

Case Report

Unusual Case of a Trunnion Fracture Following a Revision Hip Arthroplasty Surgery: A Brief Review of the Literature and Discussion About Causes of Failure

Hamilton P. Vick, MD, Grayson A. Domingue, MD^{*}, Kacy Richburg, MD, Ryan Dean, MD, Fahmida Khan, MD, MPH, Rishi Thakral, MD

University of Oklahoma Health Sciences Center, Oklahoma City, OK, USA

ARTICLE INFO

Article history:

Received 9 June 2022

Received in revised form

13 September 2022

Accepted 18 September 2022

Available online xxx

Keywords:

Arthroplasty

Trunnion

Corrosion

Implant failure

Biomechanics

ABSTRACT

Trunnion fracture is an incredibly rare complication of total hip arthroplasty. Of the few reported cases, all involve implants with faulty designs, a small neck taper, or an extended neck length or offset. Most also report corrosion and an adverse soft-tissue reaction. We present a review of the literature and report on the first case, to our knowledge, of trunnion fracture in a well-fixed, cemented cobalt-chromium femoral component with a standard neck length and offset with no evidence of corrosion. This failure was likely related to scratching of the metal during previous procedures which led to crack propagation and catastrophic failure. The patient was treated with revision hip arthroplasty to an uncemented, distal-fit femoral component and insertion of new bearing surfaces.

© 2022 The Authors. Published by Elsevier Inc. on behalf of The American Association of Hip and Knee Surgeons. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Total hip arthroplasty (THA) has become an incredibly successful procedure in modern orthopedic surgery. Early versions of THA, while successful, involved crude prosthesis that failed to restore the patient's native biomechanics. Continued innovation in the field has made great strides, both in implant selection and in operative technique, to tailor each procedure to the mechanics of the patient for which the operation is being performed. Increased modularity of components has contributed significantly to the improvements since early designs [1]. However, along with the benefits seen with modular components comes potential complications and failures at the juncture point. These connections often occur through a Morse taper and commonly involve differing metals between components. This may allow for micromotion, fretting, and disruption of the protective oxide coating around modular connections [2,3].

With the increased incidence of primary THA, revision THA has also become increasingly common. Infection, aseptic loosening, and instability are among the most common reasons to necessitate revision. A less common complication that causes the need for revision arthroplasty is failure or fracture through the femoral component. This was first studied in the 1970s and was reported from 0.23% to 11% [4,5]. The majority of reported femoral component failures happen through the femoral stem.

Rarer, still, is a fracture through the modular connection of the trunnion. Of the reported cases, most involve uncemented THA with metal-on-polyethylene (MoP) or ceramic-on-polyethylene articulations with a small femoral head and increased neck length [2,6,7]. In our report, we demonstrate a rare case of trunnion fracture in a cemented, standard neck length and offset MoP total hip replacement with no classical evidence of adverse soft-tissue reaction.

Case history

The patient is an 81-year-old male (weight 90 kg, height, 180.34 cm, body mass index 27.7 kg/m²) who underwent primary left THA in 1994 using an uncemented titanium-alloy acetabular cup with an outer diameter of 52 mm, cemented cobalt-chromium femoral

^{*} Corresponding author. University of Oklahoma Health Sciences Center, 13221 Englewood Ln, Edmond, OK 73013, USA. Tel.: +1 225 620 3384.

E-mail address: grayson-domingue@ouhsc.edu

component of 10-mm diameter (Cementra; Smith and Nephew, Memphis, TN), and a 28-mm cobalt-chromium femoral head. He subsequently returned to his preoperative activity level, but per the patient, the components began to wear out, and he underwent revision for a new cobalt-chromium femoral head and acetabular liner with placement of a Matrix titanium taper sleeve (Smith and Nephew, Memphis, TN) in 2013. Again, the patient recovered well and returned to his preoperative activity level. Eight years after his revision, he had sudden onset of pain in the left hip after a low-energy fall from standing while moving tree branches and was unable to bear weight. Radiographs at an outside facility demonstrated fracture through the femoral prosthesis at the level of the trunnion with well-fixed femoral and acetabular components, and he was transferred to our facility for further care (Fig. 1). He underwent revision THA including the entire femoral component and acetabular liner. The acetabular cup was retained as it was well-fixed and undamaged. The femoral component was noted to be broken at the level of the trunnion, with the majority of the trunnion along with the sleeve still remaining within the head component (Fig. 2). There was no concerning tissue infection and no evidence of metallosis or soft-tissue reaction. The femoral stem was found to be well-fixed but was removed without the use of an extended trochanteric osteotomy. There was a minimal amount of cement which was retrieved with the use of reverse curettes. The calcar was notably osteopenic, indicating significant stress-shielding in this area. The femoral component was revised to an uncemented STS distal stem ARCOS (size 13 diameter, length 150 mm; Zimmer Biomet, Warsaw, IN), with an ARCOS modular revision hip system proximal cone body with plasma spray (size 60 mm, size A; Zimmer Biomet, Warsaw, IN), and a 28-mm ceramic head with a Biolox option taper sleeve (Zimmer Biomet, Warsaw, IN) with a +3-mm neck (Fig. 3). The acetabular liner was replaced with a Smith and Nephew ultra-high-molecular-weight polyethylene 20-degree lipped liner with an internal diameter of 28 mm as the older model cup originally used in this patient did not allow for upsizing of the femoral head. The patient had an uneventful hospital course after the surgery and was discharged on postoperative day 3 after ambulating with the assistance of a walker. He elected to keep his hardware, so the implant was provided to him per hospital protocol and was not available for microscopic analysis. At 6-month follow-up, the patient had returned to his normal activities without the use of any assistive devices and had no residual hip pain. Consent was obtained from the patient to publish this deidentified case report.

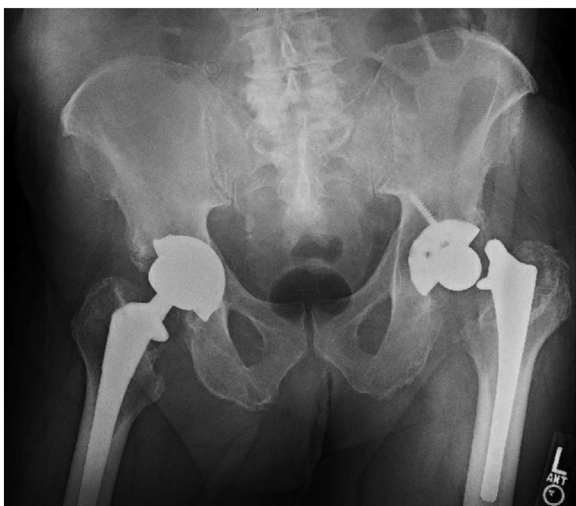


Figure 1. The preoperative anteroposterior radiograph showing our patient with hardware failure.

Discussion

Failure of the femoral component is a rare complication which most often occurs as a fatigue fracture at the femoral stem due to cyclic loading. The stem, rather than the neck, is most often involved because of increased cantilever bending of the proximal stem due to a longer moment arm relative to the hip center. This is amplified when the stem is placed in a varus position especially with insufficient proximal support [8,9].

Fractures through the prosthetic neck are far less common than fractures of the stem. This was first reported in 1985 in an implant where a trapezoidal neck shape led to increased tensile strain [10]. While forces through the neck are less than those seen in the stem, modern implants offer modular components with varied neck lengths, neck shaft angles, and high offset options that can increase the forces seen through the neck [11]. Furthermore, the neck region of the implant is susceptible to errors in mechanical processing, corrosion, or damage during the surgery, which can increase the likelihood of failure.

There have also been various case reports of trunnion failure with the use of the AML A plus (DePuy International, Leeds, England) implant, which was designed for use in Asian populations to cater to the smaller sizes needed in specific groups of patients [12,13]. This has been described both with a small, MoP construct, as well as with large, metal-on-metal constructs. The AML A plus implant uses a smaller 9/10 neck taper, rather than the standard 12/14 taper. Morlock et al. also present a case of failure due to corrosion in a smaller 11/13 taper design [14].

The intimate connection between the trunnion and bore, while providing stable fixation, can allow for imperfections at this junction. Manufacturing of these surfaces may allow for small gaps which allow for influx of fluid and microscopic movement between components. This is termed fretting and can produce mechanical debris during cyclic loading which may interfere with the protective oxide layer and increase the odds of developing mechanically assisted crevice corrosion. Mechanically assisted crevice corrosion or trunnionosis has been implicated in notching and eventual failure of the head-neck junction [2,3,14]. This was once believed to occur only in metal-on-metal implants, but more recent reports recognize this process in MoP implants at the modular connection of the head and neck [3,15]. In cases where trunnionosis is a factor, adverse local tissue response such as extremity swelling, pseudotumor, or visual corrosion and material loss are often noted [2,6,11,15–17]. Additionally, these patients commonly have prodromal symptoms of joint pain and stiffness prior to failure of the prosthesis [15]. These symptoms and observations were not seen in our patient.

While it has been reported, the failure of cobalt-chromium implants seems to occur with less frequency than other materials [18]. One analysis of cobalt-chromium implants implicated a laser etching in the neck as the cause of failure [9]. Peterson et al. [6] reported on a case of failure of the femoral neck of an uncemented, cobalt-chromium femoral component. In their analysis, the failure was believed to be related to the long neck length (+10) resulting in high cantilever bending forces which resulted in fatigue failure through the midpoint of the neck over the 25-year lifetime of the prosthesis [6]. This idea is supported by a review of a recalled implant by Urish et al. [17] where high offset and increased neck length were associated with gross trunnion failure. Case series by Banerjee et al. [2] and Martin et al. [7] lend further support as a majority of patients with gross trunnion failure had femoral necks with an extended length of +4 or greater.

This case is unique in that the fracture through the trunnion occurred in a cemented cobalt-chromium alloy femoral component with no intraoperative evidence of significant corrosion or metallosis within the soft tissue, and there was no obvious design flaw.



Figure 2. The removed femoral component.

There are no previous Food and Drug Administration reports of similar failures with the femoral stem that was used in this patient. No known risk factors such as obesity, excessive activity, varus position of the stem, small taper size, or increased neck length or offset were present [2,6,7,9,12,13,17,19]. Our patient did have revision of the femoral head component 8 years prior to the fracture of the trunnion. At that time, a titanium sleeve and a new metal head were placed. It is likely that the trunnion was scratched or pitted during the initial or revision procedure. The small surface grooves in the metal and damage to the oxide coating then acted as stress risers and corrosion initiators, allowing for eventual crack propagation and ultimately catastrophic failure after years of cyclic mechanical loading [13,19,20]. It is possible that a ceramic head, rather than a metal one, would have halted this progression.

Summary

To date, there is only 1 report of trunnion fracture following femoral head exchange [20]. However, that case also involved the use of an extended length neck and used the AML prosthesis, which has been reported to have failed through the trunnion due to its smaller taper in multiple reports. To our knowledge, this is the first report of trunnion fracture through a cemented, MoP implant with a standard neck length and 12/14 taper following head exchange. Based on these findings, surgeons should be diligent to protect the prosthetic neck from damage during primary or revision procedures by avoiding aggressive retraction, placing the component in a soft-tissue pocket, or padding them with a lap sponge when not being used.

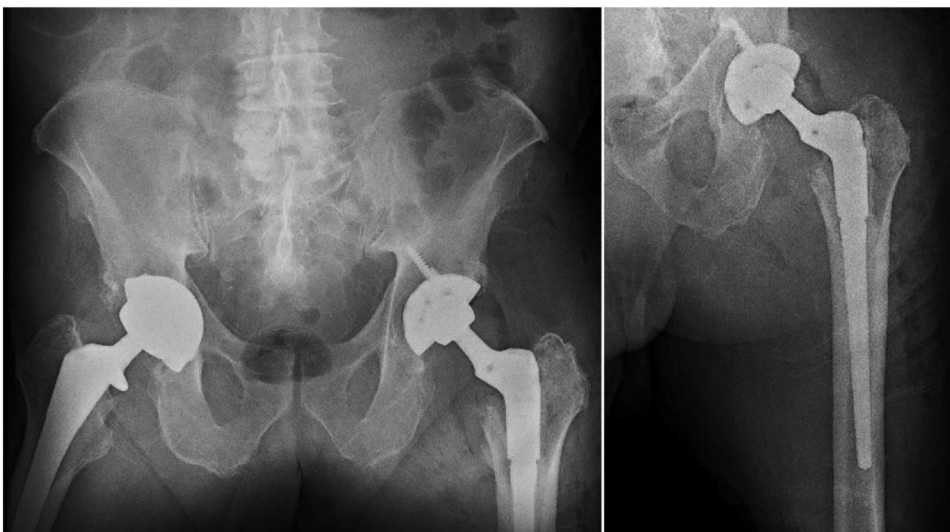


Figure 3. Postoperative anteroposterior radiographs of the pelvis and left hip.

Conflict of interest

The authors declare there are no conflicts of interest.

For full disclosure statements refer to <https://doi.org/10.1016/j.artd.2022.09.012>.

Informed patient consent

The authors confirm that informed consent has been obtained from the involved patient or, if appropriate, from the parent, guardian, power of attorney of the involved patient and that they have given approval for this information to be published in this article.

References

- [1] Bolarinwa SA, Martino JM, Moskal JT, Wolfe MW, Shuler TE. Gross trunnion failure after a metal-on-polyethylene total hip arthroplasty leading to dissociation at the femoral head-trunnion interface. *Arthroplast Today* 2019;5:5–10.
- [2] Banerjee S, Cherian JJ, Bono JV, Kurtz SM, Geesink R, Meneghini RM, et al. Gross trunnion failure after primary total hip arthroplasty. *J Arthroplasty* 2015;30:641–8.
- [3] McAleese T, Feeley I, Hughes A, Sheehan E, Merghani K, Niall D. Bilateral mechanically-assisted crevice corrosion resulting in femoral stem-head dissociation in metal-on-polyethylene total hip arthroplasty. *Arthroplast Today* 2021;8:35–9.
- [4] Charnley J. Fracture of femoral prostheses in total hip replacement. A clinical study. *Clin Orthop Relat Res* 1975;111:105–20.
- [5] Martens M, Aernoudt E, de Meester P, Ducheyne P, Mulier JC, de Langh R, et al. Factors in the mechanical failure of the femoral component in total hip prosthesis. Report of six fatigue fractures of the femoral stem and results of experimental loading tests. *Acta Orthop Scand* 1974;45:693–710.
- [6] Peterson JR, Wright TM, Wellman SS, Lachiewicz PF. Fracture of the neck of an uncemented femoral component unrelated to trunnion corrosion. *Arthroplast Today* 2019;5:52–6.
- [7] Martin AJ, Jenkins DR, Van Citters DW. Role of corrosion in taper failure and head disassociation in total hip arthroplasty of a single design. *J Orthop Res* 2018;36:2996–3003.
- [8] Rand JA, Chao EY. Femoral implant neck fracture following total hip arthroplasty. A report of three cases. *Clin Orthop Relat Res* 1987;221:255–9.
- [9] Lee EW, Kim HT. Early fatigue failures of cemented, forged, cobalt-chromium femoral stems at the neck-shoulder junction. *J Arthroplasty* 2001;16:236–8.
- [10] Burstein AH, Wright TM. Neck fractures of femoral prostheses. A report of two cases. *J Bone Joint Surg Am* 1985;67:497–9.
- [11] Berstock JR, Whitehouse MR, Duncan CP. Trunnion corrosion: what surgeons need to know in 2018. *Bone Joint J* 2018;100-B(1 Suppl A):44–9.
- [12] Eachempati KK, Dannana CS, Apsingi S, Ponnala VK, Boyapati G, Parameswaran A. Trunnion fracture of femoral prosthesis following a large metal-on-metal uncemented total hip arthroplasty: a case report. *Arthroplasty* 2020;2:32.
- [13] Unnanuntana A, Chen DX, Unnanuntana A, Wright TM. Trunnion fracture of the anatomic medullary locking a plus femoral component. *J Arthroplasty* 2011;26:504.e13–6.
- [14] Morlock MM, Dickinson EC, Gunther KP, Bunte D, Polster V. Head taper corrosion causing head bottoming out and consecutive gross stem taper failure in total hip arthroplasty. *J Arthroplasty* 2018;33:3581–90.
- [15] Zink TM, McGrory BJ. Mechanically assisted crevice corrosion in a metal-on-polyethylene total hip presenting with lower extremity vascular compromise. *Arthroplast Today* 2020;6:445–50.
- [16] Cooper HJ, Della Valle CJ, Berger RA, Tetreault M, Paprosky WG, Sporer SM, et al. Corrosion at the head-neck taper as a cause for adverse local tissue reactions after total hip arthroplasty. *J Bone Joint Surg Am* 2012;94:1655–61.
- [17] Urish KL, Hamlin BR, Plakseychuk AY, Levison TJ, Higgs GB, Kurtz SM, et al. Trunnion failure of the recalled low friction ion treatment cobalt chromium alloy femoral head. *J Arthroplasty* 2017;32:2857–63.
- [18] Morgan-Hough CV, Tavakkolizadeh A, Purkayastha S. Fatigue failure of the femoral component of a cementless total hip arthroplasty. *J Arthroplasty* 2004;19:658–60.
- [19] Vatani N, Comando D, Acuña J, Prieto D, Caviglia H. Faulty design increases the risk of neck fracture in a hip prosthesis. *Acta Orthop Scand* 2002;73:513–7.
- [20] Botti TP, Gent J, Martell JM, Manning DW. Trunion fracture of a fully porous-coated femoral stem. Case report. *J Arthroplasty* 2005;20:943–5.