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Humeral socket decoupling from the stem causes mechanical failure of a reverse shoulder prosthesis. A case report

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The reverse total shoulder arthroplasty (rTSA) is a standard procedure nowadays mainly indicated for the treatment of rotator cuff tear (RCT) arthropathy or pseudoparalysis, irreparable RCT, tumor resection, revision shoulder arthroplasty, fracture sequelae, and, more recently, for comminuted nonreconstructable proximal humerus fractures.[1,4] Reverse shoulder prostheses (RSPs) have been used for more than 3 decades with favorable functional results, especially in older patients (>70 years old) and relatively low complication rates.[1,4] Huddleston et al[15] reported 90-day and long-term complication rates of 7.1%-11.5% and 7%, respectively. Chelli et al[7] estimated a pooled complication incidence of 16.5% (range, 2%-38%) in patients 65 years or younger, while Su et al[29] found a pooled complication rate of 9.9% (range, 3.5%-41.9%) in patients over 70 years of age, being the most common instability and infection for the former group[7] and acromion stress fracture for the later.[29]

Mechanical failure of the RSP can occur on the glenoid or humeral components (HCs), primarily documented in association with implant loosening[14] and glenosphere disengagement[9,13,21] or the polyethylene dissociation from the humeral stem.[10,25,26,32] Although uncommon, humeral tray failure could be related to design flaws or fatigue fractures.[16,17,19,31]

Here, we present the case of a patient who underwent rTSA with excellent functional results but who, a year later, after multiple surgical interventions nonrelated to the RSP, presented an implant failure with decoupling of the humeral socket that rotated on its axis.

Case report

A 65-year-old patient required an rTSA with latissimus dorsi transfer of the right shoulder for a massive, irreparable, Goutallier 3 – 4/4, RCT (Patte stage III of supraspinous and infraspinous tendons' retraction and Lafosse type IV of subscapularis tendon rupture) after a failed repair of the RCT with biceps tenotomy presenting with combined loss of active elevation and external rotation/CLEER.[5] The rTSA was performed with a standard deltopectoral approach using a modular RSP (RSP, DJO Surgical) with glenoid lateralization and latissimus dorsi transfer through the same deltopectoral approach. The latissimus dorsi transfer was performed through a bone tunnel, fixating it with a button according to the technique described by Boileau et al[5] respecting the insertion of the pectoralis major muscle. A 7-mm stem HC was used with a cementless fixation performed with an impaction technique of bone autograft from the humeral head, as described by Lucas et al.[18] The patient recovered adequately after the rTSA; at 6 months postoperative (POP) presented an elevation of 120° (180° in the contralateral shoulder), symmetrical external rotation of 45°, and internal rotation to L1 (to T10 in the contralateral shoulder), and mild, occasional pain (visual analog scale of 3) (Fig. 1).

The patient returned after 11 months of POP, experiencing intense pain in the right shoulder for about 1 month that arose after several surgical procedures and hospitalization due to a complicated prostatectomy. The patient did not recall any impact, trauma, or sudden movement that could have caused the pain. At examination, the right shoulder did not show external signs of trauma or deformity; the active elevation was 100°, external rotation was 0°,

The ethics committee of authors' institution approved this report; Clinica del Campestre (file number AD-AU-39 of 11/10/2023).

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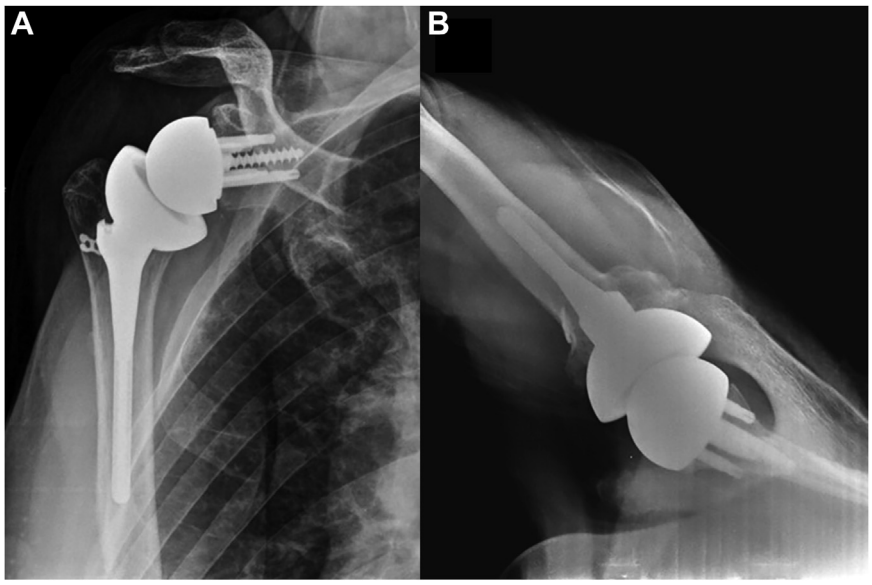

Figure 1 Six months follow-up X-rays of first RSP. Anteroposterior (**A**) and axillar (**B**) projections of the right shoulder show the correct initial position of both humeral and glenoid components of the reverse shoulder prosthesis. *RSP*, reverse shoulder prosthesis.

and a positive external rotation lag sign. The anteroposterior, lateral, and axillar X-ray views showed the prosthesis's failure of the HC with the humeral socket out of contact with the stem but still articulating with the geosphere (Fig. 2).

The revision surgery went without complications. Even though there were no signs of loosening during the procedure, the HC was removed for further evaluation and to obtain samples for cultures. The same deltopectoral approach through the incision of the index procedure was used, finding that the humeral socket was loose and rotated on itself (Fig. 3). Causes such as an active infection through negative cultures (joint fluid, capsular membrane, humeral canal membrane, shoulder membrane, and humeral bone) or bone defects were ruled out. The new HC comprised a 7-mm stem attached to antibiotics-loaded cement, a 4+ humeral socket, and a 36 semiconstrained insert. The glenoid component (GC) was intact and stable.

Once the failed HC was retrieved, it was noticed that the complete humeral socket was decoupled but not fractured from the stem; the manufacturer's representative inspected the HC (socket and stem) to analyze the cause of the decoupling. There were no mechanical implant failures or signs of overload, as the components appeared intact (Fig. 4).

From the early POP evaluations, the patient showed functional recovery to the levels achieved before the implant failure. Eighteen months after the index surgery and 6 months after the revision procedure, the patient reported occasional pain visual analog scale 2 in the right shoulder that, at physical examination, showed an elevation of 130°, external rotation of 45°, and internal rotation to T10. The follow-up radiographic views show the implant and all its components in place and fully articulated (Fig. 5).

Our institutional review board approved this report, and the patient signed an informed consent authorizing the use of his clinical data for this publication.

Discussion

We present the case of a humeral socket decoupling from the stem of a modular RSP after a year of an otherwise successful rTSA. Rarely, in this case, the HC decoupled rather than fracturing. To our knowledge, a case like this has yet to be published.

RSP emerged several decades ago as a more controlled implant of inversed configuration that would improve the tension in the deltoid, increase the range of upper limb movement, and stabilize the glenohumeral joint to compensate for rotator cuff insufficiency.[3,6]

Since then, the implants have evolved in their designs and surgical approaches, considering variables that influence clinical outcomes such as glenosphere diameter, glenoid base plate tilt, neck–shaft angle of the humerus, and component fixation.[1] Initially, in Grammont's design, the HC integrated a small cup with a nonanatomic neck–shaft angle of 155° that covered less than half of the glenosphere[12]; this cemented stem showed a high rate of loosening and impaired range of motion due to increased stress shielding.[12] Advances in the prosthesis design have included uncemented and proximally coated HCs for press-fit fixation[12] and reductions of the HC neck–shaft angle to minimize inferior scapular impingement and notching.[4] On the other hand, a modular humeral stem design has allowed easiness of conversion from an anatomical total shoulder arthroplasty to rTSA by avoiding removal of the cemented or fixed glenoid or HCs and the complications it might have, such as fractures and bone loss.[11,24,30]

Different mechanical failures of the modular RSPs have been published. Shah et al[27] reported a pooled mean incidence of GC and HC loosening of 2.3% and 1.4%, respectively, probably related to proximal bone resorption and stress shielding or infection.[27] Dissociation of the polyethylene liner has been reported by several authors owing it to loosening after a closed dislocation reduction[10,23,25,32] or scapular notching.[22]

Before the Morse taper implant design entered the market, the reported GC and HC dissociations were mainly caused by unscrewing of the glenosphere to the baseplate[28] and of the humeral tray from the stem due to the torque at the screwed junction during maximal internal rotation.[2,8,31]

With the most recent Morse taper design, GC and HC dissociations have also been reported. Glenosphere-baseplate dissociation was informed by Cusick et al[9] with a rate of <1%, of which 85% occurred in DJO implants. The authors suggested that mechanisms

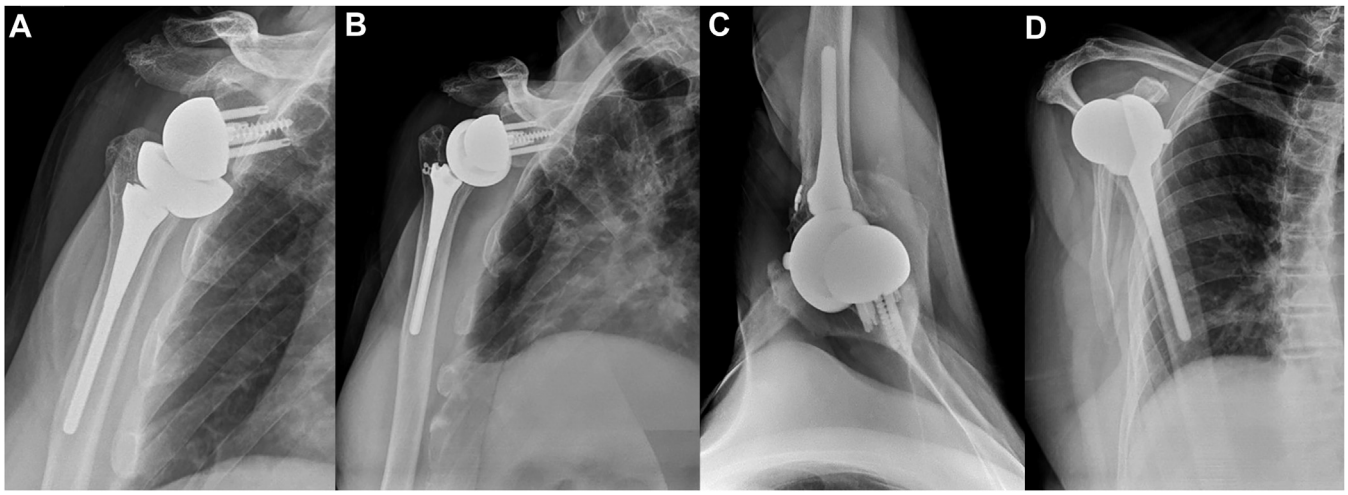

Figure 2 Implant failure X-rays. Anteroposterior (**A** and **B**), axillar (**C**), and lateral (**D**) radiographic views of the right shoulder display a variation in the position of the humeral socket with rotation on its axis.

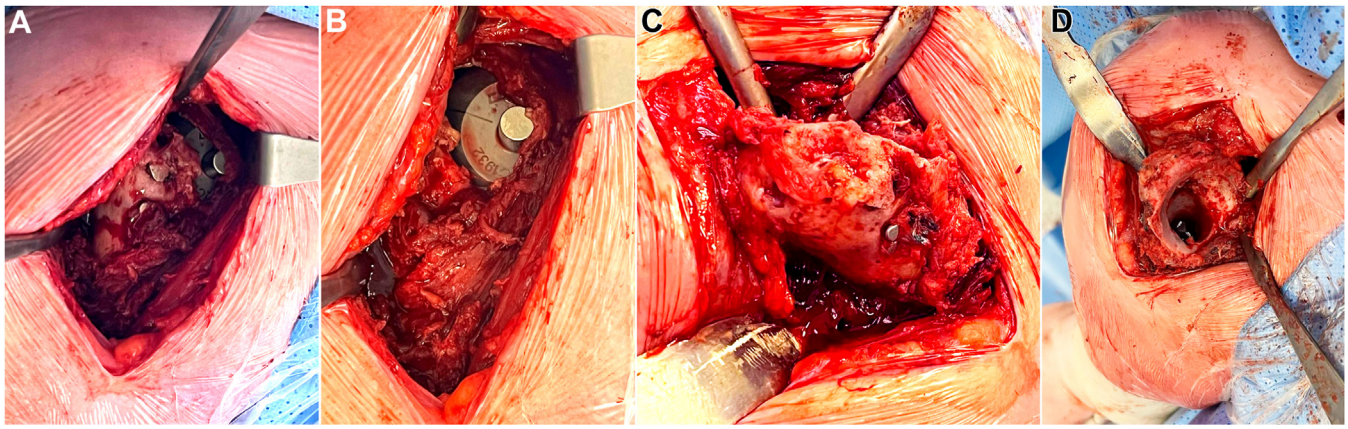

Figure 3 Surgical views of the decoupled humeral socket. Images (**A**) and (**B**) show the humeral socket decoupled from the stem, exposing the Morse taper. Pictures (**C**) and (**D**) depict the humeral bone and canal without bone defects or macroscopic signs of infection. The latissimus dorsi transfer fixation button previously performed with the rTSA appeared in place and intact. *rTSA*, reverse total shoulder arthroplasty.

such as inadequate taper design, manufacturing, or surgical impaction, among others, could contribute to GC failure.[9] Conversely, the HC failures have been attributed to fatigue leading to cracks or fractures at the taper fillet in titanium alloy implants,[17,19] specific implant models,[16] or to loosening and detachment of the tray from the taper.[14,20]

In the literature, when the dissociation was not caused by a fatigue fracture in the trunnion–tray interface like the cases informed by Lewicki et al[17] and MacDonald et al,[19] it originated from a traumatic event leading to failure in the tray–taper interface, as evidenced by dynamic fluoroscopic assessment, like in some of the cases published by McDonald et al[20] or by a non-traumatic separation at the tray–taper interface with the socket remaining attached to the stem, as described by Hosking et al.[14]

In our case, the clinical presentation was very florid, with intense pain and functional disability, yet the etiologic mechanism was not precise. At the x-rays, it was evident that the hole humeral socket was still attached to the tray and taper, but it was separated from the stem and rotated on its axis.

Like the findings of McDonald et al,[20] in our case, the visual inspection of the retrieved components showed no signs of wear, overload, cracks, or fracture lines at the socket-stem or tray-taper interfaces or metallic debris or glenoid notching.

We speculate that, in the absence of trauma, the HC failure of the Morse taper implant in our patient at nearly 1 year of the rTSA could likely be caused by a manufacturing deficiency or a technical or human error during the surgical procedure, such as some barrier preventing the correct assembly of the parts of the HC or low impaction force at the socket-stem union. However, the presence of a barrier is unlikely, as the surgeons would have noticed it. The manufacturer representative was present during the revision surgery and notified the headquarters; by the time of submission of this report, a response from the manufacturer had not been received.

To overcome these potential errors, we suggest the surgeon always check the impaction and verify that the humeral module composed of stem and socket does not move after impaction; this should be part of the procedure checking list. In our setting, the manufacturer representative enters and participates in the surgery and is usually in charge of the impaction. We advise the surgeon to double-check this part of the procedure customarily.

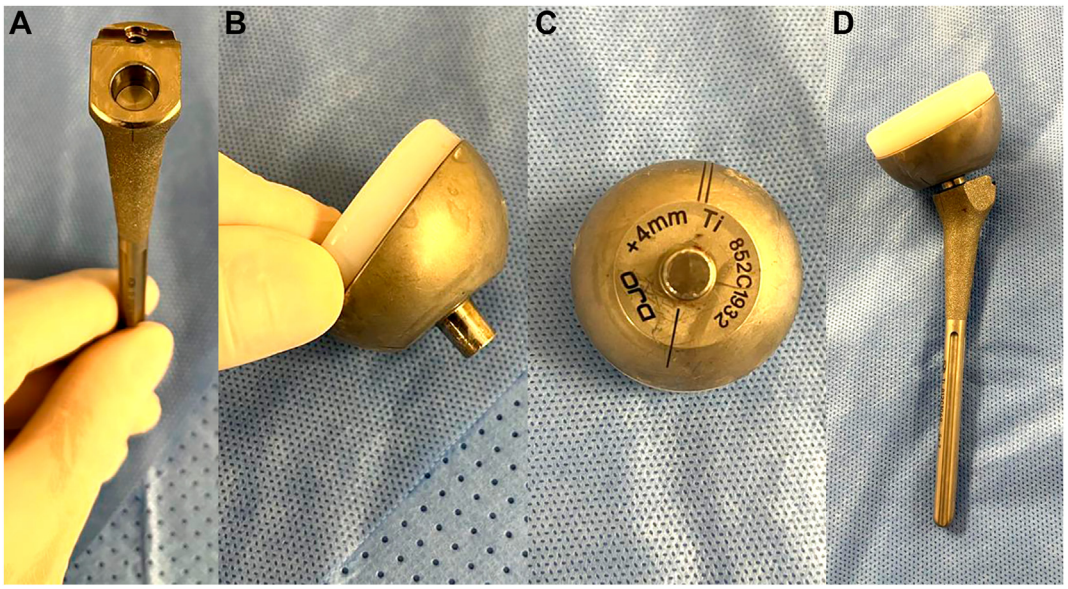

Figure 4 Retrieved humeral components of the RSP: Stem (**A**), socket (**B** and **C**), and assembled component (**D**). Humeral components showed no signs of mechanical failure in the Morse taper or polyethylene wear. *RSP*, reverse shoulder prosthesis.

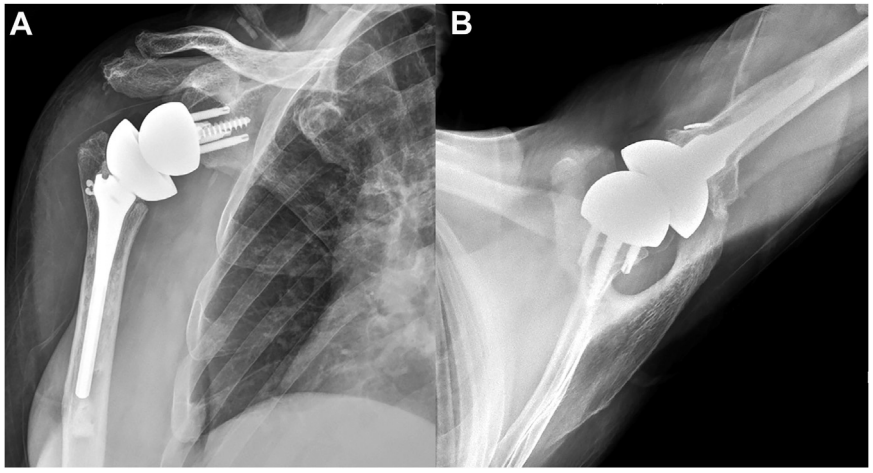

Figure 5 Twenty-four weeks follow-up X-rays of revision surgery. Revision follow-up anteroposterior (**A**) and axillary (**B**) radiographs of the cemented humeral component showed recovery of the position and reference parameters in all the projections.

Conclusion

We report a rare case of humeral socket decoupling from the stem after an otherwise successful rTSA, which occurred 1 year following the procedure without any trauma. Management of this complication required retrieving the whole HC and replacing it during revision surgery, after which the patient had a successful outcome. No other similar events have been reported involving this specific prosthesis model. Shoulder surgeons should be aware of this infrequent complication, especially when using modular prostheses, and should always check for the correct assembly of the components.

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