

Metallosis after reverse total shoulder arthroplasty

Alexander J. Rondon, Tyler R. Clark, Felix H. Savoie

ABSTRACT

Introduction: We present a case of metallosis following a reverse total shoulder arthroplasty. We are not aware of any cases described in literature of metallosis following reverse total shoulder arthroplasty with well-fixed implants. To date, there have been four cases described in literature that have found metallosis following shoulder replacement surgery: three following hemiarthroplasty and one following total shoulder arthroplasty. **Case Report:** Our patient dislocated seven months postoperatively, and with concern of further instability as noted on examination, the patient was taken to the operating room for glenosphere and liner exchange. During surgery, severe metallic staining was discovered in the joint as well as significant inferomedial wear to the polyethylene insert. This was likely due to instability as a result of inadequate tension on the deltoid muscle, inadequate liner size, early hypermobility, downward tilt of the glenoid, and failure to lateralize the component sufficiently. **It is our hypothesis that the glenoid component articulated with the metal humeral neck due to asymmetric polyethylene wear of the humeral cup. This likely led to metal-on-metal wear and allowed the release of metal ions into the local**

environment. Conclusion: Future consideration must be given to the size and angle of the humeral and glenoid components in reverse total shoulder arthroplasties. It is our hope that our case emphasizes the importance of proper prosthetic placement and establishes a higher level of suspicion for metallosis as a complication for reverse total shoulder arthroplasties.

Keywords: Arthroplasty, Metallosis, Reverse, Shoulder

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INTRODUCTION

Metallosis is defined by the accumulation of metal-on-metal wear debris that results in the release of metal ions. These metal ions produce a hypersensitivity reaction characterized by a macrophage response with the formation of giant cells and fibrosis [1, 2]. Metallosis most commonly occurs in weight bearing orthopedic prosthetic implants, though it has also been observed in non-weight-bearing implants.

There have been four cases in literature that have found metallosis following shoulder replacement surgery. Two cases following hemiarthroplasty of the shoulder

due to wear against metal suture anchors, one case following hemiarthroplasty of the shoulder due to surface coating of implant, and one case following Nottingham total shoulder arthroplasty due to porous metal attaching to poly and causing abrasive wear of humeral head [1–3]. The only documented cases of metallosis following reverse total shoulder arthroplasty have occurred after patient developed loose components, we are unaware of any cases of metallosis following reverse total shoulder arthroplasty with well-fixed implants in literature [4]. In this case report, we describe a case of metallosis in a reverse total shoulder arthroplasty that was revised due to dislocation and metallosis failure.

CASE REPORT

A 65-year-old female with a history of scleroderma, underwent right shoulder arthroscopic rotator cuff repair in 2012 at age 62. By age 63, she had recurrent rotator cuff tears with atrophy in her right shoulder and had failed conservative measures. In 2015, she was treated with a reverse total shoulder arthroplasty due to her connective tissue disorder.

The reverse total shoulder arthroplasty was performed with a reverse shoulder prosthesis (Figure 1). Her postoperative course was initially uncomplicated. Three-week and five-month follow-up radiographic examination revealed intact prosthesis (Figures 2 and 3).

Seven months postoperatively, the patient reported a muscle spasm in her right shoulder while at the grocery store where her right shoulder spontaneously dislocated. Examination of the right shoulder revealed the shoulder in a shortened internally rotated position. The prosthesis was palpable and dislocated anteriorly. Plain radiographs revealed dislocated right shoulder prosthesis (Figure 4), which was later manually reduced via closed reduction in the emergency room.

Given the elevated humeral component and clinical instability of the shoulder, the decision to return to the operating room for revision surgery was taken. Initial concerns for infection were high. Prior to surgery, laboratory results were taken to rule out infection and were unremarkable. She was taken to the operating room for a liner exchange and increase in the glenosphere from 36–42 due to concern of under sizing of liner. During surgery, severe metallic staining was detected in the intra-articular cavity and in the extra-articular tissues (Figures 5 and 6). The polyethylene cup was removed and found to have some wear on the inferior surface (Figure 7). A diagnosis of metallosis of reverse total shoulder arthroplasty was made. The metallic, blackened tissue was removed and sent for frozen section (Figure 8). The prosthesis were exchanged. Pathology reported the tissue frozen section sample contained fibrin clots with macrophages containing black-green cytoplasmic pigment consistent with origin from detritus-like change.

The patient's postoperative course for her revision RTSA has been stable and since uncomplicated with negative final intraoperative cultures. Three month postoperative blood workup for cobalt was negative and within normal limits. Three month postoperative bloodwork for chromium were slightly elevated at the high end within normal limits. Six-month blood work all returned within normal limits.

DISCUSSION

We are not aware of any cases described in literature of metallosis following reverse total shoulder arthroplasty with well-fixed implants. The only documented cases of metallosis following reverse total shoulder arthroplasty



Figure 1: Postoperative radiograph for primary reverse total shoulder arthroplasty.



Figure 2: Three-week follow-up postoperative radiograph for primary reverse total shoulder arthroplasty.



Figure 3: Five-month follow-up postoperative radiograph for primary reverse total shoulder arthroplasty.

have occurred after patient developed loose components [4]. There have been four cases in literature that have found metallosis following shoulder replacement surgery. Two cases following hemiarthroplasty of the shoulder due to wear against metal suture anchors, one case following hemiarthroplasty of the shoulder due to surface coating of implant, and one case following Nottingham total



Figure 5: Intraoperative image during revision reverse total shoulder arthroplasty.



Figure 4: Primary reverse total shoulder arthroplasty dislocation.



Figure 6: Intraoperative image during revision reverse total shoulder arthroplasty.



Figure 7: Polyethylene cup with inferior wear removed during revision reverse total shoulder arthroplasty.



Figure 8: Blackened fibroconnective tissue collected during revision reverse total shoulder arthroplasty.

shoulder arthroplasty due to porous metal attaching to poly and causing abrasive wear of humeral head [1–3].

Metallosis is defined by the metal-on-metal contact with periprosthetic tissues leading to the release of metal ions, which in turn bind to native proteins resulting in a hypersensitivity reaction. This reaction leads to an inflammatory response resulting in the recruitment of macrophages and formation of granulation tissue [1, 5, 6]. Typically, metallosis has been reported following total hip arthroplasty and total knee arthroplasty [7–12]. It has also been reported in non-weight bearing orthopedic joint implants such as wrist, elbow, and shoulder [12, 13]. The diagnosis of metallosis cannot be made radiographically as imaging has not been able to reliably demonstrate the presence of metallosis [11].

Reverse total shoulder arthroplasty (RTSA) are traditionally performed as a final option for when all prior avenues have been exhausted in rotator cuff deficient shoulders. Indications for RTSA are rotator cuff tear arthrosis, pseudo-paralysis due to irreparable rotator cuff tear, severe fracture not amenable to conservative management or open reduction and internal fixation, prosthetic revision in cuff deficient shoulder, or tumor [14]. Primary goals for this procedure are pain relief and functional improvement. RTSA reverse engineers the normal anatomy of the shoulder ball and socket joint by placing the ball on the glenoid component and creating a socket in the humeral component. RTSA can fail for several reasons such as instability, infection, component loosening, periprosthetic fracture, motion loss, or soft tissue failure [4, 15]. One study examined over 4000 patients who required a revision RTSA of a shoulder arthroplasty within one year. Several factors were found that predisposed individuals to early revision of RTSA. These factors included whether they were male, under age of 65, smoking status, obesity, and morbid obesity [15]. Interestingly, the patient in this case report had none of these factors.

A retrospective study, examining 191 RTSA, found dislocations to be a common complication seen in 7.5% (15 total) of RTSA [16]. Another article performed a systematic review of 782 RTSA and reported incidence of instability to be 4.7% (37/782). 97.3% of these complications occurred in patients who had undergone a deltopectoral approach [17].

Infection and instability are concerning complications of RTSA occurring in 3.8% and 4.7% of cases, respectively, thus a high index of suspicion for infection was warranted following a successful reduction of the dislocation [17, 18]. After infection was ruled out, the plan for her revision of her right RTSA was to perform a liner exchange and increase glenosphere size from 36–42. Increasing the size of the glenoid component increases shoulder stability and arc of motion [14].

During surgery, severe metallic staining was discovered in the joint confirming the diagnosis of metallosis as well as significant inferomedial wear to the polyethylene insert. This was likely due to instability as a result of inadequate tension on the deltoid muscle, inadequate liner size, early hypermobility, downward tilt of the glenoid, and failure to lateralize the component sufficiently [14]. Pathology reported the tissue collected during surgery contained fibrin clots with macrophages containing black-green cytoplasmic pigment consistent with origin from detritus-like change. It is important to note that three month post-operative bloodwork for chromium did return slightly elevated, however, were still within normal limit range. A review article by Jantzen et al. examined 43 separate studies examining metal-on-metal implants and metal ion concentrations in blood and serum. It was concluded in the article that ion concentrations at which toxicity is induced are not yet known, so safe levels of cobalt and chromium cannot be determined [19].

It is our hypothesis that the glenoid component articulated with the metal humeral neck due to asymmetric polyethylene wear of the humeral cup. This likely led to metal on metal wear and allowed the release of metal ions into the local environment. Gutierrez et al. describe the most effective method to avoid adduction impingement is to have humeral neck shaft angle of 130 degrees, followed by inferior glenosphere position, 10 mm lateral offset center of rotation, and 42 mm diameter glenosphere [17, 18, 20]. In this case, a DePuy Unite reverse shoulder prosthesis was utilized. The humeral shaft angle of 135° was achieved along with a 10 mm lateral offset center for rotation, however, a 36 mm glenosphere was used.

Nalbone et al. conducted a computer-based study focusing on instability and polyethylene wear in reverse total shoulder arthroplasties with a focus on humeral component positioning. This study evaluated shoulder stability in reverse total shoulder arthroplasty while varying the humeral component positioning. The humeral component position was found to be a major contributor to stability and overall wear on the polyethylene cup. It found that when the humeral component was retroverted at 20° versus 0°, stability increased while overall wear on the polyethylene cup decreased. Glenosphere radius, depth of humeral cup, reconstruction of the soft tissues, tensioning of the deltoid, components positioning, inadequate bone stock of the glenoid and the humeral head were several factors found to contribute to glenohumeral instability [21]. Component positioning, failure to lateralize the humeral component sufficiently and/or downward tilting of glenoid, is a potential cause for dislocation in this case. As shown in Nalbone et al., proper humeral component position can lead to increased stability and decreased polyethylene wear.

Struyf et al. performed a systematic review of scapular position with respect to glenohumeral shoulder instability, and found that patients with increased instability had decreased scapular upward rotation and increased internal rotation [22]. This relationship of scapular positioning and shoulder instability could be the root source for the failure in this case report.

In addition to component positioning, early hypermobility of the reconstructed shoulder could have contributed to the failure. In our case, the patient quickly progressed to improved range of motion after surgery. Her early return to mobility as well as her underlying connective tissue disorder may have created sufficient laxity to contribute to a subluxation. Though scleroderma is typically associated with tightening of tissues and joints, there has been one case documented in literature of hypermobility associated with scleroderma [23].

CONCLUSION

Orthopedic surgeons should keep metallosis in mind as a differential diagnosis for reverse total shoulder arthroplasty complications when other causes have

been ruled out. This case reports the first documented case of metallosis occurring in a reverse total shoulder. We suggest, based on the inferior wear of the humeral polyethylene cup, that erosion of the polyethylene humeral cup lead to the articulation of the glenosphere with the metallic humeral component resulting in metal-on-metal contact. Future consideration must be given to the size and angle of the humeral and glenoid components in reverse total shoulder arthroplasties. It is our hope that our case emphasizes the importance of proper prosthetic placement and establishes a higher level of suspicion for metallosis as a complication for reverse total shoulder arthroplasties.

Author Contributions

Alexander J. Rondon – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published

Tyler R. Clark – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published

Felix H. Savoie – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published

Guarantor

The corresponding author is the guarantor of submission.

Conflict of Interest

The author, Alexander J. Rondon MS, declares no conflict of interest.

The author, Tyler R. Clark MD, declares no conflict of interest.

The author, Felix H. Savoie, III MD, conflicts of interest are listed below:

American Shoulder and Elbow Surgeons: Board or committee member

Arthroscopy: Editorial or governing board

Arthroscopy Association of North America: Board or committee member

Biomet: Unpaid consultant

Conmed Linvatec: Unpaid consultant

Exactech, Inc: IP royalties; Unpaid consultant

J wrist surgery: Editorial or governing board

Mitek: Paid presenter or speaker; Research support; Unpaid consultant

Rotation Medical: Unpaid consultant

Smith & Nephew: Paid presenter or speaker; Unpaid consultant

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