CASE REPORT

Modular Well-Fixed Hip Revision Stem Fracture: A Case Report and Literature Review

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Abstract

This study presents a case of repeated prosthetic fractures in a modular hip prosthesis in a 56-year-old male patient. After the initial implantation of a modular total hip prosthesis in 2006, the patient experienced two instances of prosthetic implant fractures over seventeen years. In this study, we analyze the clinical case, explore potential underlying causes of this complication, and delve into current indications and strategies for the revision of fractured prosthesis stems. The discussion is informed by a literature review and underscores the significance of selecting appropriate revision techniques to address this challenge.

Level of evidence: III

Keywords: Fracture, Hip arthroplasty, Modular, Revision, Well-fixed stem

Introduction

Total hip arthroplasty is an effective surgical intervention widely used to relieve pain, restore hip function, and improve quality of life in most patients suffering from advanced hip osteoarthritis or other hip conditions like dysplasia.[1] However, the procedure is not completely failure-free, and new designs, such as the modular neck (MN) femoral stem, are continually being developed.

The modular neck femoral stem was introduced to give the surgeon the possibility to improve restoration of the joint biomechanics by adjusting the femoral version, the lower limb length, the neck-shaft angle, and the femoral offset (FO). Restoring FO is essential for enhancing joint stability, optimizing functional outcomes, and ensuring implant longevity. This modular approach is especially beneficial in complex cases with significant anatomical challenges, such as developmental dysplasia of the hip (DDH), where it can help avoid additional procedures like osteotomies. It also facilitates the management of post-traumatic osteoarthritis, making surgical correction of a deformed hip more straightforward, safer, and reproducible, ultimately leading to better outcomes.[2]

Despite the advantages of modularity, numerous studies have highlighted an increased risk of serious complications, particularly mechanical failures at the neck-stem junction,[3,4] including dissociation, neck fractures, and issues related to fretting and corrosion. These complications have been associated with a higher rate of prosthetic revisions,[5] especially in patients with inadequate proximal femoral support and in those who are obese.[6]

Nonetheless, cementless modular revision stems have shown long-term clinical success and continue to be considered a safe and reliable option for managing complex revision surgeries.[7,8]

Prosthetic collar and stem fractures represent a rare yet significant complication in modular hip prosthesis. This study focuses on repeated fracture of modular prostheses and explores underlying causes, treatment options, and technical considerations for revising fractured stems.

Case Presentation

This case involves a 56-year-old male patient who, after the initial implantation of a total hip prosthesis in 2006, experienced two instances of prosthetic fractures over seventeen years.

The initial prosthetic implantation was performed at another medical facility in 2006, and in 2011, the first fracture of the modular neck occurred, followed by the first prosthesis revision also performed at another hospital

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[Figure 1, 2].

Figure 1. Preliminary X-rays of the first prosthetic modular neck fracture (2011)

Figure 2. Post-operative X-rays of the first revision surgery (2011)

In January 2023, approximately one week following the onset of right hip pain without trauma, the patient arrived to our emergency department where new X-rays were performed, revealing a fracture of the prosthetic stem [Figure 3].

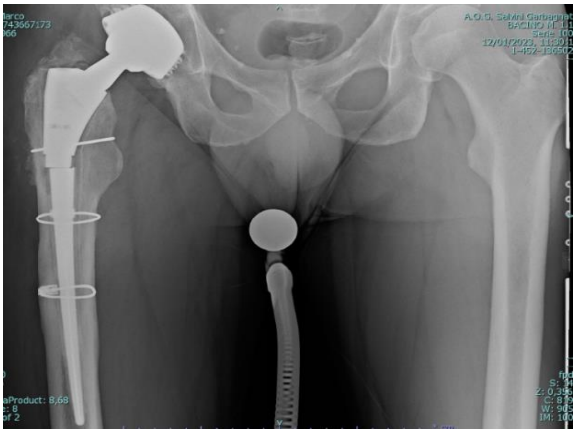

Figure 3. Preliminary X-rays of the second prosthetic modular stem fracture (2023)

To better define the clinical case and plan the surgical intervention, a CT scan with 3D reconstruction was performed [Figure 4, 5].

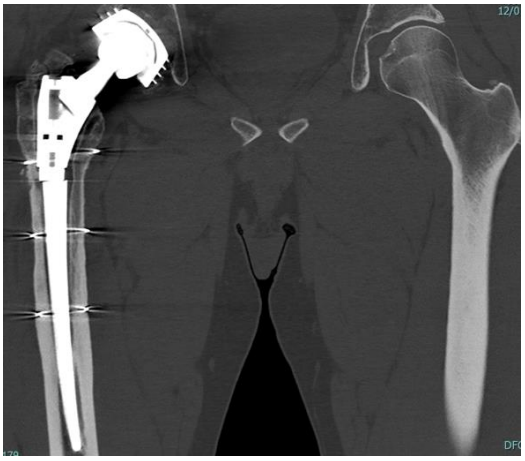

Figure 4. Preliminary CT-scan (coronal) of the second prosthetic modular stem fracture (2023)

Figure 5. Preliminary CT-scan (3D reconstruction) of the second prosthetic modular stem fracture (2023)

The preoperative planning involved a posterolateral approach, utilizing part of the previous surgical scar, and the revision of the prosthetic stem through extended trochanteric osteotomy (ETO).

With the patient in the left lateral decubitus position, an incision was made along the previous extended surgical scar for approximately 15cm. Following fasciotomy and exposure of the short rotators and the femoral shaft on the lateral side, existing cerclages were identified. Subsequently, a segmental resection of the pisiform-conjoint tendon and capsule was performed, exposing the joint and then dislocating the prosthesis. The acetabular-ceramic insert complex appeared to be in good conditions with adequate stability, leading to the decision not to revise these components.

After the cleaning of the proximal portion of the greater trochanter, the prosthetic collar was exposed, noting its mobilization. It was then manually extracted, preserving the

trochanteric region intact [Figure 6]. Subsequently, with a safety cerclage placed below the planned osteotomy point, an extended sub-trochanteric osteotomy was performed from the bottom of the first cerclage to the level of the isthmus. Sequential drilling was performed and subsequently joined by cutting with a blade along the posterior femoral region, laterally to the rough line, and the anterior femoral region [Figure 7]. After removing the bone flap, the prosthetic stem was exposed, detached, and extracted [Figure 8].

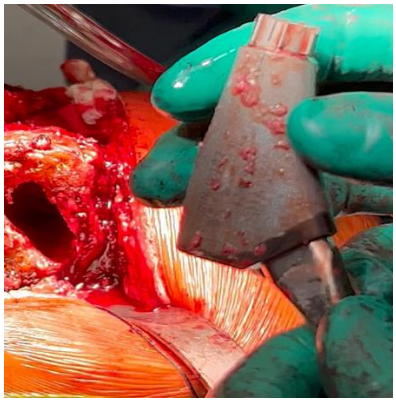

Figure 6. Intraoperative image: extraction of the prosthetic collar

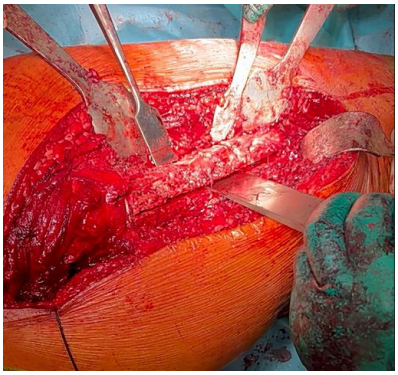

Figure 7. Intraoperative image: subtrochanteric osteotomy

Figure 8. Intraoperative image: extraction of well-fixed stem

Following meticulous canal debridement and the insertion of progressively larger broaches, a definitive uncemented stem was implanted with a lateralizing turret and ceramic head [Figure 9]. Finally, the bone flap was repositioned and fixed with 3 cable-ready cerclages [Figure 10].

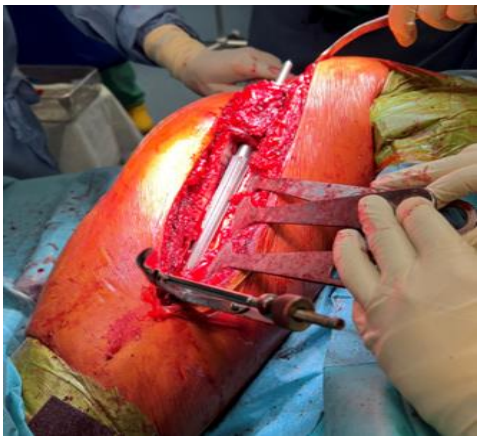

Figure 9. Intraoperative image: implantation of revision uncemented stem

Figure 10. Intraoperative image: cable-ready cerclages

Upon reduction of the implant, stability was achieved, allowing for a good range of motion of the hip.

After the surgery, postoperative follow-up X-rays were performed [Figure 11, 12].

Figure 11. Post-operative x-rays: antero-posterior projection

Figure 12. Post-operative X-rays: axial projection

Following the intervention, the patient was gradually permitted to increase weight-bearing activities, reaching full weight-bearing capacity by one month postoperatively. Sports activities were restricted for six months.

X-rays and clinical evaluations were done after 1, 3, 6, 10 and 14 months.

In the last evaluation (14 months) no signs of complications were observed and the patient had an Harris Hip Score of 91, 5 [Figure 13-16].

Figure 13. X-ray at 14 months: antero-posterior projection

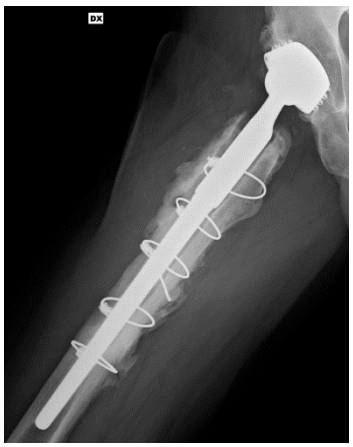

Figure 14. X-ray at 14 months: axial projection

Figure 15. Clinical evaluation at 14 months: extension

Figure 16. Clinical evaluation at 14 months: flexion

Discussion

Prosthetic stem fracture is a rare yet noteworthy complication in modular hip prostheses. Modularity offers advantages such as intraoperative customization but can also increase the risk of complications related to modular interfaces [Table 1]. Causes of stem fracture encompass mechanical stress, collar design, patient-specific factors, and assembly issues. Repeated stem fractures are even rarer and warrant comprehensive evaluation of underlying causes.

We describe a case of repeated atraumatic stem fracture in a 56-year-old patient and a literature review.

Skendzel et al[9] presented 2 cases of modular femoral neck fractures that required revision procedures. In both cases, an anterolateral approach to the hip was performed, and an extended trochanteric osteotomy was carried out.

Wright et al[10] reported a case of modular femoral neck device fracture that underwent a revision total hip arthroplasty by posterior approach and extended trochanteric osteotomy. In this case, an acetabular revision was also performed.

Papaioannou et al.[11] reported a case involving a 71-year-old obese female patient (body mass index, 58 kg/m^2) who experienced a late-onset dissociation of the neck-stem junction without hip dislocation, five years after the initial surgery. The primary procedure was performed using a Kocher-Langenbeck approach and a modular hip prosthesis was implanted. Following the radiographic diagnosis of neck-stem dissociation, a revision surgery was conducted five years later using a Hardinge approach, during which a

"figure of eight" wiring technique was employed to reattach and stabilize the neck to the stem.

Zajc et al.[12] described a case of a modular femoral neck fracture that occurred 21 months after the revision of the acetabular component. In the subsequent revision surgery, performed through a direct lateral approach, the prosthetic stem was removed using a single longitudinal proximal splitting combined with a two-chisel technique.

Kouzelis et al[13] presented a case of dissociation of modular total hip arthroplasty at the neck-stem interface without dislocation in a 72-year-old man. The total hip arthroplasty revision was performed and an open-book technique was used to extract the modular stem.

Gallart et al[14] described 2 cases of well-fixed femoral stem fractures of revision hip arthroplasty that underwent a second revision using a series of hollow trephine reamers to over-drill the well-fixed distal femoral component.

Table 1. a literature review

Article	Type of study	N. patients	Revision approach	Femoral osteotomy
Skendzel et al[9]	Case report	2	*Anterolateral*	ETO
			Anterolateral	ETO
Wright et al[10]	Case report	1	*Posterior*	ETO
Papaioannou et al[11]	Case report	1	*Direct lateral*	Only wiring fixation
Zajc et al[12]	Case report	1	*Direct lateral*	Single longitudinal proximal splitting and two-chisel technique
Kouzelis et al[13]	Case report	1	-	Open book technique
Gallart et al[14]	Case report	2	-	Series of hollow trephine reamers
			-	Hollow trephine reamers associated to transverse osteotomy
Canton et al[15]	Case report	1	*Posterolateral*	Femoral osteotomy according to Wagner
Akrawi et al[16]	Case report	2	*Posterior*	Modified sliding cortical window technique
			-	Modified sliding cortical window technique
Graulich et al[17]	Case report	1	*Posterior*	Proximal femur osteotomy leaving the well-fixed part of the stem in place

Canton et al[15] reported a case of non-modular mid-neck rupture in a patient with pseudo-ankylosis due to massive heterotopic calcifications that required a revision procedure performed via a posterolateral approach and femoral osteotomy according to Wagner.

Akrawi et al.[16] reported two cases in which a modified sliding cortical window technique was employed to assist in the removal of a fractured cemented femoral stem during the revision total hip arthroplasty. This technique utilized a tungsten carbide drill, Charnley pin retractor, and an orthopedic mallet.

Graulich et al.[17] detailed a case involving a fractured modular revision stem managed via a posterior approach, where the well-fixed portion of the stem was left intact. They developed a custom-made cemented tube to connect the well-fixed distal stem to a new proximal component. Additionally, they preoperatively designed a custom-fabricated scale bar to guide the femoral osteotomy required for removing the proximal part of the prosthesis.

Pelayo-de-Tomás et al.[18] conducted a prospective cohort study involving 317 consecutive patients and identified only one instance of a broken modular neck, which occurred in an obese patient who had a long titanium neck.

Benazzo et al.[19] conducted a prospective evaluation of 239 primary total hip replacements using a conical stem in combination with modular necks of different lengths and angles. All patients were followed for a minimum of 2 years, with none lost to follow-up. Two stems required revision: one due to a Vancouver type 2 periprosthetic fracture and another due to stem subsidence 10 days postoperatively, following an intraoperative femoral split with the patient subsequently weight-bearing against advice. In both instances, a modular revision stem was employed.

As the number of revisions to total hip arthroplasty is regularly growing, several technical issues have risen and have been solved by orthopedic surgeons. ETO is one of these solutions proposed to remove femoral implants to improve surgical technique as well as clinical outcomes.

The concept of trans-femoral osteotomy was first introduced by Wagner in 1987, while the ETO was later

described by Younger et al. in 1995. ETO is now regarded as the gold standard for the extraction of well-fixed femoral stems and it applies to almost any patient undergoing femoral revision. The literature describes various methods for securing the osteotomized femoral flap, with most studies comparing fixation techniques using metallic wires, cables, or cords.[20]

Although these techniques are the most commonly used, recently the scientific community has shown interest in developing new variants of this technique, including the trochanteric slide osteotomy (TSO) and the trans-femoral approach.[21]

Furthermore, some authors have proposed osteotomy interventions based on an anterior approach, as in the case of the "Inside-Out" anterior osteotomy of the proximal femur via the direct anterior approach.[22]

Conclusion

Modular neck fractures are a notable concern, particularly in obese male patients with long modular necks, who are at increased risk. Microstructural analysis of retrieved implants has revealed that fractures commonly occur at the base of the neck junction and its anterolateral distal part. Surgeons should be aware of this complication while using or revising such prostheses.[23]

Repeated prosthetic stem fractures are a rare yet plausible occurrence in modular hip prostheses.[24] managing this complication demands a thorough assessment of underlying causes and the adoption of suitable revision strategies. The European Federation of National Associations of Orthopedics and Traumatology (EFORT) furnishes guidelines for hip prosthesis management, emphasizing the importance of appropriate material and modular size selection to minimize complication risk. The risk of wear and neck-taper fractures is notably higher in obese male patients with a BMI > 30 who have high functional demands, making the use of modular stems in this population inadvisable. Additionally, careful consideration is required when opting for long or extra-long necks in these patients.[2]

Lastly, as the number of revised total hip arthroplasty procedures is steadily increasing, osteotomy techniques are also undergoing a progressive period of evolution, and new techniques will likely be implemented in the coming years.

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