Catastrophic Femoral Neck Failure after THA with the Accolade® I Stem in Three Patients

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Abstract

Case Description We report a series of three femoral stem failures, each occurring at the head-neck junction, with all patients experiencing limited and painful ambulation, leading to subsequent revision arthroplasty. All patients were male with high-offset femoral stems and increased head lengths, and each had undergone primary

THA at a minimum of 7 years before presentation (average, 94 months). There were no associated deep infections or cases of aseptic loosening in the cohort.

Literature Review There is a paucity of similar reports in the literature regarding femoral stem failure at the head-neck junction. When failures of titanium stems have been reported, failure has been attributed to material design and geometry, laser etching, overload, implant alignment, and patient characteristics.

Purpose and Clinical Relevance Catastrophic failures of femoral stems at the head-neck junction are a rare cause for revision after THA. Component material and design, surgical technique, and patient factors may contribute.

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Each author certifies that his or her institution approved the reporting of this case report, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Introduction

Catastrophic failures of surgical implants are an infrequent cause for revision after THA. More commonly, instability, dislocation, aseptic loosening, and infection have been cited as reasons for failure after THA [3]. Unlike other causes of dissatisfaction after hip replacement such as leg length discrepancy, trochanteric bursitis, and persistent limp, catastrophic failure of implants almost universally

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results in revision surgery [6, 14]. Some authors have suggested that the incidence of catastrophic failure may be mitigated with appropriately designed implants and surgical techniques [13], however failures have been reported even with contemporary designs [1].

Fracture of the femoral prosthesis at the head-neck junction has been reported although infrequently [1, 2, 9], and some authors have attributed such instances to increased mechanical stresses, higher levels of activity, and cyclic loading [4, 5, 7, 19]. Although the mechanisms of such fractures are likely to be multifactorial, the clinical presentation of these events often has less variation. Patients commonly present with limited and painful ambulation and difficulty standing for extended durations [7, 12]. We present the cases of three patients with femoral stem failures at the head-neck junction of the Accolade® I femoral stem (Stryker® Corporation, Kalamazoo MI, USA).

Case Reports

Between December 2010 and July 2013, three patients with femoral stem catastrophic failures were identified by the senior author (JY). Institutional review board approval was received for this study. Data were collected for patient age, sex, weight, BMI, comorbidities, side of catastrophic hip failure, time elapsed since index procedure, estimated blood loss at revision, intraoperative complications, need for transfusion, and minimum of 18 months followup after the revision procedure. The implants were evaluated for stem type, stem offset, femoral head size and diameter, femoral stem and head material, position of femoral component, and acetabular cup abduction angle.

Patient 1

A 55-year-old male presented 7 years (80 months) after THA with left hip pain and no antecedent trauma. He was at home ambulating when his hip suddenly gave way. On presentation, the patient required a walker to ambulate. He presented with normal neurologic and vascular status to the affected left extremity. Radiographs showed a fracture of the left femoral stem at the head-neck junction of the trunnion (Fig. 1). He underwent revision hip arthroplasty without complication, and removal of the implant showed a fracture of the femoral neck (Fig. 2). There was no evidence of loosening of the femoral stem or acetabular component. Deep cultures were negative for infection. One month after the revision surgery, the patient was able to walk with the assistance of a cane. His postoperative radiographs showed a stable revision implant without evidence of subsidence or fracture and he had improvement of

Fig. 1A–B Preoperative (A) AP and (B) lateral radiographs of the left hip show catastrophic failure of the left femoral stem at the trunnion and head-neck junction. A retained neck fragment in the femoral head can be seen.

pain which he reported as two on a scale of 10. He progressed as expected, and by 6 months he returned to his preoperative baseline level of function. At 28 months after surgery, he continued to ambulate without a cane or limp.

Patient 2

A 72-year-old male presented with 8 months of increasing right hip and groin pain after a right THA 10 years (120 months) before. He had tried physical therapy, ordered by his primary care physician, for relief of his pain and had been using a cane for ambulatory assistance. At presentation, his physical examination was remarkable for tenderness over the greater trochanter, Trendelenberg gait pattern, and limited ROM of the right hip. Radiographs showed evidence of

Fig. 2 Explant analysis of the failed femoral stem showed a fracture of the femoral neck.

failure at the head-neck junction with extensive heterotopic ossification of the right hip, and an acetabular cup abduction angle of 59° (Fig. 3). At the time of revision, the components showed catastrophic failure of the trunnion with varus deformity of the metal head on the trunnion causing local metallosis in and around the hip (Fig. 4). The acetabular and femoral components were revised without intraoperative complication, and postoperative radiographs showed revision of the femoral stem and substantial residual heterotopic bone. The acetabular component also was revised owing to the abduction position. By the 6-week followup, the patient showed improvement of VAS pain score from seven of 10 to one of 10. At 6 months followup, he continued to gain strength in the hip, and had pain-free motion with clear improvement from his preoperative status. He was using a cane. At 19 months after revision surgery, he had the ability to ambulate without the cane for short distances, but continued to prefer the cane for long distances outside the home. He had limited, but painless ROM of the right hip.

Patient 3

A 49-year-old male with a history of bilateral THAs 7 years earlier presented after feeling “something giving way” in his left hip and being unable to bear weight. He worked in construction. His physical examination showed normal muscle strength and tone, and neurovascular examination of his left lower extremity was normal. A radiograph showed evidence of a left prosthetic femoral neck fracture (Fig. 5). At the time of revision, the metallic

Fig. 3A–B Preoperative (A) AP and (B) lateral radiographs of the right hip show failure at the head-neck junction with extensive heterotopic ossification and an acetabular cup abduction angle of 59° .

femoral head, with retained trunnion, was removed readily without evidence of loosening of the acetabular or fractured femoral components from the bone. The failed stem subsequently was removed and revised. The patient progressed with physical therapy assistance and was discharged home. At 2 years after surgery, the patient was ambulating with minimal pain and reported being overall satisfied with the revision surgery of his hip.

Discussion

Catastrophic failure of implants after THA is an infrequent cause of revision in patients in the United States, with fracture of the femoral prosthesis at the head-neck junction

Fig. 4 The explanted failed femoral stem shows wear of the area of the trunnion and head-neck region.

Fig. 5 The patient's preoperative AP radiograph of the left hip shows catastrophic failure of the femoral stem at the trunnion and head-neck junction. There is a retained neck fragment in the femoral head.

rarely reported [1, 2, 4, 9, 10, 15]. Vatani et al. [16] conducted a survey of orthopaedic surgeons to determine the causes of prosthetic implant failures. They identified worn and fractured polyethylene components as the most common cause of failure, with femoral stem fractures being an infrequent cause, occurring in only 172 of more than 60,000 cases reviewed, for a rate of 0.27%. More commonly, instability, dislocation, aseptic loosening, and

infection have been cited as reasons for failure after THA [3]. In the current series, the senior author (JY) identified three patients with femoral stem failures during a 3-year period. All stems were the Accolade® I design. This prompted a comprehensive review of his practice, yielding only these three cases of stem failures. To our knowledge only one similar failure of this stem has been reported [1], and no failures have been reported with complete fracture of the neck of the prosthesis.

As there was no failure analysis of the retrieved components, no definitive conclusions could be drawn regarding the causes of femoral stem failures based on our study. Although the possibility of design or metallurgic flaws of the stem should be considered, we are unable to provide any information regarding this possibility. Ti-12Mo-6Zr-2Fe is a beta titanium alloy which currently is used only in the Accolade® I femoral stem. The purported benefits include 25% greater flexibility than conventional Ti-6Al-4V alloys, thus yielding a modulus of elasticity that more closely resembles that of bone, while maintaining 20% higher tensile strength than traditional Ti-6Al-4V alloys [17].

The mechanisms of catastrophic failure of hip implants after THA are multifactorial. White et al. [18] reported on factors predictive of catastrophic failure of THAs, which included implant loosening, distal potting of the femoral stem with cantilever bending, varus positioning, excessive body weight, metallurgic defects, and medial calcar bone resorption. Failure of the femoral component at the neck has been attributed to mechanical (including fatigue) and material properties of the implant, corrosion, and increased neck lengths [3, 8, 11, 16]. In our series of three stem fractures, the Ti-12Mo-6Zr-2Fe titanium alloy Accolade® I femoral stem was used with a cobalt-chromium alloy femoral head. All patients were male and each had their components in for a minimum of 7 years before symptoms. As such, these can be considered to be failures that may have been partly attributable to fatigue loading, perhaps accelerated by corrosion at the head-neck junction. Other design features such as neck and taper geometry may have contributed to reducing the fatigue life of the components. Two of the three stems failed after stem fracture. None of the patients showed evidence of deep infection by routine blood work, intraoperative examination, or deep cultures. All failed THAs had a 127°, high-offset femoral stem, with increased neck length of 8 to 10 mm, and a skirted, cobalt chromium femoral head (Table 1). Two of the three stems were positioned in 6° varus, and all three patients weighed more than 200 pounds (Table 2), potentially adding higher peak mechanical stress and loading and more fatigue cycles to the femoral components than may be experienced in smaller patients.

Clinical presentations of our cohort showed painful ambulation, leg length discrepancy with the operative side being shorter, and difficulty standing for substantial

Table 1. Characteristics of failed femoral stems

Variable	Patient 1	Patient 2	Patient 3
Femoral stem offset	High ⁺	High	High
Femoral head diameter	36 mm	32 mm	36 mm
Femoral head length	+10 mm	+8 mm	+10 mm
Skirted head	Yes	Yes	Yes
Acetabular cup abduction angle	59°*	39°	33°
Femoral stem alignment	Distally wedged stem; limited proximal metaphyseal filling	6° varus	6° varus

⁺ High-offset stem = 127° neck-shaft angle; *acetabular component revised owing to unacceptable positioning.

Table 2. Patient demographics

Demographic	Patient 1	Patient 2	Patient 3
Age (years)	72	55	49
Sex	Male	Male	Male
BMI (pounds/inches ²)	26	31	28.8
Comorbidities	Coronary artery disease, hypertension, hyperlipidemia, asthma, sarcoidosis	Hyperlipidemia, obesity, pulmonary nodule	Tobacco use
Failed side	Right	Left	Left
Time to failure (months)	120	80	83

durations, consistent with previous reports [7, 12]. All patients presented with groin pain, painful ambulation, and two of the three patients required an assistive device for ambulation. To our knowledge, our study is the first report of complete neck fracture of the Accolade® I femoral stem, and the largest series of failures of this stem. We recommend future studies directed toward mechanical analysis to better understand and remedy underlying causes as appropriate.

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