Editorial

SCR 2021

You're going out a youngster but you've *got* to come back a star.

—James Seymour and Rian James, *42nd Street* (1993)

A remarkable development in orthopaedic sports medicine during the last decade has been the emergence of the superior capsule of the shoulder as a clinically important structure. If the parts of the shoulder were the cast of actors in a Broadway play, the superior capsule is the understudy that finally got its chance to play the lead, to the great acclaim of drama critics and theatergoers alike. That role of a lifetime has come in the international smash hit *Superior Capsular Reconstruction*.[1,13] In the words of 2 "critics," "this procedure has become a game changer, especially for a young and high-demand patient population."[15]

Until recently, I think it's fair to say that orthopaedic surgeons were aware that the superior shoulder capsule existed but generally regarded it as a thin layer on the undersurface of the rotator cuff with little function of its own. To quote an anatomic description of the supraspinatus and infraspinatus from 1992, "the fifth and deepest layer is a thin (1.5 to 2 millimeters thick) continuous sheet of interwoven collagen fibrils. This layer, which is the capsule of the shoulder joint, extends from the glenoid labrum medially to the humerus laterally where the fibrils insert on the humerus as Sharpey fibers within the bone."[6(p723)] More recently, a 2008 study that focused on the relative insertion footprints of the supraspinatus and infraspinatus contained a few brief mentions of the capsule.[29] In retrospect, the authors' observation that prior reports probably overestimated the size of the supraspinatus and infraspinatus insertions because they "contained the insertion area of the joint capsule" might have presaged coming recognition of greater functional importance for the capsule itself.[29(p967)]

Indeed, in 2012 several of the same authors promoted the superior capsule from a bit player in articles about the rotator cuff to a starring role in its own study.[30] In the process of more precisely describing the anatomy of the superior capsule, the authors of this investigation inferred a more important functional role than may have been previously appreciated. "In particular," they stated, "at the border between the infraspinatus and teres minor, the very thick attachment of the articular capsule compensated for the lack of tendinous insertion."[30(p868)] Conversely, they noted that the capsule varied considerably in the width of its footprint and that its thinnest point of attachment might contribute to the initiation of degenerative rotator cuff tears.

The authors of this important study may have been motivated by a 2010 case series published in the Japanese-language journal *Katakansetsu (The Shoulder Joint)*. "Clinical Outcomes After Arthroscopic Superior Capsular Reconstruction for Irreparable Rotator Cuff Tear"[28] would be the beginning of a long line of publications that would indelibly link the name of its first author, Teruhisa Mihata, with the concept of performing a superior capsular reconstruction (SCR) in shoulders whose rotator cuffs were damaged irretrievably beyond the reach of primary repair. This study served to introduce the surgical technique with a series of 10 patients followed for 12 to 18 months after surgery. The crux of the procedure was the creation of a new superior capsule with a fascia lata autograft anchored to the glenoid and humerus.

The biomechanical rationale for this technique was explained by Mihata and other colleagues in an English-language study published in the *American Journal of Sports Medicine* in 2012.[27] The authors created a simulated irreparable supraspinatus tear in 8 cadaveric shoulders and proceeded to reconstruct it in 3 ways: patching the gap in the supraspinatus tendon, using a similar patch to reconstruct the superior capsule, and reconstructing both the capsule and the supraspinatus with patches. While the laboratory-created cuff tear resulted in abnormal superior translation of the humeral head during simulated muscle contraction at varying degrees of abduction, patch-grafting the supraspinatus alone only partially restored normality. On the other hand, reconstruction of the superior capsule, with or without concomitant tendon reconstruction, reestablished normal humeral head position. A later study in cadavers by Mihata et al[26] noted additional biomechanical benefits of suturing the SCR graft to the residual infraspinatus tendon.

In subsequent publications, Mihata and multiple colleagues have added more patients and greater length of follow-up to the initial clinical report.[19,22,24] Mean 3-year results in 24 shoulders were published in 2013,[24] showing dramatic increases in active elevation from 84° to 148°, external rotation from 26° to 40°, acromiohumeral distance (AHD) from 4.6 mm to 8.7 mm, and American Shoulder and Elbow Surgeons (ASES) scores from 23.5 to 92.9. Five-year follow-up in a group of 30 patients, published in 2019,[22] documented a further improvement in the ASES score over the first-year results. Three patients with torn grafts exhibited severe rotator cuff arthropathy, while the remaining 27 had no progression of arthropathy over their baselines. A third study focused on the ability of patients to return to sports or physical work after SCR in

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a cohort of 100 participants.[19] When assessed 4 years after surgery, all 26 who played sports previously had resumed their avocations, while 32 of 34 physical laborers returned to full duty. Mihata and colleagues[23] have also reported the use of SCR to reinforce rotator cuffs that were severely degenerated but still repairable. In that study, the authors noted improvement in some magnetic resonance imaging parameters in the augmented cases but no difference in clinical outcome scores compared with patients who had isolated repair of similar rotator cuff tears.

In recent years, other surgical groups have also reported the results of autograft SCR, often with their own modifications.[2,3,12,16] Azevedo et al,[2] for example, utilized a fascia lata autograft harvested with a minimally invasive technique. Kholinne et al[12] reported that reinforcing a fascia lata autograft SCR with polypropylene mesh yielded improved results in graft integrity and several clinical parameters. Barth and colleagues[3] have described their experience utilizing the native long head biceps tendon in lieu of fascia lata for massive posterosuperior rotator cuff tears. Compared with double-row repair and transosseous equivalent repair with an absorbable patch, the biceps SCR technique produced similar clinical outcome scores but better strength and a higher percentage of repair integrity, as visualized by ultrasound 1 year postoperatively.

Some surgeons have been reluctant to use the fascia lata autograft recommended by Mihata. Whether motivated by concerns of donor site morbidity or increased operating time, they have preferred to utilize a dermal allograft to reconstruct the superior capsule. Denard et al[8] reported minimum 1-year results in 59 patients, 25 of whom had a prior failure of rotator cuff repair. In the group as a whole, pain scores (visual analog scale), ASES, and Single Shoulder Value improved, but AHD remained unchanged at final follow-up. The authors deemed 68% to 75% of the cases to be successful, while 11 patients underwent revision surgery, 7 of which were reverse shoulder arthroplasties. More recently, the senior author of that paper reported 41 patients with a mean follow-up of 34 months (minimum 2 years).[5] In that series by Burkart et al, 85% of grafts had fully healed, and the average AHD improved by 1 mm. Nineteen percent were judged to have unsatisfactory outcomes. Other groups reporting their results with allograft SCR include Pennington et al[31] and Lacheta et al.[14]

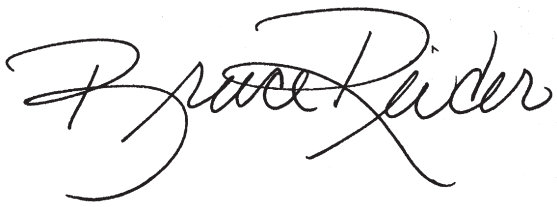
Besides differing in donor source and tissue of origin, fascia lata autografts and dermal allografts usually differ in thickness, a distinction that Mihata has stressed as important.[17] In the 2012 anatomic study already referenced, Nimura et al[30] noted that the width of the superior capsular footprint varied from 3.5 mm to 9.1 mm. Most surgeons reporting dermal allograft SCR have utilized a piece of tissue 3 mm in thickness, whereas Mihata has recommended a much thicker graft. In a 2016 biomechanical study in cadaveric shoulders, Mihata et al[25] reported that 8-mm grafts both lowered peak subacromial pressure and decreased superior humeral translation, while 4-mm-thick grafts only improved peak subacromial pressure. This study emphasized that proper graft tensioning is also important to the restoration of normal shoulder biomechanics, a point underscored recently by Dyrna and colleagues.[9] An additional cadaveric study by Mihata et al[18] compared an 8-mm-thick fascia lata allograft SCR construct with a single layer of a commercially available dermal allograft in a simulated massive rotator cuff tear model. The authors reported that the fascia lata allograft restored normal superior humeral translation, superior glenohumeral joint force, and subacromial contact pressure, while the dermal graft fully restored the latter 2 parameters but not the superior humeral translation.

Does SCR have a place in the treatment of a rotator cuff tear in the patient who exhibits pseudoparalysis? Definitions of this condition vary, but loss of active shoulder elevation or abduction in the scapular plane beyond 90° are commonly cited.[10,33] A 2017 systematic review of pseudoparalysis mentioned SCR among the possible treatments[33] but observed that, to date, the SCR literature had not specifically addressed this topic. The following year, however, Mihata et al[20] published a study that tackled this issue, "Arthroscopic Superior Capsule Reconstruction Can Eliminate Pseudoparalysis in Patients With Irreparable Rotator Cuff Tears." Among 88 patients with irreparable cuff tears, they identified 28 with moderate and 15 with severe pseudoparalysis, distinguished by the absence or presence of a drop-arm sign. The fascia lata autograft SCR reversed the pseudoparalysis in over 90% of the patients in both these groups, with mean active elevation increasing to about 150°. Failure of pseudoparalysis to resolve was associated with SCR graft tear. Subsequent studies by Takayama et al[32] and Burkart and Hartzler[4] also report the resolution of pseudoparalysis after autograft or allograft SCR.

In the setting of large to massive rotator cuff tears, pseudoparalysis has been linked to the extent of the tear and specifically to the involvement of the subscapularis.[4,7,10,32] In the July 2020 *AJSM*, Takayama et al[32] reported success using SCR to reverse pseudoparalysis, except in patients with irreparable subscapularis tears. In the December 2020 *AJSM*, Mihata et al[21] compared outcomes after SCR in patients with and without subscapularis tears. They reported that patients with an intact or reparable subscapularis regained motion and strength, while those with irreparable subscapularis tears achieved improved functional and pain scores but failed to recover strength or range of motion.[21] A study in this month's *AJSM* differentiated between pseudoparalysis, defined as active elevation less than 45°, and pseudoparesis, defined as active elevation greater than 45° but less than 90°.[11] Analysis of the results showed that the more severe degree of involvement was associated with stage 3 fatty infiltration of more than 50% of the subscapularis.

In the language of our theatrical analogy, *Superior Capsular Reconstruction* continues to attract a wide audience and promises a long run. (Rumors that Disney has animated and musical versions in development could not be substantiated at press time.) However, every operation has limits and contraindications. Just as a hit play may not appeal to certain audiences, there are always individuals for whom a given surgical procedure will not be appropriate. Advanced subscapularis disease appears to raise

a red flag, as indicated in these warnings from Denard et al, "We advise caution in recommending SCR in patients with advanced preoperative atrophy of the subscapularis (ie, grade 3 or 4),"[8(p98)] and Mihata et al, "These results suggest that other surgical treatments, such as SCR with tendon transfer or reverse shoulder arthroplasty, should be considered to improve shoulder function in the case of irreparable posterior-superior rotator cuff tears with concomitant irreparable subscapularis tear."[21(p3437)] Other options are available for treating irreparable rotator cuff tears, including rehabilitation alone, partial repair, patch grafting, muscle transfer, and reverse total shoulder arthroplasty, that may be more suitable for specific patients. Future clinical research will further delineate the capabilities, durability, and limitations of SCR and explore the relative merits of autograft and allograft techniques.



Bruce Reider, MD
Chicago, Illinois

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