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Distal Fixation of Proximally Coated Tapered Stems May Predispose to a Failure of Osteointegration

H. John Cooper, MD, Anitha P. Jacob, PA-C, and José A. Rodriguez, MD

Abstract: Despite excellent long-term results of proximally coated tapered wedge femoral stems in noncemented total hip arthroplasty, we have consistently observed a minority fail to achieve osteointegration. We retrospectively reviewed 320 consecutive total hip arthroplasties performed by a single surgeon using a single stem over a 4-year period. Clinical and radiographic parameters were analyzed for risk factors predisposing to a failure of osteointegration, defined as a progressive circumferential radiolucency around the proximal porous coating on both anteroposterior and lateral radiographs. Fifteen stems (4.7%) failed to osteointegrate; 3 underwent femoral revision for persistent thigh pain, whereas the remainder expressed varying degrees of symptomatology. Risk factors associated with failure of osteointegration were male sex, a smaller canal-flare index, larger stem size, and greater canal fill at the mid- and distal-thirds of the stem. Awareness of variability in proximal femoral morphology and problems caused by distal fixation with a proximally coated implant may help avoid this uncommon but potentially serious complication. **Keywords:** distal fixation, femoral stem, noncemented, osteointegration, total hip arthroplasty.

Proximally coated tapered wedge femoral stems have demonstrated excellent long-term clinical results in noncemented total hip arthroplasty (THA), with numerous authors reporting survivorship ranging from 98% to 100% at 10-year follow-up [1-6]. Because of their clinical success and reproducible ease of implantation, these stems are commonly used for femoral fixation in primary hip arthroplasty in the United States and are increasingly replacing the use of cemented stems and other noncemented stem designs.

Despite the excellent long-term clinical results of these stems, we have consistently observed a minority of patients who fail to achieve osteointegration after implantation with this commonly-used stem design. To the best of our knowledge, this is an underreported phenomenon, as we are not aware of any prior studies describing this early complication with this type of stem design.

The aims of this study are threefold: (1) to report the incidence of this problem, (2) to describe its clinical sequelae, and (3) to identify potential risk factors which may predispose patients to this failure of osteointegration.

Materials and Methods

This study was designed as a retrospective consecutive cohort study. Institutional review board approval was obtained before review of any medical records. Eligible subjects included those who had undergone total hip arthroplasty performed by the senior author. The inclusion criteria were (1) elective surgery and (2) femoral fixation with a single proximally coated, tapered-wedge stem design. Patients were excluded from the analysis if (1) they had undergone a previous arthroplasty of the affected hip or (2) were undergoing THA for femoral neck fracture, as it was thought these patients might have abnormal bone quality different from a primary THA population. From March 2005 to July 2009, a total of 320 hips met these inclusion and exclusion criteria. The medical records of all patients were reviewed to collect basic demographic data. A total of 280 patients (40 underwent bilateral procedures) were included in the analysis. Of these 280, 120 were male (43%) and 160 were female (57%); mean age was 60.9 years old (range, 22-96 years old) and mean body mass index (BMI) was 29.2 kg/m^2 (range, 18.1-53.2).

All surgeries were performed using a standardized protocol throughout the preoperative, perioperative,

From the Department of Orthopaedic Surgery, Lenox Hill Hospital, New York, New York.
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Reprint requests: John Cooper, MD, Department of Orthopaedic Surgery, Lenox Hill Hospital, William Black Hall, 11th Floor, 130 East 77th Street, New York, NY 10075.

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and postoperative course. Precise preoperative templating was performed in every case using previously described and well-accepted techniques [7]. A posterior approach to the hip was used in 304 hips, whereas a direct anterior approach was used in 16 hips, reflecting a change in operative technique by the senior author toward the end of the study period. In either approach, femoral fixation was obtained using a hand-broached press-fit technique, which required no reaming. All patients were implanted with a single femoral implant design (Accolade TMZF stem; Stryker Orthopaedics, Mahwah, NJ). This stem is made from a titanium alloy and has a proximal circumferential plasma spray that features a 50-μm-thick hydroxyapatite (HA) coating (Purefix HA; Stryker Orthopaedics) and a distal matte finish; it is available in 13 sizes. Intraoperatively, stem stability was verified by the senior author. All patients were encouraged to ambulate and bear weight as tolerated starting on the first postoperative day.

Patients were evaluated clinically at 2 weeks, 6 weeks, 3 months, 1 year, and annually thereafter. At each clinical visit, detailed records were kept, including a history and physical examination, as well as a patient-based questionnaire which included a subjective assessment of pain. Anteroposterior (AP) and false-profile radiographs of the affected hip, as well as an AP radiograph of the pelvis, were taken at 6 weeks, 1 year, and annually thereafter. Additional clinical visits occurred and radiographs were performed whenever prompted by patient symptomatology.

Radiographs were reviewed by all authors for failure of osteointegration of the femoral component, which was defined as a progressive circumferential radiolucency around the proximal porous coating on both AP and false-profile radiographs of the hip, with absence of spot welds or other radiographic evidence of bony ingrowth (Fig. 1). Detailed radiographic analyses were then performed on all patients. Preoperative radiographs were used to analyze proximal femoral geometry using previously described radiographic parameters, including the morphologic cortical index (MCI) [8], the canal-bone ratio (CBR) [9], the canal-calcar ratio (CCR) [10], and the canal-flare index (CFI) [11]. These are each simple ratios that can be easily calculated from measurements made on an AP radiograph of the hip. Postoperative radiographs were used to assess the amount of canal fill of the smooth distal portion of the stem, defined as the width of the stem divided by the width of the canal, at both the middle-third and distal-third of the stem. All measurements were performed digitally using the ruler function on the Picture Archiving and Communication System at our institution (Synapse; Fujifilm Medical Systems, Stamford, CT).

Data were entered into a Microsoft Excel spreadsheet (Microsoft Corp, Seattle, WA) and transferred into a statistical software program for analysis. Clinical (age, sex, BMI), surgical (stem size, choice of approach), and radiographic (MCI, CBR, CCR, CFI, canal-fill at the mid- and distal-thirds) parameters were analyzed to assess for any risk factors that might predispose to a failure of osteointegration. Continuous variables were analyzed with use of unpaired *t* tests to compare means and standard deviations, whereas categorical variables were assessed with Fisher exact test. To determine the most important predictors of a failure of osteointegration, a stepwise multiple linear regression analysis of significant

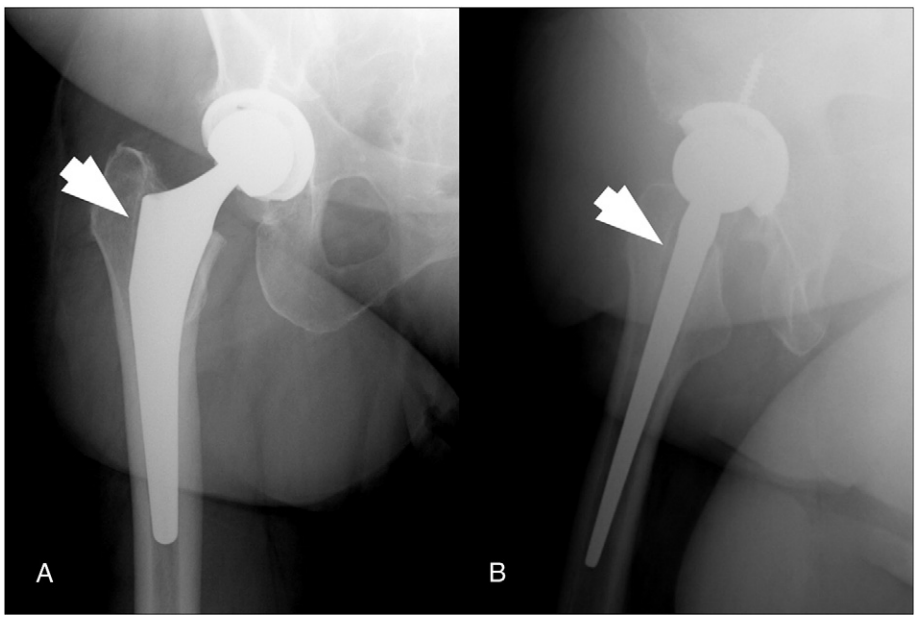

Fig. 1. (A) Anteroposterior and (B) false-profile radiographs of a right hip demonstrating a radiolucency around the proximal femoral stem, suggestive of a failure of osteointegration of the surrounding metaphyseal bone into the porous surface. These radiographs were taken 3 months postoperatively in a 60-year-old woman complaining of thigh pain and a limp.