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Staged Arthroscopic Rotator Cuff Repair with a Bridging Acellular Human Dermal Graft in the Treatment of Infection Following Open Rotator Cuff Repair

A Case Report

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Investigation performed at The Shoulder Center, Carmel, Indiana

Although infection after rotator cuff repair occurs infrequently, it can be a catastrophic complication. To the best of my knowledge, there are only a small number of reports in the literature regarding management of these infections, and none of these report the outcome of a staged arthroscopic approach[1-6]. Once the infection has resolved, reconstruction of the residual rotator cuff defect can present a substantial challenge for the treating orthopaedic surgeon.

The purpose of this report is to present the clinical, functional, and magnetic resonance imaging (MRI) results of an all-arthroscopic approach for the management of a massive rotator cuff tear defect resulting from an infection after an initial open rotator cuff repair. The patient was informed that data concerning his case would be submitted for publication, and he provided consent.

Case Report

A thirty-two-year-old right-hand dominant man with medical comorbidities including diabetes, hypertension, and obesity (body-mass index [BMI] > 40) was referred to our shoulder clinic in October 2009 for a persistent deep left shoulder infection after an open rotator cuff repair. The patient had initially been treated with an open rotator cuff repair with a mesh reinforcement graft in August 2009. The patient had experienced persistent pain and had developed a draining wound, which had been managed with serial debridement, wound care, and intravenous antibiotics for a period of three weeks, followed by oral antibiotics (Augmentin [amoxicillin and clavulanate] and then Levaquin [levofloxacin]) and dressing changes. Previous culture specimens had been positive for *Propionibacterium acnes*. Despite the aggressive surgical care and serial debridement, the patient had a persistent arthrocutaneous fistula along with dehiscence of the deltoid muscle. He then was referred to our tertiary care shoulder clinic for definitive

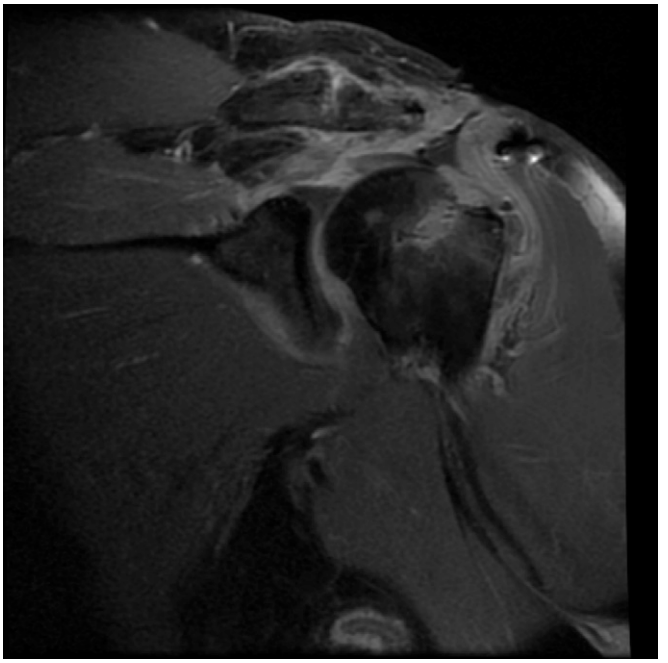

Fig. 1

MRI (coronal view) of the shoulder, consistent with osteomyelitis of the greater tuberosity, diffuse infectious synovitis, deltoid dehiscence, arthrocutaneous fistula, and a massive rotator cuff tear with substantial retraction and fibrosis to the undersurface of the acromion.

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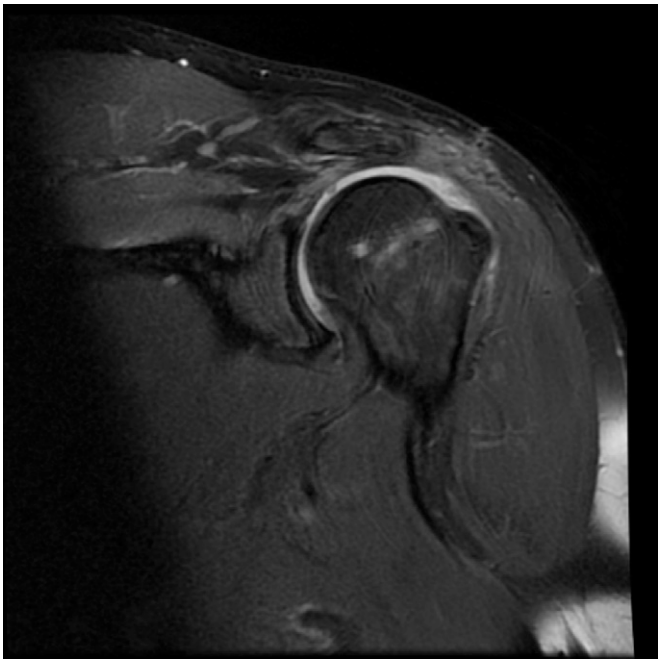

Fig. 2

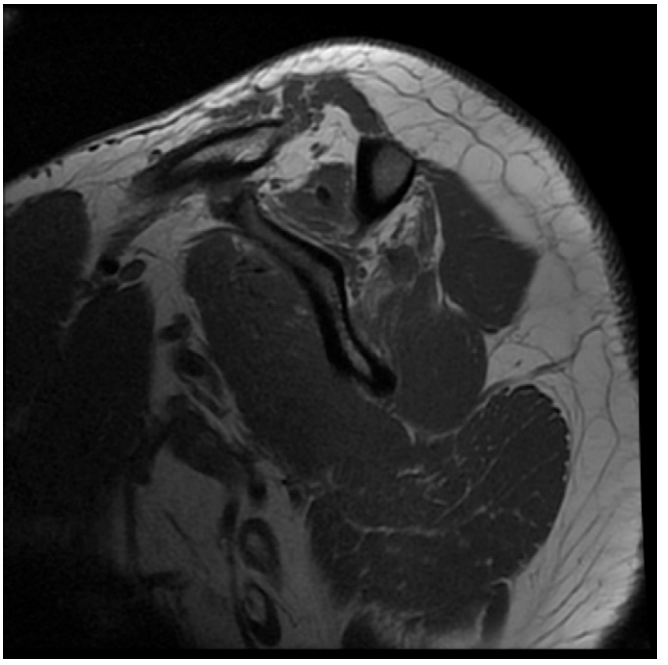

Fig. 3

Fig. 2 MRI (coronal view) of the shoulder following initial definitive debridement, consistent with resolution of osteomyelitis and repaired deltoid dehiscence and residual massive rotator cuff tear. **Fig. 3** T1-weighted MRI (sagittal view) of the shoulder shows grade-1 fatty infiltration of the supraspinatus muscle with a positive tangent sign consistent with substantial atrophy, and grade-2 fatty infiltration of the infraspinatus muscle.

management. In addition to a thorough history and physical examination, we also obtained an infectious disease consultation and MRI of the left shoulder with intravenous (IV) gadolinium enhancement. The MRI was consistent with osteomyelitis of the greater tuberosity, diffuse infectious synovitis, deltoid dehiscence, arthrocutaneous fistula, and a massive rotator cuff tear involving

Fig. 4-A

Fig. 4-B

Fig. 4-A MRI (coronal view) of the shoulder at one-year postsurgery shows the supraspinatus tendon at the level of the humeral head with the bridging graft (arrows). **Fig. 4-B** MRI (sagittal view) of the shoulder at one-year postsurgery shows the intact bridging graft (arrows).

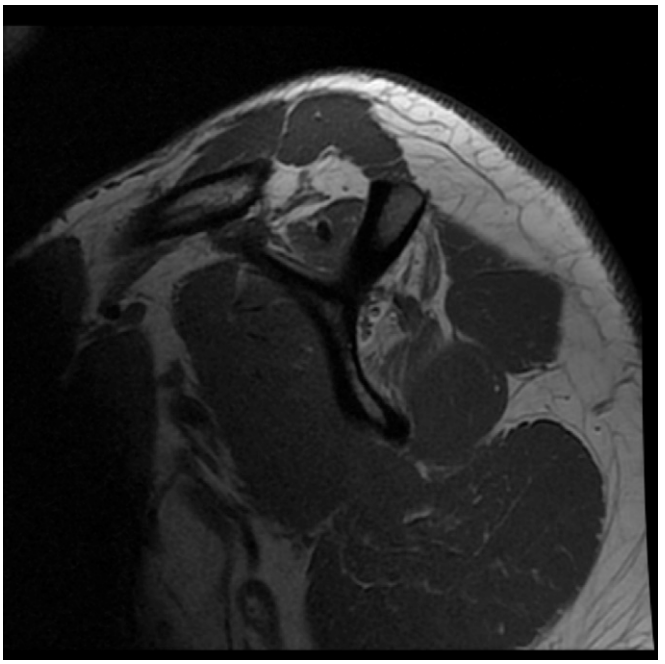

Fig. 5

T1-weighted MRI (sagittal view) of the shoulder at one-year postsurgery shows grade-1 fatty infiltration of the supraspinatus muscle with a positive tangent sign, consistent with substantial atrophy (unchanged from before surgery), and grade-3 fatty infiltration of the infraspinatus muscle (had progressed from the grade-2 changes before surgery).

the supraspinatus and infraspinatus tendons with substantial retraction as well as atrophy with fibrosis of the rotator cuff to the undersurface of the acromion (Fig. 1). After the infectious disease consultation, we recommended discontinuation of all antibiotics for at least two weeks prior to the initial radical debridement portion of our recommended staged approach in order to have the best chance of isolating an organism in the intraoperative culture specimens. We performed an extensive arthroscopic debridement, including global capsulotomy, biceps tenotomy (frayed), coring of prior suture anchor tracks with removal of retained foreign body and placement of vancomycin-impregnated calcium paste (PRO-DENSE; Wright Medical), excision of the fistula, primary repair of the deltoid dehiscence with absorbable monofilament suture, and closure of the skin wound with monofilament nylon suture. All culture specimens were negative, and the patient was empirically started on daptomycin for a six-week postoperative duration. He healed uneventfully, and a repeat MRI of the left shoulder with IV gadolinium enhancement demonstrated excellent healing of the deltoid dehiscence and resolution of the osteomyelitis (Fig. 2). At that time, he had a massive rotator cuff tear with grade-1 fatty infiltration of the supraspinatus muscle with a positive tangent sign for substantial atrophy, and grade-2 fatty infiltration of the infraspinatus muscle with substantial retraction and fibrosis (Fig. 3). Two months after the radical debridement, we proceeded with revision arthroscopic repair of the massive rotator cuff defect. Because the patient had a deficiency of a substantial portion of the supraspinatus tendon, we elected to utilize an acellular dermal graft (Allopatch HD; Musculoskeletal Transplant Foundation [MTF]) to serve both reinforcement and bridging functions. The postoperative course was uneventful. The patient maintained supine passive and active motion for twelve postoperative weeks and then gradually progressed to full upright active shoulder motion. At the one-year follow-up, MRIs showed an intact bridging graft (Figs. 4-A and 4-B) with maintenance of grade-1 fatty infiltration of the supraspinatus muscle and increased grade-3 fatty infiltration of the infraspinatus muscle (Fig. 5). No evidence of recurrent or indolent infection was noted. The patient was extremely pleased with the outcome and had full active shoulder motion (Video 1; see Appendix). The Constant-Murley Shoulder Outcome Score improved from 25 (pretreatment) to 78 at the one-year follow-up, with the strength subset score improving from 0 to 5.5 kg. The normalized Flexilevel Scale of Shoulder Function score improved from 50 (pretreatment) to 70 at the one-year follow-up.

Discussion

Infection after rotator cuff repair is an infrequently reported but potentially devastating complication. Reported rates of infection following rotator cuff repair range from 0.27%[6] to 1.7%[7] for open repairs and 1.9%[4] for mini-open repairs. There are other potential complications stemming from infection following rotator cuff repair, including acute adhesive capsulitis, chondrolysis, osteomyelitis, secondary osteoarthritis, and failure of the rotator cuff repair[5,8]. Traditionally, the key to success is early detection, radical debridement, and long-term antibiotic therapy. Many authors report a mean of two-and-a-half serial procedures in concert with antibiotics to treat this problem[2,4-6].

Infection after open rotator cuff repair in the studies in the literature presents as two distinct populations: one acute or subacute, presenting within ninety days of the index procedure, and the other a chronic infection typically referred and/or treated at an interval greater than ninety days. Delay in diagnosis and treatment can result in poorer outcomes[5].

Mirzayan et al. outlined several factors associated with an increased risk of infection after open rotator cuff repair[5]. Chen et al. noted an increased rate (10%) of infection after open rotator cuff repair in thirty diabetic patients[9]. Our patient also had diabetes as an identifiable risk factor. As noted by Mirzayan et al. and reflected in our report, the number of patients in our experience is too small to draw any meaningful conclusions; however, a thorough evaluation preoperatively can help identify patients who are at risk for deep infection following shoulder surgery. Because there appears to be a lower rate of infection associated with arthroscopic surgery than with an open approach, these patients may benefit when it is possible to use an arthroscopic approach[10].

The most common pathogens cited in rotator cuff infections include *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Propionibacterium acnes*, and coagulase-negative staphylococci. Other reported organisms include *Peptostreptococcus*

magnus, *Pseudomonas aeruginosa*, streptococcal species, and Clostridium species[2,5].

Presenting signs, symptoms, and laboratory parameters can also vary based on the offending pathogen, as well as the severity and duration of infection. Acute infection, especially with a virulent organism, can present with a draining wound, elevated erythrocyte sedimentation rate, and elevated C-reactive protein level. Conversely, a chronic indolent infection with a fastidious organism may present with few or no clear indicators of deep infection. As noted by Mirzayan et al. and Settecerri et al., given the variable nature of presentation, a high index of suspicion is paramount because delay in treatment can affect outcomes[5,6].

As elegantly outlined by Mirzayan et al.[5], the principles of treatment for deep infection after rotator cuff repair include radical debridement of all devitalized and infected tissue while preserving as much residual muscle function as possible. Furthermore, when possible, all foreign material, including sutures (given that a lower bacterial load can result in infection in the presence of suture material[11]), should be removed to avoid any persistent nidus for infection[5]. In addition, adequate soft-tissue coverage can help promote host defense mechanisms to control the infection. It is important to note that fibrosis or dysfunction of the deltoid muscle also affects shoulder function[12].

A more minimally invasive approach has been cited to reduce morbidity to the deltoid muscle[13]. While remaining true to the principles of treatment outlined in previous studies, we chose an arthroscopic approach to debridement in order to preserve the soft-tissue envelope, minimize collateral trauma to healthy tissues, and allow comprehensive access to the entire glenohumeral joint and subacromial space for removal of devitalized tissue and foreign material. Additionally, we combined the initial radical arthroscopic debridement with excision of the arthrocutaneous fistula and repair of the deltoid dehiscence to provide a closed soft-tissue envelope[1,5]. Given the favorable results reported previously for a staged protocol for septic arthroplasty[14-16], we felt that a similar protocol may provide a more favorable outcome, reduce the number of surgical procedures, and reduce morbidity. Because of the advanced atrophy and retraction of our patient's rotator cuff muscles at the time of final reconstruction, complete primary repair was not possible. Rather than proceed with tendon transfers, based on our own experience and favorable reports in the literature, we elected to proceed with an entirely arthroscopic approach utilizing a bridging and reinforcement graft technique[17-19].

Regardless of the approach (open or arthroscopic), given the variable nature of presenting symptoms and delay in diagnosis, a high index of suspicion should be maintained when evaluating patients with persistent difficulty after shoulder surgery. An arthroscopic approach to debridement, followed by a staged reconstructive procedure, may be an alternative to serial debridement. For those patients with a residual rotator cuff defect after successful eradication of shoulder infection, an arthroscopic staged approach to treatment with use of an acellular dermal graft (Allopatch HD) may be a viable option.

Appendix

(eA) A video demonstrating that the range of motion of the left (treated) shoulder is similar to that of the unaffected right shoulder at the one-year follow-up is available with the online version of this article as a data supplement at jbjs.org. ■

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