone loss to the level of the baseplate (including any uncovered bone) up to 50% of the width of the tray. Grade 2 was defined as bone loss beyond 50% of the width of the tray, but not to the level of the keel. Grade 3 involved bone loss to/beyond the level of the keel. The point in time at which the bone loss was first identified was recorded, and if later