Ceramic-on-Ceramic Failure Secondary to Head–Neck Taper Mismatch

Donald W. Hohman, MD, Jesse Affonso, MD, and Mark Anders, MD

Abstract

We report a case of catastrophic failure of ceramic-on-ceramic total hip arthroplasty without precipitating event or trauma. The patient was a 64-year-old woman who had degenerative osteoarthritis and underwent the index primary total hip arthroplasty 3 years earlier. Intraoperative findings included an intact ceramic femoral head, a slightly damaged ceramic liner insert, diffuse metallosis, and excessive wear of the trunnion of the stem. After removal of the metallic debris, excision of metalloid tissue, and copious lavage of the joint, the prosthesis was revised to a modular revision system. Although previous operative reports had been reviewed before surgery, there was no indication of a head–neck taper mismatch. Only after revision surgery was performed, and high suspicion arose, were previous implant records analyzed and the mismatch identified.

In January 2005, a 64-year-old woman (weight, 154 lb) underwent uncemented right total hip arthroplasty (THA) for degenerative osteoarthritis. Components used were Trident PSL Acetabular Shell/52E, Trident 0° Alumina Insert/32E, Accolade TMZF Plus Hip Stem, and Alumina C-Taper Head 3200E (all manufactured by Stryker Howmedica, Kalamazoo, Michigan). The operation was performed without complication at an outside institution. There were no reported perioperative complications, and the patient reported doing well during the initial postoperative period. At 6- and 12-month evaluations, she had no pain symptoms and hip motion was excellent (Figure 1).

In December 2008, the patient was evaluated at our institution for right groin pain and crepitus with no history of trauma. Radiographs showed signs of implant failure (Figures 2A, 2B).

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Given the patient's clinical presentation and the radiographic signs of hardware failure, revision surgery was performed. Intraoperative findings included diffuse metallosis, a pseudocapsule containing black metalloid fluid, excessive wear of the trunnion, and no appreciable wear of ceramic head and liner (Figures 3A, 3B). The uncemented stem and the acetabular component were stable. The THA was revised to a modular prosthesis with a bearing surface of metal on highly cross-linked polyethylene. Review of the operative reports revealed that, during the initial component selection, an alumina head of incorrect size was chosen. An alumina V40 head would have been the appropriate match for the implanted stem and trunnion.

The patient provided written informed consent for print and electronic publication of this case report.

Discussion

According to recent studies, contemporary alumina-on-alumina hip arthroplasties performed with a metal-backed socket and a cementless stem are associated with excellent clinical results and implant stability.[1] Potential

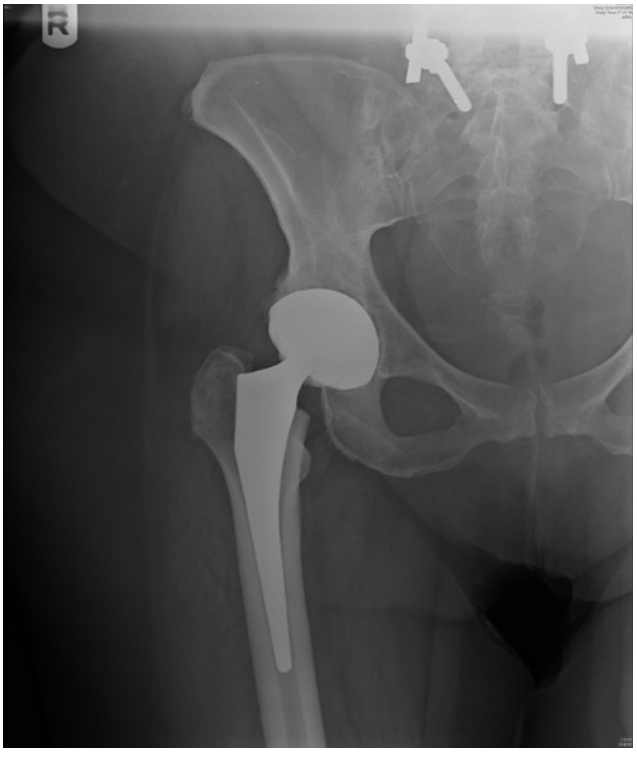


Figure 1. Radiograph 12 months after index procedure shows no obvious implant malpositioning or signs of failure.

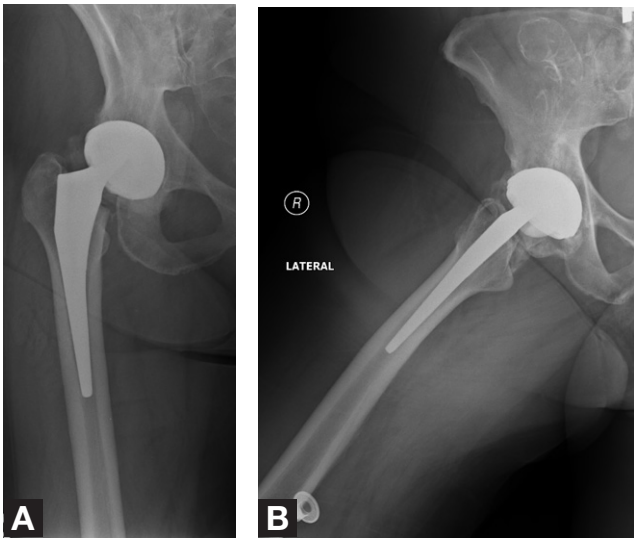
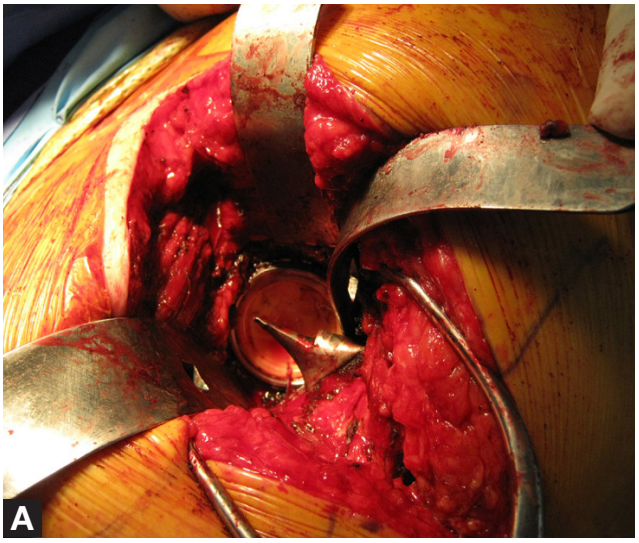


Figure 2. Anteroposterior (A) and lateral (B) radiographs completed approximately 36 months following the index procedure demonstrating signs of implant failure.

complications of using such prosthetic designs include ceramic fractures and third-body wear. Management of ceramic implant fractures, which are more common than mismatched components, has received considerably more attention by authors, but remains controversial.[2,3]

The potential for component mismatch was addressed in a 2003 survey by the New Zealand Orthopaedic Association.[4] Of 148 questionnaires sent out, 120 were returned (response rate, 81%). Twenty-eight surgeons (23%) had implanted mismatched components within the preceding 5 years. Of the 30 mismatches reported by the 28 surgeons, 20 involved THA, 6 involved knee arthroplasty, and 4 involved other surgeries. The mismatches were discovered before wound closure (in 39% of cases), during admission (51%), or after discharge (10%). They led to another surgical procedure in 13 (46%) of the 28 patients.[4]

In our patient's case, component mismatch led to accelerated wear and subsequent revision surgery. The rapid component deterioration can be explained by the fact that the contact area of the trunnion taper and the femoral head was much smaller than normal because of incongruence and taper mismatch. The V40 alumina head would have been the appropriate match for the implanted stem. The femoral head initially used was designed for the neck of a C-taper stem, which is more robust proximally. The head that should have been used would have accommodated the V40 neck geometry, which is much more slender proximally. The V40 neck is smaller than the C-taper in cross-section. A V40 femoral implant has a smaller neck diameter and, as a result, lowers bending stiffness. In the mismatch scenario presented here, the contact stress of the trunnion was increased. The ultimate result observed is that of altered mechanics and accelerated component wear. Multiple taper options result in flexibility for optimal component selection, but scrutiny is required before implantation.



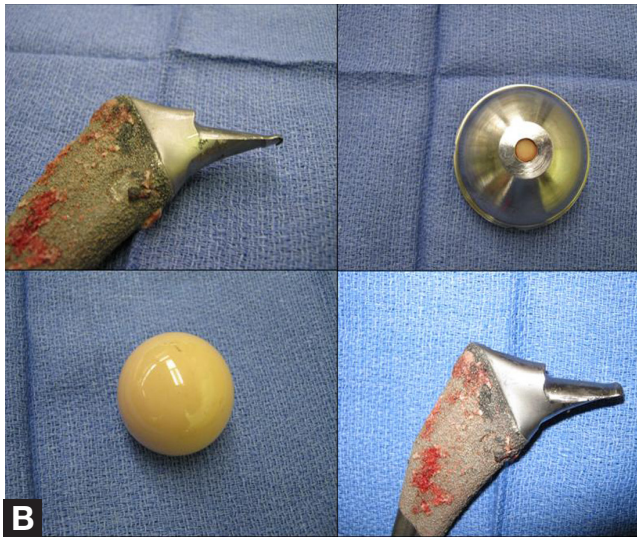


Figure 3. (A) Intraoperative findings included diffuse metallosis, and excessive wear of the trunnion. (B) At the time of implant removal, there was no appreciable wear of the ceramic head and liner.

Under normal loading conditions, contact stress at the hip joint may be multiple times that of body weight. In our patient's case, the resulting rapid deformation of the trunnion surface increased the altered surface area contact and resulted in rapid wearing of the component. This patient's observed results corroborate other authors' speculations that severe wear may result from size and angle mismatches involving femoral heads and taper locks.[5] Perhaps more important, during our patient's operation, the ceramic head was rotationally free on the neck. A free-spinning ceramic head on a titanium-alloy stem would lead to excessive wear of the stem.

Among the many factors that govern wear is hardness of materials. "High-hardness" bearings generate less wear than "low-hardness" bearings do.[6] Thus, the least wear is expected with ceramic-on-ceramic bearing surfaces. In our patient's case, however, a hard

ceramic head was rotationally free on a softer titanium-alloy stem—which created a "sharpening" effect as the head wore down the soft stem, ultimately leading to rapid implant failure. The main options for revision are ceramic-on-ceramic, followed by ceramic-on-highly cross-linked polyethylene, followed by metal-on-highly cross-linked polyethylene.[7] Obviously, during revision surgery, a ceramic ball cannot be safely placed on such a severely damaged trunnion. Given the need to revise both femoral and acetabular components and the associated bone loss, we used modular revision components with bearing surfaces of metal-on-highly cross-linked polyethylene. Ceramic-on-ceramic surfaces represent the foremost option because of their scratch resistance, but, in the setting of extensive metallotic debris, extensive soft-tissue involvement, and an associated reaction, we decided against ceramic. Metal-on-highly cross-linked polyethylene is now used most frequently,[7] though long-term results are yet to be determined. We avoided metal-on-conventional polyethylene because it has been shown to carry a risk for accelerated wear and the need for early re-revision.[8,9]

In light of recent advances in creating and implementing a national joint registry, our patient's case raises several issues relevant to the ongoing debate. We believe this case may serve as an example of how and why it is important to be precise with the criteria regarding what is useful and what is not useful in a clinical registry. An appropriately designed and targeted clinical registry has the potential to become a powerful quality assurance tool. Not only would a national joint registry become a source of standardized outcomes, but a uniform system for collecting implant device data and monitoring could help prevent the kind of complications experienced by our patient. Although the breakdown in this particular case likely occurred on multiple levels, one can foresee circumstances in which joint registry data collection may serve as a system of checks and balances, resulting in early detection of such an oversight or, ideally, complete avoidance (eg, implementation of a universal bar coding system). This case represents an extreme scenario, but such diligence ultimately will bring about significant clinical improvement.

Although these potential complications have received some attention with respect to management strategies and recommendations, the potential for human error and mismatched components remains a threat to treating physicians, particularly in a referral setting. We have reported the case of a patient who presented to our department from an outside facility 3 years after initial THA with implantation of mismatched components. This case should emphasize the importance of preoperative planning, particularly in revision surgery. In the absence of documentation, prosthetic component mismatch cannot always be excluded as a cause of failure.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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This paper will be judged for the Resident Writer's Award.