Acta Biomed 2023; Vol. 94, Supplement 2: e2023117 DOI: 10.23750/abm.v94iS2.13888

Case report

Total hip arthroplasty monobloc stem neck rupture in patient with massive heterotopic ossifications: a case report and literature review

Gianluca Canton, Giovanni Barbo, Roberto Fattori, Nicholas Rasio, Luigi Murena

Orthopedics and Traumatology Unit, Cattinara Hospital - ASUGI, Department of Medical, Surgical and Life Sciences, Trieste University, Trieste (Italy)

Abstract: *Background and aim of the work:* Fractures of the femoral stem neck are a rare complication in hip prosthetic surgery, especially in non-modular components. The authors report a case associated with massive heterotopic ossifications, with the purpose to analyze risk factors and specific characteristics. *Methods:* A case of femoral monobloc stem neck rupture is described. A non-systematic literature review regarding risk factors for femoral stem neck fracture was conducted in the PubMed database. *Results:* We report the case of a 61-year-old male who underwent surgery to remove calcifications four years after THA. Four months later the patient reported acute pain in the left hip, arising after a combined movement of external rotation and axial load while standing on the left foot, in the absence of any prodromic symptom. On radiographs, a displaced fracture of the neck of the hip prosthesis was revealed, together with massive heterotopic ossifications. After THA revision the patient's symptoms were resolved. *Conclusions:* Prosthetic femoral neck fractures are a rare complication. We suggest that this case represents a unique type of fatigue rupture, where neck length and the presence of massive heterotopic calcifications contributed to flexion forces, resulting in failure in the midpoint of the neck. (www.actabiomedica.it)

Key words: Total hip arthroplasty, femoral prosthesis neck fracture, heterotopic ossification

Introduction

Fractures of prosthetic components are a rare complication in hip prosthetic surgery.

According to USA retrospective data, the percentages of total hip revision due to implant rupture are in fact 1%. (1)

Among the various types that have been reported, the rupture of the implant neck is certainly the least common although the most interesting, thanks to the advent of modularity.

More specifically, implant neck rupture can typically occur in two areas, proximally

at the head-neck junction and distally at the neck-shoulder junction. (2).

This complication is due to a chain reaction, that begins with the mechanical friction in the head-neck coupling, which leads to damage to the metal due to corrosion and subsequent fracture due to fatigue (3). With the advent of modularity, the same cascade can also occur at the modular junction between stem and neck (4).

Rarer and less described is the possibility of a rupture of the neck at the level of the middle third.

The purpose of this work is to describe a particular case of non-modular mid-neck rupture in a patient with pseudo-ankylosis due to massive heterotopic calcifications, analyzing the risk factors and specific characteristics of the case.

Case report

A 61-year-old male suffering from primary hip arthritis underwent left total hip arthroplasty at another institution in 2014. The patient had a sedentary lifestyle, his BMI was 32.5 (Height 1.84, weight 110 Kg). Hip replacement was accomplished through a direct anterior minimally invasive surgical approach, with a press fit 56mm cup (Pinnacle® Acetabular Cup, Johnson&Johnson) a press-fit monobloc stem (Corail® Hip System KHO, Johnson&Johnson) ceramic on ceramic coupling and an XL extrusion cone. Postoperative course was free from complications. Radiographs taken six months after surgery showed correct positioning of the implant, with an initial heterotopic bone formation (Figure 1).

In 2016, at the same office, a diagnosis of massive periprosthetic heterotopic (fourth-class according to Brooker (22) classification – bony ankylosis) with a major functional limitation was made (Figure 2).

For this reason, the patient underwent neo-adjuvant radiotherapy and surgical removal of heterotopic bone was scheduled. The intervention, according to what is described in the surgical report, was performed through a direct lateral approach, with intraoperative evidence of extensive bone formation especially on the anterior side. The colleagues reported removal to be rather difficult due to both joint and tissues stiffness. Thus, after obtaining the recovery of a functional ROM with 90 ° of flexion, some residual heterotopic bone was left in place. Finally, the ceramic head was replaced without changing size and type.

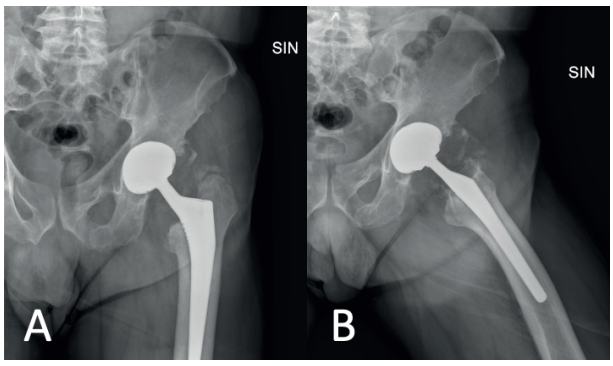

Figure 1. AP (Figure 1A) and Axial (Figure 1B) radiographic views of left hip months after total hip replacement show correct implant positioning and initial heterotopic bone formation.

Four months after revision surgery, the patient came to our facility due to acute pain in the left hip, arising after a combined movement of external rotation and axial load while standing on the left foot, in the absence of any prodromic symptom. At the x-rays taken at the Emergency department a displaced fracture of the prosthetic neck was revealed (Figure 3A).

Four days after the patient underwent revision surgery through an extended posterolateral surgical approach. Heterotopic ossifications resulted to be massive with a complete subversion of normal muscle anatomy. A femoral osteotomy according to Wagner was necessary to remove the prosthetic stem which was well integrated. The cup insert was not visible as it was covered with heterotopic bone formation that encompassed the head and made it difficult to remove it together with the portion of the broken prosthetic neck (Figure 3B).

Implant revision was accomplished using a long uncemented modular stem (Lima Corporate®, Revision stem) with a high offset modular neck and a ceramic head. The acetabular component, being well integrated and correctly oriented, was preserved.

Once the stability of the implant was verified and the osteotomized bone fragment was modeled in order

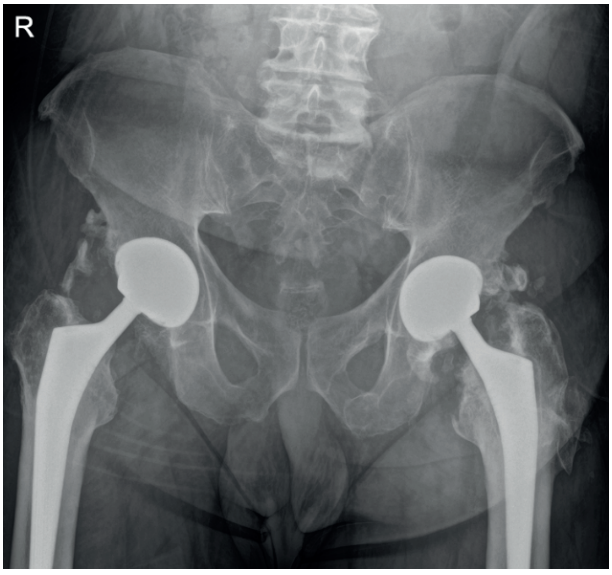

Figure 2: AP radiographic view of pelvis two year after left total hip replacement shows Fourth-class heterotopic ossification according to Brooker.

to adapt to the shape of the femoral stem, Wagner osteotomy was fixed with cerclage wires (Figure 4).

After surgery, immediate rehabilitation especially driven to ROM maintenance was started. Ambulation was allowed with partial weight bearing for the first 8 weeks. Three months after surgery, the patient was walking without aids and without referred pain. Stiffness was still present, with hip flexion limited to 60° degrees.

Discussion

The rupture of the implant neck is a rare complication, mostly related to modular neck implants.

The underlying etiology is multifactorial and knowing the risk factors becomes essential from a perspective of future prevention.

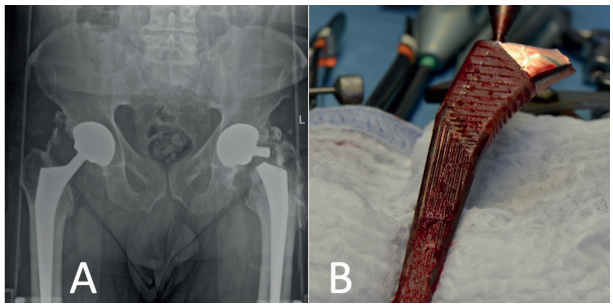

Figure 3. The AP radiograph of the pelvis (Fig 3A) shows implant rupture at the femoral stem neck of the left total hip prosthesis and the presence of extensive heterotopic calcifications. The photograph (Fig 3B) shows the removed stem. The complete fracture in the middle third of the prosthetic neck is visible.

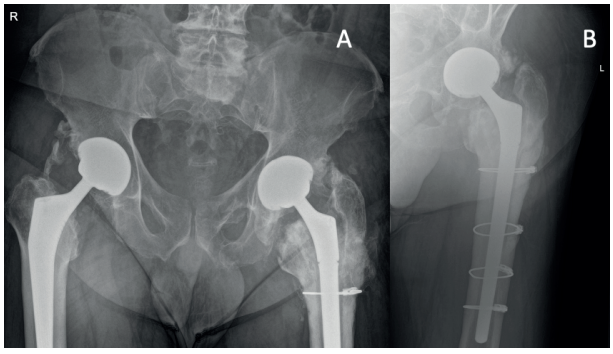

Figure 4: AP radiographic view of pelvis two year after left total hip replacement shows Fourth-class heterotopic ossification according to Brooker.

The available literature identifies and divides the risk factors into three groups: patient-related, prosthetic-related and surgeon-related.

In the first group the relevant aspects are the high BMI, which involves an increase in the force vector acting on the neck of the prosthesis, and the degree of physical activity of the patient which certainly leads to an increase in micro-movements at the head-neck junction with consequent increase in the phenomenon of "Trunnionosis" (5-7).

In the second group, the modularity of the implant with some characteristics such as neck length, varus angulation and excessive ante-retroversion play an important role (8).

Design and manufacturing defects that may be associated with fracture of the femoral component should also be considered (9-10).

Related surgeon factors concern the correct assembly of the prosthetic components, respect for their integrity and cleanliness (11-12), the choice of material (13), and the combined coupling of components belonging to different manufacturers (14-15).

In hip replacement surgery, heterotopic ossifications represent a relatively frequent condition which in some patients can led to pain and limitations in motion.

The causes are multifactorial: age (16), male sex (17), comorbidities, previous hip fractures (18), the degree of heterotopic calcification occurring at a previous contralateral THA (20), and according to some studies, surgical approach with the related soft tissue trauma and length of surgery (19-21).

Heterotopic ossifications following THA influence prosthetic hip joint function, which is inversely proportional to the classification stage according to Brooker (23).

In the case reported, the patients presented a Brooker fourth-class heterotopic ossification despite only length of surgery (which lasted two hours) and male gender could be identified as risk factors.

To our knowledge, the role of heterotopic ossifications as a predisposing risk factor for rupture of the non-modular prosthetic neck is not mentioned in previous literature reports. Nonetheless, the authors believe that in the presented case the severe stiffness and mechanical impingement caused by massive

heterotopic ossifications might have been relevant in causing stem neck rupture. Nevertheless, as far as risk factors for neck rupture are concerned, the patient also presented high BMI and high neck offset. Conversely, no evidence of manufacturing or corrosion problems in the fractured component were found in our case.

The authors suggest that this case represents a unique type of fatigue rupture, where the presence of massive heterotopic calcifications contributed to flexion forces, resulting in failure in the midpoint of the neck.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Author Contributions Statement: C. G.: Conceptualization, methodology, software, validation, review and editing. B. G.: Formal analysis, investigation, data curation, original draft preparation. F. R.: Conceptualization, methodology, review. R. N.: Conceptualization, methodology, review. M. L.: Conceptualization, methodology, software, validation, review.

Funding: None

Ethics approval and consent to participate: The work was undertaken according to the provisions of the Declaration of Helsinki. The involved subject gave informed consent to participate and patient anonymity has been constantly preserved. Ethical committee approval was not required due to the retrospective nature of the study.

References

1. Clohisy JC, Calvert G, Tull F, McDonald D, Maloney WJ. Reasons for revision hip surgery: a retrospective review. Clin Orthop Relat Res. 2004 Dec;429:188–92.
2. van Doesburg PG, van Langelaan EJ, Apachitei I, Bénard MR, Verdegaal SHM. Femoral prosthesis neck fracture following total hip arthroplasty - a systematic review. Arthroplasty. 2020 Oct 16;2(1):28. doi: 10.1186/s42836-020-00047-3. PMID: 35236443.
3. McTighe T, Brazil D, Keppler L, Keggi J, McPherson E. Metallic Modular Taper Junctions in Total Hip Arthroplasty. Recon Rev [Internet]. 2015 Aug. 12 [cited 2022 Oct. 22];5(2)
4. Grupp TM, Weik T, Bloemer W, et al. Modular titanium alloy neck adapter failures in hip replacement-failure mode analysis and influence of implant material. BMC Muskuloskelet Desord 2010; 11: 3-14.
5. Bitter T, Khan I, Marriott T, Lovelady E, Verdonschot N, Janssen D. A combined experimental and finite element approach to analyse the fretting mechanism of the head-stem taper junction in total hip replacement. Proc Inst Mech Eng H. 2017;231(9):862–70.
6. Jones DM, Marsh JL, Nepola JV, et al. Focal osteolysis at the junctions of a modular stainless-steel femoral intramedullary nail. J Bone Joint Surg Am 2001; 83: 537-48.
7. Lee SH, Brennan FR, Jacobs JJ, et al. Human monocyte/macrophage response to cobalt-chromium corrosion products and titanium particles in patients with total joint replacements. J Orthop Res 1997; 15: 40-9.
8. Murena L, Maritan G, Concina C, Scamacca V, Ratti C, Canton G. Fracture of Cobalt-Crome Modular Neck in Total Hip Arthroplasty. Acta Biomed [Internet]. 2019 Dec. 5 [cited 2021 Oct. 17];90(12-S):187-91.
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.
10. Vatani N, Comando D, Acuna J, Prieto D, Caviglia H. Faulty design increases the risk of neck fracture in a hip prosthesis. Acta Orthop Scand 2002;73:513.
11. Bitter T, Khan I, Marriott T, Lovelady E, Verdonschot N, Janssen D. The effects of manufacturing tolerances and assembly force on the volumetric wear at the taper junction in modular total hip arthroplasty. Comput Methods Biomech Biomed Eng. 2019;17:1–12.
12. Berstock JR, Whitehouse MR, Duncan CP. Trunnion corrosion: what surgeons need to know in 2018. Bone Joint J. 2018;100-b(1 Supple A):44–9.
13. Siljander MP, Gehrke CK, Wheeler SD et al. Does taper design affect taper fretting corrosion in ceramic-on-polyethylene total hip arthroplasty? A retrieval analysis. J Arthroplast. 2019;34(7S):S366– S372.e2.
14. Tucker K, Pickford M, Newell C, Howard P, Hunt LP, Blom AW. Mixing of components from different manufacturers in total hip arthroplasty: prevalence and comparative outcomes. Acta Orthop. 2015;86(6):671–7.
15. Mueller U, Panzram B, Braun S, Sonntag R, Kretzer JP. Mixing of head-stem components in Total hip Arthroplasty. J Arthroplast. 2018;33(3):945–51.
16. Ahrengart L, Lindgren U. Heterotopic bone after hip arthroplasty. Defining the patient at risk. Clin Orthop. 1993;293:153–159.
17. McCarthy EF, Sundaram M. Heterotopic ossification: a review. Skeletal Radiol. 2005;34:609–619.
18. Toom A, Haviko T, Rips L. Heterotopic ossification after total hip arthroplasty. Int Orthop. 2001;24(6):323–326.
19. Morrey BF, Adams RA, Cabanela ME. Comparison of heterotopic bone after anterolateral, transtrochanteric, and posterior approaches for total hip arthroplasty. Clin Orthop. 1984;188:160–167.
20. Eggli S, Woo A. Risk factors for heterotopic ossification in total hip arthroplasty. Arch Orthop Trauma Surg. 2001;121(9):531–535.
21. Unger AC, Schulz AP, Peach A, Jurgens C, Renken FG.

Modified direct anterior approach in minimally invasive hip hemiarthroplasty in a geriatric population: a feasibility study and description of the technique. Arch Orthop Trauma Surg. 2013;133(11):1509–16.
22. Brooker AF, Bowerman JW, Robinson RA, et al. Ectopic ossification following total hip replacement. J Bone Joint Surg Am 1973;55-A:1629.
23. Pohl F, Seufert J, Tauscher A, et al. The Influence of Heterotopic Ossification on Functional Status of Hip Joint Following Total Hip Arthroplasty. Strahlenther Onkol 181, (2005);529–533.

Correspondence:
Received: 2 November 2022
Accepted: 16 March 2023
Giovanni Barbo
Orthopedics and Traumatology Unit, Cattinara Hospital - ASUGI, Department of Medical, Surgical and Life Sciences, Trieste University, Trieste (Italy)
Phone number: +39 0403994730.
Fax number: +39 0403994544.
E-mail address: giovanni.barbo@outlook.it