Published in final edited form as:

J Shoulder Elbow Surg. 2020 April ; 29(4): 674–680. doi:10.1016/j.jse.2019.10.024.

Defining Massive Rotator Cuff Tears: A Delphi Consensus Study

Adam Schumaier, MD[1], **David Kovacevic, MD**[2], **Christopher Schmidt, MD**[3], **Andrew Green, MD**[4], **Andrew Rokito, MD**[5], **Charles Jobin, MD**[2], **Ed Yian, MD**[6], **Frances Cuomo, MD**[7], **Jason Koh, MD**[8], **Mohit Gilotra, MD**[9], **Miguel Ramirez, MD**[10], **Matthew Williams, MD**[11], **Robert Burks, MD**[12], **Rodney Stanley, MD**[13], **Samer Hasan, MD, PhD**[14], **Scott Paxton, MD**[4], **Syed Hasan, MD**[9], **Wesley Nottage, MD**[15], **William Levine, MD**[2], **Uma Srikumaran, MD**[16], **Brian Grawe, MD**[1]

[1.]University of Cincinnati Department of Orthopaedics and Sports Medicine, Cincinnati, Ohio, USA

[2.]Department of Orthopaedic Surgery, Columbia University Medical Cente r, New York, New York, USA

[3.]Department of Orthopaedic Surgery, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, USA

[4.]Department of Orthopaedic Surgery, Warren-Alpert School of Medicine at Brown University, Providence, Rhode Island, USA

[5.]Langone Orthopaedic Hospital, New York University Langone Health, New York, New York, USA

[6.]Department of Orthopaedics, Southern California Permanente Medical Group, Anaheim, California, USA

[7.]Department of Orthopaedic Surgery, Montefiore, New York, New York, USA

[8.]Department of Orthopaedic Surgery, Northshore University Health System, Evanston, Illinois, USA

[9.]University of Maryland School of Medicine, Department of Orthopaedics, Baltimore, Maryland, USA

[10.]Department of Orthopaedic Surgery, OSF HealthCare, Peoria, Illinois, USA

[11.]Louisiana Orthopaedic Specialists, Lafayette, Louisiana, USA

[12.]Department of Orthopaedic Surgery, University of Utah Medical Center, Salt Lake City, Utah, USA

[13.]OrthoCarolina, Mooreseville, North Carolina, USA

[14.]Cincinnati Sports Medicine, Cincinnati, Ohio, USA

[15.]The Sports Clinic Orthopaedic Medical Associates, Laguna Hills, California, USA

Corresponding Author Information: Adam Schumaier, MD, PO Box 670212, Cincinnati, OH 45267, USA. schumaam@ucmail.uc.edu.

This study did not require ethical committee approval. Patient health information was not used in this study.

[16]Department of Orthopaedic Surgery, The Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

Abstract

Purpose: To use the modified Delphi technique to determine a practical definition for massive rotator cuff tears (MRCT).

Methods: This study is based on responses from twenty experts who participated in four rounds of surveys to determine a consensus definition for MRCT. Consensus was achieved when at least 70% of survey responders rated an item at least a 4 on a 5-point scale. A set of core characteristics was drafted based on literature review and then refined to achieve a consensus MRCT definition.

Results: The following core characteristics reached consensus in the first round: tear size, number of tendons torn, and degree of medial retraction. MRI and intraoperative findings reached consensus as the modalities of diagnosis. The second round determined that tear size should be measured as a relative value. An initial definition for MRCT was proposed in the third round: retraction of tendon(s) to the glenoid rim and/or a tear with ≥ 67% greater tuberosity exposure [65% approval]. A modified definition was proposed which specified that degree of retraction should be measured in the coronal or axial plane and that the amount of greater tuberosity exposure should be measured in the sagittal plane [90% approval].

Conclusions: This study determined with 90% agreement that MRCT should be defined as retraction of tendon(s) to the glenoid rim in either the coronal or axial plane and/or a tear with ≥ 67% of the greater tuberosity exposed measured in the sagittal plane. The measurement can be performed either with MRI or intraoperatively.

Level of Evidence: Survey Study; Experts; Delphi Method

Keywords

massive rotator cuff tear; rotator cuff tear; shoulder surgery; definition; classification; Delphi technique; consensus

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Patients with massive rotator cuff tears (MRCTs) may have significant pain, decreased range of motion, and impaired activities of daily living. Repair is a treatment option, but the prognosis is not always clear because the re-tear rate is higher than that of smaller tears.[15,17,20,21] Many efforts have been made to improve treatment of MRCTs, including the application of double row suture techniques,[7] superior capsular reconstruction,[12] muscle/tendon transfers,[30] and reverse shoulder arthroplasty.[37] Many recent studies have focused on these challenging conditions as there are over 100 PubMed indexed articles mentioning “massive rotator cuff tear” in the title or abstract within the past 5 years.[35]

There is little consensus regarding the definition of “massive” despite its widespread use in describing rotator cuff tears. Authors commonly use one or more definitions by Cofield (≥5 cm in size),[8] Gerber (≥2 tendons),[16] or Nobuhara (amount of humeral head exposure).[31] This inconsistent terminology can complicate interpretation of the literature; as pointed out by Ok et al,[32] reports of re-tear rates have ranged from 17.6% to 94%.[14,23,33,34,38] Inconsistent definitions may be an explanation for the variability in outcomes following

treatment of MRCTs. In order to draw more accurate conclusions from the literature and perform high-level clinical studies comparing treatment options for MRCTs, a standardized definition would be useful. The goal of this study was to use the Delphi technique to determine a practical definition for MRCTs.

Methods

Delphi Technique

The Delphi technique is a widely accepted, modifiable process for acquiring information and achieving consensus among a panel of experts[22] that has been useful in many areas of orthopedics.[1,3,26,29,36] The Delphi method was originally used for creating public policy, forecasting, and guiding industry.[25] The process involves series of surveys followed by comments from the survey responders. The participants are blinded to each other's responses during each questioning period. Responses are returned to a researcher who collects, summarizes the data, and removes identifiers from the comments. Data from each round is shared amongst participants allowing comparisons between individual and group responses before future rounds. The process can be continuously iterated until a desirable consensus is achieved, but three rounds are typically sufficient.[4,10,11,27] This study utilized a modified Delphi process with four rounds over three months in order to maximize agreement. The threshold for consensus was defined as more than 70% of responders rating an item at least a 4 on a 5-point Likert scale (Figure 1), similar to other studies in the orthopedic literature that defined consensus as two-thirds agreement.[1,19,26]

Panel Selection

The survey participants were members of the American Shoulder and Elbow Surgeons (ASES) peer-selected MRCT study group, the ASES MERIT Investigators (Massive Cuff Evaluation and Research Initiative). The group was created to answer some of the controversial questions surrounding the treatment of massive rotator cuff tears. In total, twenty surgeons participated in all rounds of the study, representing sixteen different institutions and ten states. Of the twenty participants, three (B.M.G., C.C.S., D.K.) were selected (each from different institutions) to act as mediators between the survey rounds. The survey mediators oversaw survey design but were blinded to participant responses. Data from each round was summarized and anonymized by a research assistant who did not participate in the survey (A.P.S.).

Literature Review

A literature review for MRCT definitions was conducted using the PubMed / NCBI database and combined with data from a systematic review that utilized the search term "massive rotator cuff tears OR rotator cuff tears OR irreparable rotator cuff tears." A set of "core characteristics" for the MRCT definition was drafted based on data from the literature review and additional input from the survey mediators.

Round 1: Core Characteristics

The goal of the first survey was to identify features of a rotator cuff tear that would be important for classifying the tear as massive (core characteristics). Based on data from the

literature review and input from the survey mediators, the following tear features were deemed to be core characteristics: 1) defect size, 2) number of tendons torn, 3) tear chronicity, 4) degree of medial retraction, 5) pseudoparalysis. Participants also graded the importance of existing definitions for a massive tear, which included the following: 1) tendon retraction to the glenoid rim, 2) complete tear of two tendons, 3) complete tear of one tendon with a full-thickness, incomplete tear of a second tendon. Lastly, the survey asked participants to grade the importance of the following diagnostic methods: 1) magnetic resonance imaging (MRI), 2) x-ray, 3) clinical findings, and 4) intraoperative findings.

Round 2: Refining the Core Characteristics

The goals of the second survey were to 1) refine the concept of measuring tear size and 2) identify threshold values for the tear size to be considered massive. Participants were asked if the tear should be measured as an absolute value or as a relative value. For an absolute measurement, participants chose a tear size in centimeters (2cm, 3 cm, 4cm, or 5 cm) and a dimension of measurement (anteroposterior [AP], mediolateral [ML], both AP/ML, or whichever dimension the tear is measured largest). For a relative measurement, participants chose a tear size based on the percentage of exposed greater tuberosity or remaining cuff tendon (50%, 67%, 75%, or 100%) and a dimension of measurement (anteroposterior [AP], mediolateral [ML], both AP/ML, or whichever dimension the tear is measured largest). Lastly, participants were asked if the tear should be measured with MRI, intraoperatively, either MRI OR intraoperatively, or both MRI AND intraoperatively.

Round 3: Initial Proposal of Definition

Results from the first and second round were used to create a definition for a MRCT. An initial definition was proposed, and respondents were asked to either agree or disagree with the definition. Respondents who disagreed were required to provide a reason for disagreeing. The responses from those who disagreed were anonymized and returned to the survey mediators who developed a modified definition based on their responses.

Round 4: Proposal of Modified Definition

The modified definition was sent to the group in order to achieve consensus. The survey concluded when greater than 70% of the respondents agreed with the definition. Comments were requested from those who remained outside of the consensus.

Source of Funding: Funding for this project was supported by the National Institute of Arthritis and Musculoskeletal and Skin Diseases of the National Institutes of Health.

Results

All twenty participants responded to the four rounds of the survey except for the second round (19/20). The first round of the survey (Fig. 2a) identified the following as important characteristics, with the number of individuals rating ≥ 4- on 5-point scale in parentheses: 1) defect size 90% (18/20), 2) tendon number 70% (14/20), 3) degree of medial retraction 70% (14/20). The following historical definitions were deemed important: retraction of tendon to glenoid rim 85% (17/20) and complete tear of two tendons 75% (15/20). Tear chronicity

45% (9/20), pseudoparalysis 45% (9/20), and a complete tear of one tendon with a full-thickness, incomplete tear of a second tendon 10% (2/20) did not reach consensus for importance. For the modality of diagnosis, MRI 100% (20/20) and intraoperative findings 85% (17/20) reached consensus while clinical findings 40% (8/20) and x-ray 50% (10/20) did not.

The second round determined that tear size should be measured as a relative value or proportion 74% (14/19) instead of an absolute value in centimeters 26% (5/19) (Fig. 2b). A majority felt that the relative value should be measured as a percentage of exposed greater tuberosity 79% (15/19) as opposed to a percentage of remaining tendon attached to the greater tuberosity 21% (4/19). Consensus was not achieved for a single percentage of greater tuberosity exposure that would qualify as massive, but 86% (16/19) of the responders chose a percentage of 67% or higher. Similarly, consensus was not achieved for a single dimension of measurement, but the majority felt that the tear dimensions should be measured in either the AP plane 47% (9/19) or both the AP and ML planes 47% (9/19).

The results from the first and second rounds were used to draft the first definition of a MRCT. The initial definition was retraction of tendon(s) to the glenoid rim and/or at least two-thirds (≥ 67%) of the greater tuberosity exposed, and diagnosed either with MRI or intraoperatively. The number of torn tendons was left out of the initial definition because the survey mediators felt that defect size and tendon number were overlapping concepts, and the panel determined in the first round of the survey that defect size 90% (18/20) was more important than tendon number 70% (14/20).

The first definition was approved by 65% (13/20) of the group and did not reach consensus. Based on comments from those participants who disagreed, a modified definition was proposed which stated that the degree of retraction should be measured in the coronal or axial plane and that the amount of greater tuberosity exposure should be measured in the sagittal plane. These modifications were approved by 90% (18/20) of the group, ending the Delphi process with the following definition of a MRCT:

- Retraction of tendon(s) to the glenoid rim, measured in either coronal or axial plane (Fig. 3)
- And/or ≥ 67% of the greater tuberosity exposed, measured in the sagittal plane (Fig. 4)
- Diagnosed either with MRI or intraoperatively (Fig. 5 and Fig. 6)

One participant who disagreed stated that they preferred a diagonal measurement which takes into account the size of the tear and the amount of retraction; further, they expressed concern that the definition does not account for the tear pattern. The other participant who disagreed stated that the definition should not include retraction because retraction implies chronicity and not size.

Discussion

The ideal treatment of MRCTs has not been defined. While several classification schemes have been developed in order to advance management of these injuries,[18] inconsistency in defining the pathology often complicates interpretation of the literature.[32] To design high-level clinical studies that compare different treatments for MRCTs, it is imperative that investigators define tear pathology in a similar fashion. The goal of this study was to develop a practical definition for a MRCT based on expert opinion. The Delphi consensus panel arrived at the following definition for a MRCT: retraction of a tendon(s) to the glenoid rim (measured in either the coronal or axial plane) and/or ≥ 67% of the greater tuberosity exposed (measured in the sagittal plane).

Tear chronicity and pseudoparalysis did not reach consensus as important factors for classifying a tear as massive. The most likely reason is that pseudoparalysis is not clearly defined.[6,40] A 2017 systematic review by Tokish et al included 12 studies that classified tears as pseudoparalytic, 5 did not define the term and 7 had heterogeneous definitions. Most articles defined pseudoparalysis as active elevation less than 90°, but the roles of passive elevation and pain limited motion were variable.[40] Burks and Tashjian contend that pseudoparalysis should include elevation up to 45° in association with a chronic, atraumatic, massive rotator cuff tear with at least grade 2 to 3 fatty infiltration.[6] Our definition is only about tear size, and defining pseudoparalysis/tear chronicity were outside the scope of this study.

Several definitions for a massive tear exist in the literature. Cofield defined a massive tear as being ≥ 5 cm in maximum length, demonstrating that patients with increasingly larger tears had less strength, satisfaction, and Neer scores following repair.[9] Some have proposed an area-based calculation. Tauro suggested multiplying the AP and ML dimensions of the tear[39] while Nobuhara believed a better parameter is obtained by multiplying the length of the avulsed tendon insertion by the height of the torn portion.[31] Gerber and Zumstein defined a massive tear as a complete tear of two or more tendons,[16,42] and Burkhart proposed a tear pattern and tendon mobility based classification.[5] The practicality, validity, and reliability of these definitions is largely uncertain. Additionally, few of these definitions account for both the tear size and the tear retraction. The goal of this study was to better define what a massive tear means from a practical standpoint (a definition that is easy to understand and apply in clinical practice). Our goal was not to define whether the tear is repairable or the likelihood of healing following repair.

Many of these classification systems are vulnerable to error because they are based on absolute values that do not account for variation in patient size, patient positioning at the time of measurement, and the techniques used to measure the amount of retraction.[2] In a cadaveric study of twenty shoulders by Dugas et al,[13] the anterior-posterior insertions of the subscapularis, supraspinatus, infraspinatus, and teres minor ranged from 1.81–2.78 cm, 1.01–2.08 cm, 1.19–2.11 cm, and 1.76–2.65 cm, respectively. Studies utilizing MRI have found age-related and inter-individual variability in the width and thickness of the rotator cuff tendons.[28,41] An MRI study of 25 healthy volunteers found that the width of the anterior supraspinatus, posterior supraspinatus, and infraspinatus tendons ranged from 0.39–0.91 cm,

1.1–1.9 cm, and 1.98–3.37cm, respectively.[28] Further, ultrasound studies have found significant differences in tendon thickness and footprint insertion width between men and women.[24] These findings suggest that measuring tear size and retraction by absolute values may not be reproducible.

The definition from our study is based on the expert opinion of twenty peer-selected shoulder specialists. The strengths of our definition are that it 1) accounts for both tear size and retraction, 2) allows for preoperative or intra-operative measurement, and 3) is based on relative values instead of absolute values. The major limitation is that it is not clear how strongly this definition relates with patient symptoms and function. Additionally, the inter- and intra-observer reliability of the definition is not clear. These factors will need to be investigated in future clinical studies. Lastly, a complete consensus was not achieved (90% consensus), and the comments of those who disagreed should be noted as limitations (our definition does not reference tear pattern, and retraction might imply chronicity as opposed to tear size).

Conclusions

This study determined with 90% agreement that MRCT should be defined as retraction of tendon(s) to the glenoid rim in either the coronal or axial plane and/or a tear with ≥ 67% of the greater tuberosity exposed measured in the sagittal plane. The measurement can be performed either with MRI or intraoperatively. This practical definition can be used to compare clinical outcomes between various management strategies in patients with MRCT.

Acknowledgments

Funding for this project was supported by the National Institute of Arthritis and Musculoskeletal and Skin Diseases of the National Institutes of Health. Grant number K08AR072092-02. Funds were used to facilitate preparation and editing of the manuscript.

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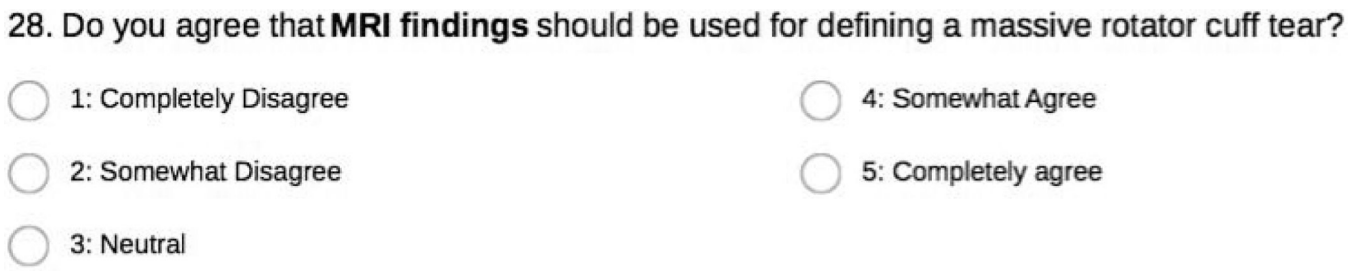


Figure 1.
Example of a 5-point Likert scale. Consensus was achieved when at least 70% of respondents ranked an item at least 4 on the 5-point scale.

Massive Rotator Cuff Tear Delphi Study Process

Pre-Survey:	Panel Selection Literature Review	
Survey Round 1:	Core Characteristics	Rated At Least 4 Out Of 5
	• Tear Size	90%
	• Number of Tendons Torn	70%
	• Tear Chronicity	45%
	• Degree of Medial Retraction	70%
	• Pseudoparalysis	42%
	Importance of Previous Definitions	
	• Retraction to Glenoid Rim	85%
	• Complete Two Tendon Tear	75%
	• Complete One Tendon Incomplete Second Tendon	10%
	Modality of Diagnosis	
	• MRI	100%
	• Intraop Findings	85%
	• Clinical Findings	40%
	• Xray	50%

Survey Round 2:	Refining Tear Size (Absolute vs Relative)	Percentage Agreement
	• Tear Size as Absolute Value (cm)	26%
	• Tear Size as Relative Value	74%
	Relative Value Method	
	• Percentage of Exposed Tuberosity	79%
	• Percentage of Remaining Tendon	21%
	Threshold for Massive	
	• 50% of Tuberosity Exposed	16%
	• 67% of Tuberosity Exposed	37%
	• 75% of Tuberosity Exposed	37%
	• 100% of Tuberosity Exposed	10%
	Dimension of Measurement	
	• AP Plane	47%
	• ML Plane	0%
	• Both AP and ML Plane	47%
	• Whichever is Largest	6%
	Refining Modality of Diagnosis	
	• MRI	0%
	• Intraop Findings	11%
	• Either MRI or Intraop Findings	42%
	• Both MRI and Intraop Findings	47%

Figure 2.

(a) First round of survey identified several core characteristics for defining a MRCT. (b) Second round of survey refined tear size, established thresholds for MRCT size and modality for diagnosis.

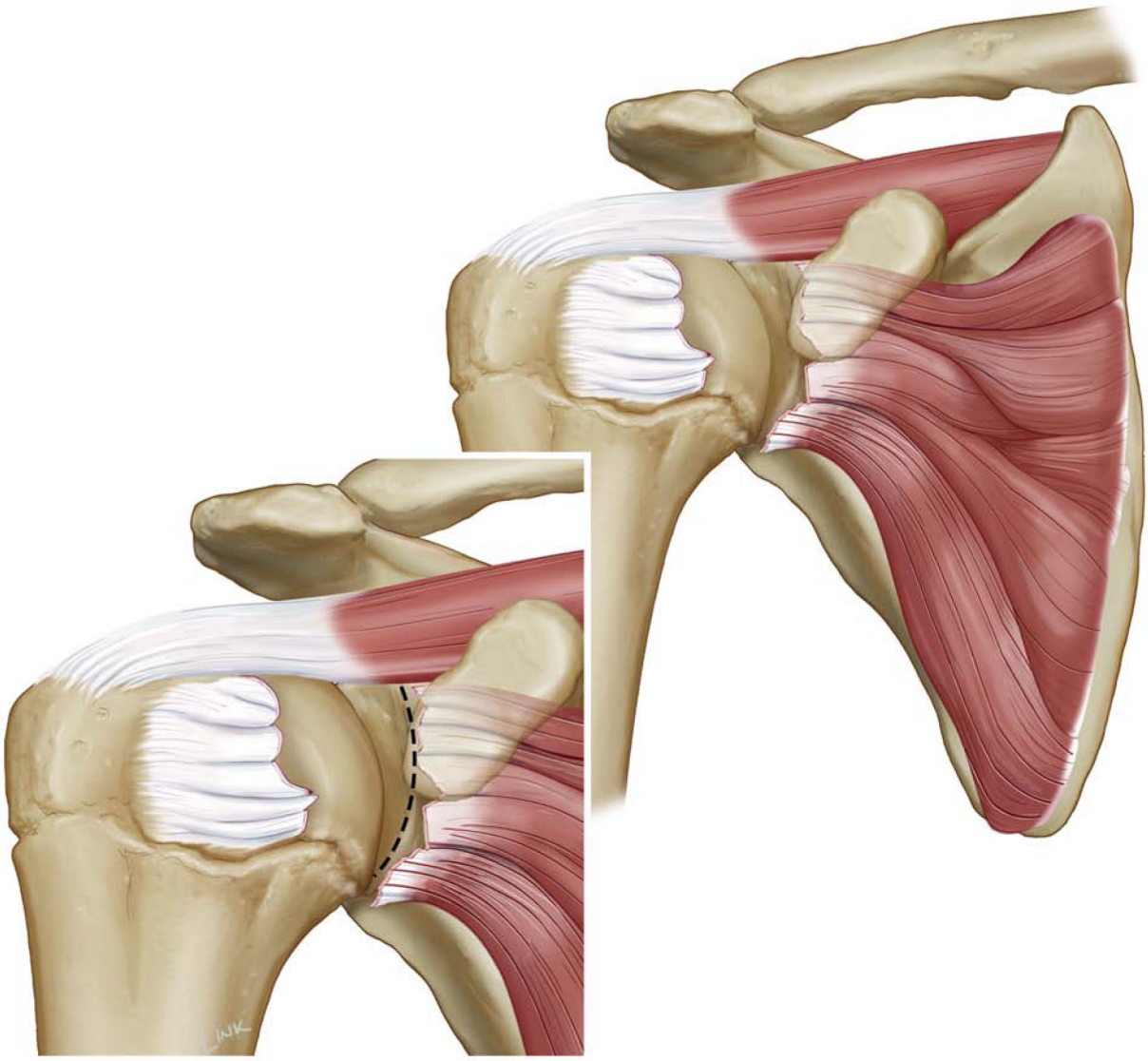
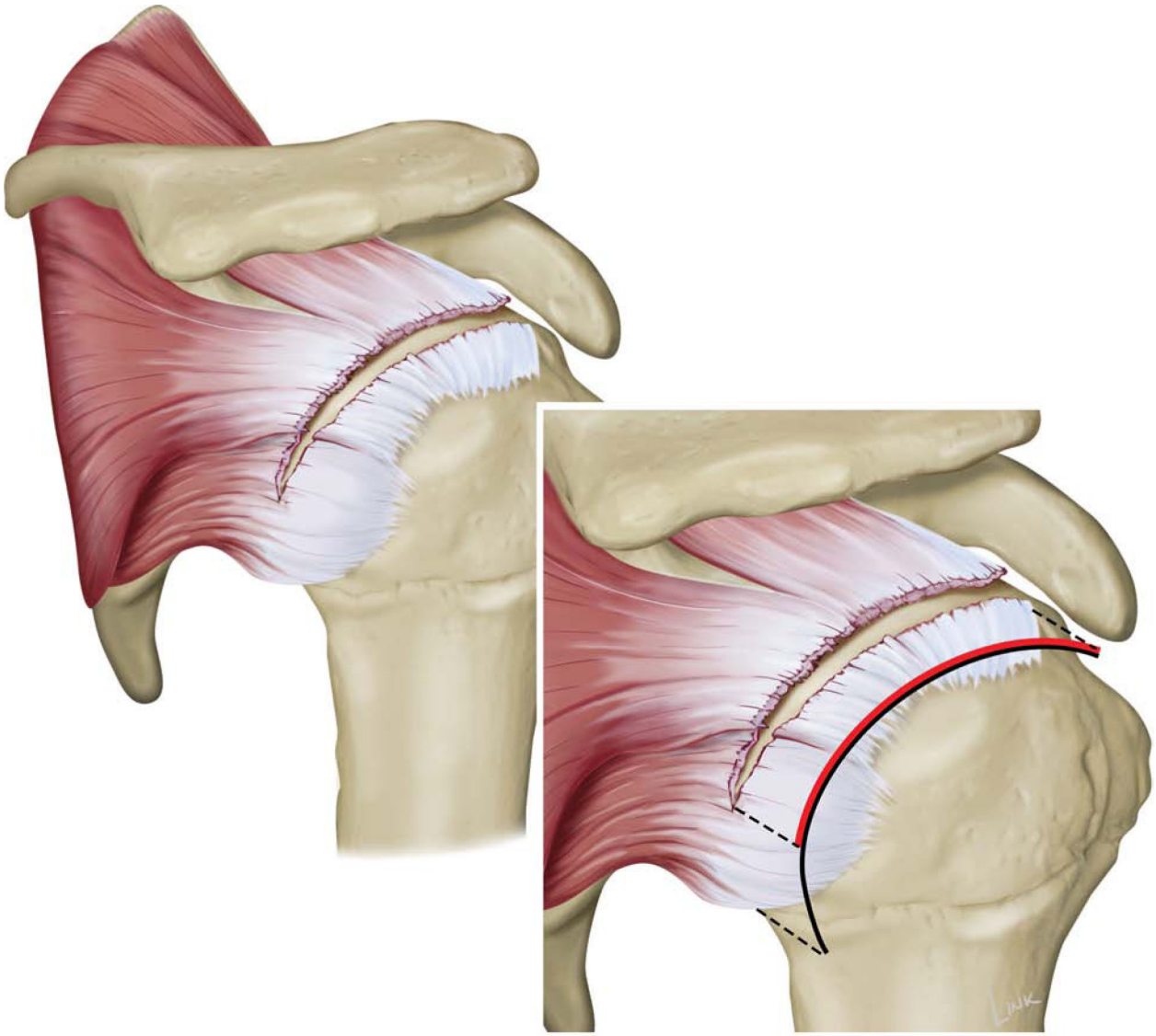


Figure 3.

Anteroposterior view of the shoulder demonstrating a rotator cuff tear that is retracted medial to the glenoid rim, indicating that this is a massive rotator cuff tear.



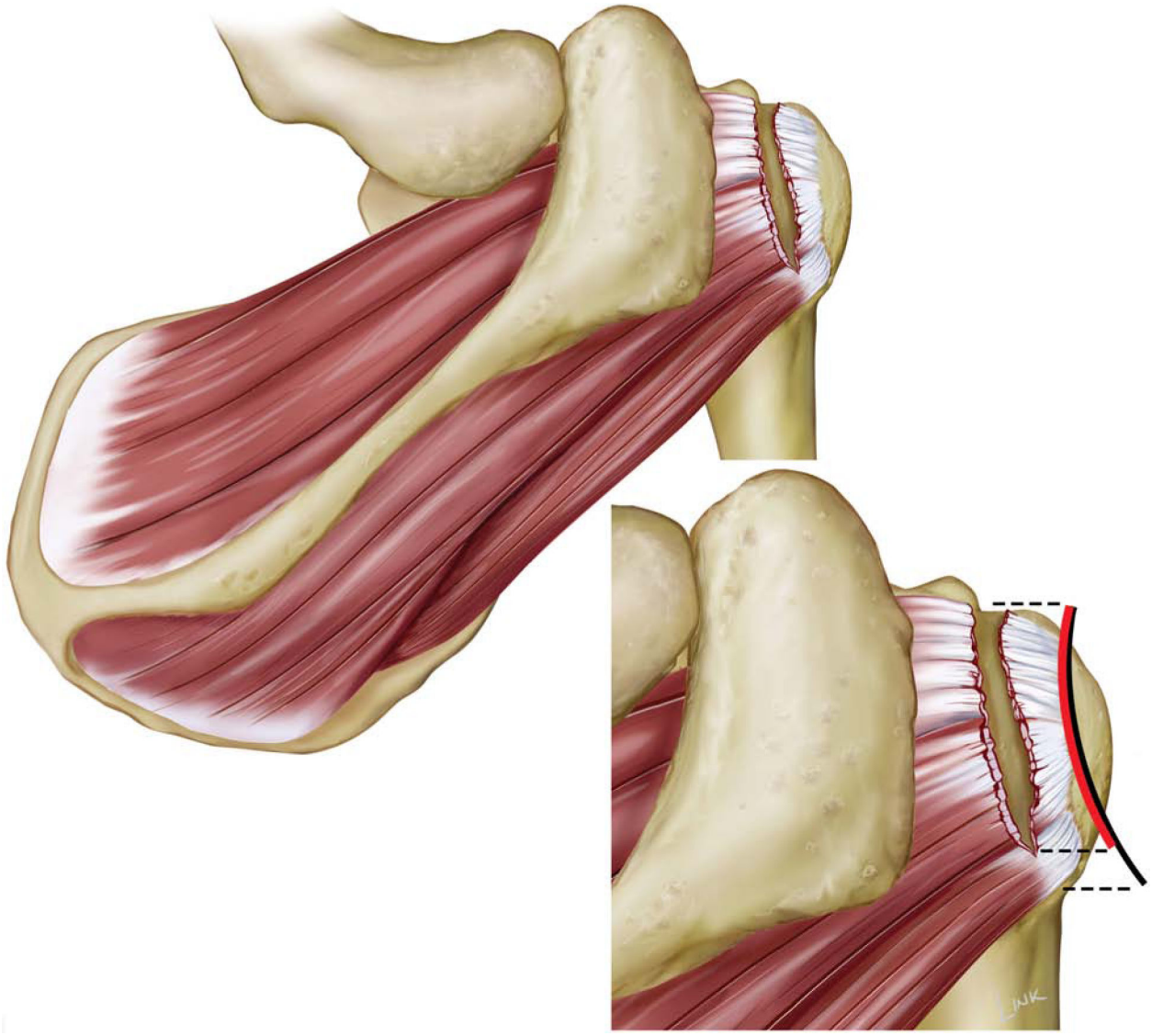


Figure 4.

Posterolateral (a) and superior (b) views of the shoulder demonstrating a rotator cuff tear that exposes ≥67% of the greater tuberosity, indicating that this is a massive rotator cuff tear.

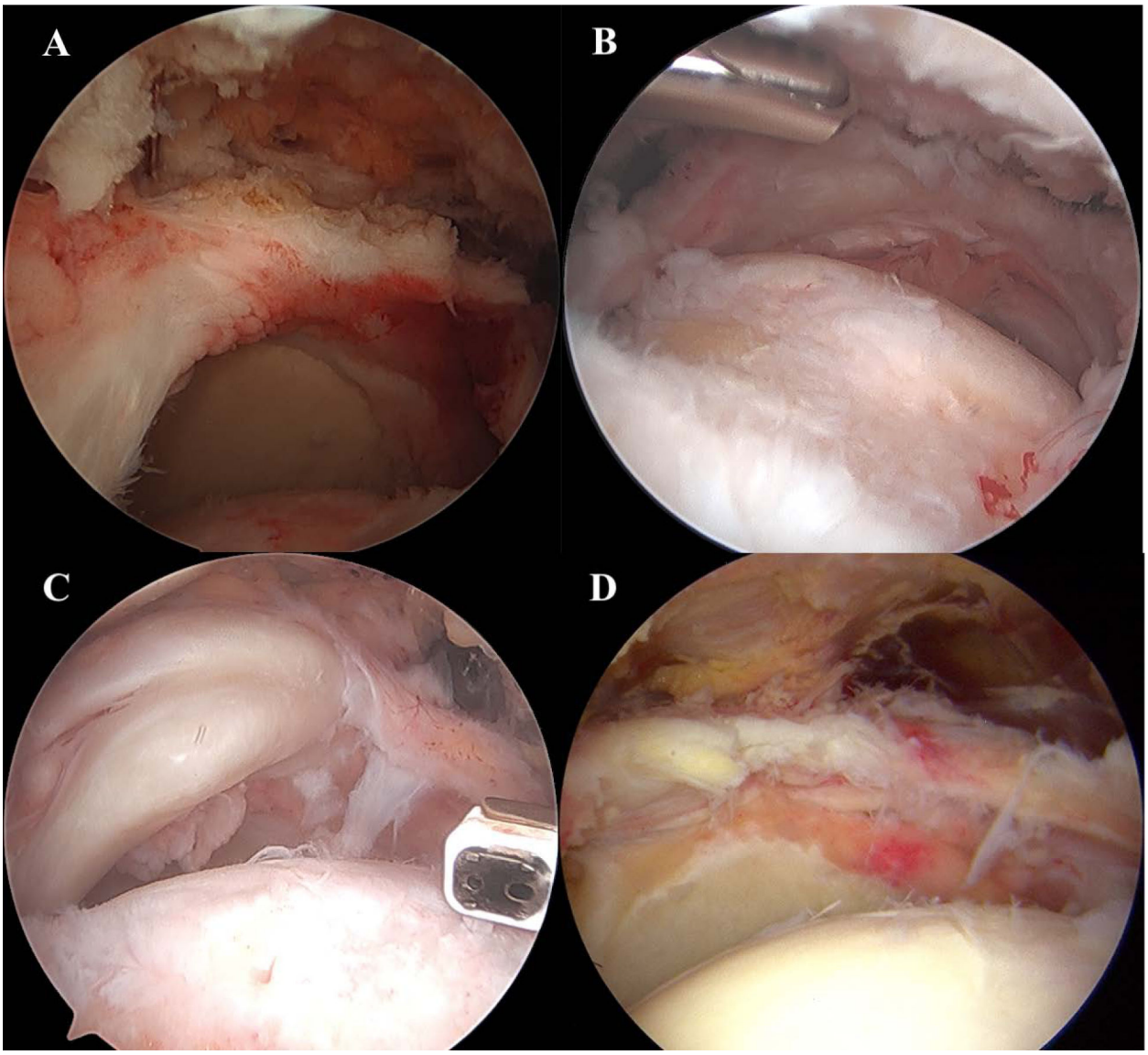


Figure 5.

These are four arthroscopic images demonstrating a massive rotator cuff tear. Panels B and C demonstrate at least 67% greater tuberosity exposure with little remaining tendinous attachments. Panel D demonstrates retraction of tendon past the glenoid rim.

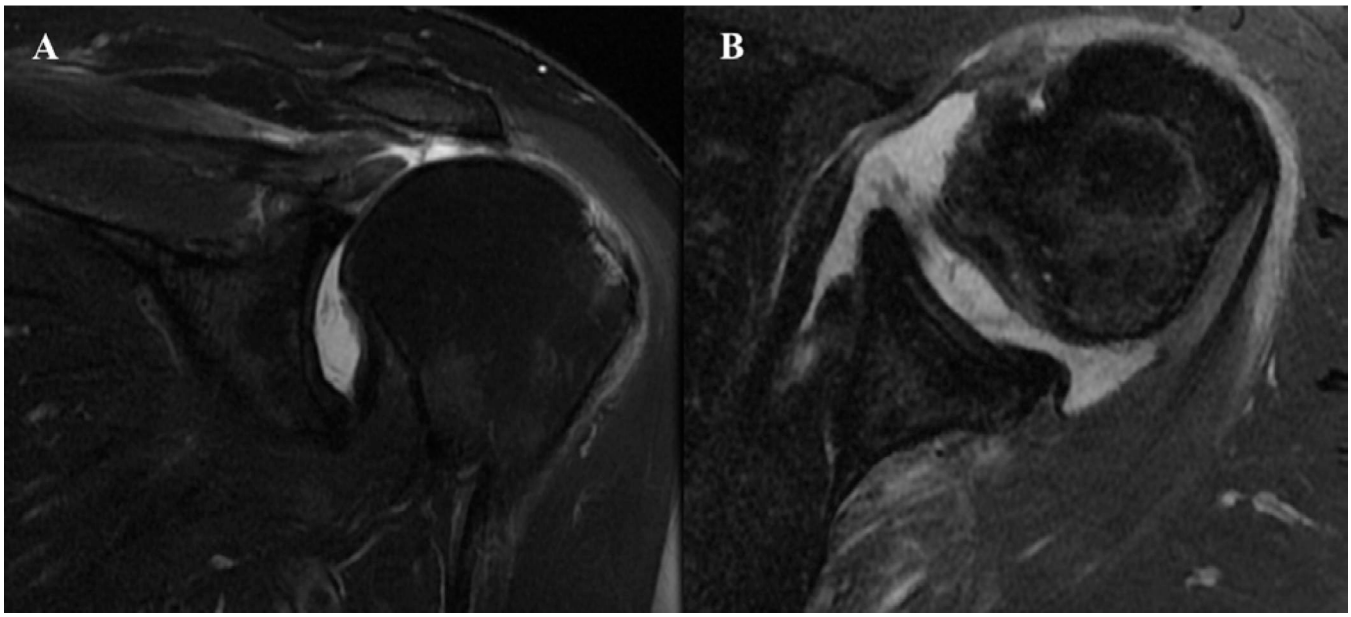


Figure 6.

These are 2 MRI images demonstrating massive rotator cuff tears. Panel A is a coronal T2 weighted image depicting a supraspinatus tear that is retracted past the glenoid rim. Panel B is an axial T2 weighted image depicting a subscapularis tear that is retracted past the glenoid rim.