Current Concepts With Video Illustration

The Geometric Classification of Rotator Cuff Tears: A System Linking Tear Pattern to Treatment and Prognosis

James Davidson, M.D., and Stephen S. Burkhart, M.D.

Abstract: A valuable classification system allows for communication among surgeons and/or other investigators and offers information on treatment and prognosis. It provides a means for comparison of epidemiologic data and treatment outcomes. There is no current standard classification for rotator cuff tears. Authors and practicing orthopaedists use a variety of descriptions when communicating about cuff tears. Older classifications do not use 3-dimensional information derived from the present use of arthroscopy and magnetic resonance imaging. The new geometric classification offers guidance on treatment and prognosis. Type 1, crescent-shaped tears are repaired end to bone and have a good to excellent prognosis. Type 2, longitudinal (L- or U-shaped) tears are repaired side to side with margin convergence and have a good to excellent prognosis. Type 3, massive contracted tears have coronal and sagittal dimensions greater than 2×2 cm on preoperative magnetic resonance imaging; are repaired with interval slides or partial repair; and have a fair to good prognosis. Type 4, rotator cuff arthropathy tears have end-stage degenerative changes of the glenohumeral joint and have articulation of the humeral head with the undersurface of the acromion; are irreparable; and require arthroplasty if surgery is considered. This classification describes complete tears of the superior and posterior rotator cuff, supraspinatus, infraspinatus, and teres minor. Additional notation can be made regarding the presence of related pathology including tears of the subscapularis, biceps, or labrum; instability or arthritic change of the glenohumeral or acromioclavicular joints; or fatty degeneration of the cuff.

In 1944 McLaughlin[1] described lesions of the cuff as (1) transverse ruptures, (2) vertical splits, and (3) retracted tears. The geometric classification described in this article shares common features with McLaughlin's classification. However, McLaughlin's system was not widely adopted. Later cuff tear classifications often described the 1-dimensional length of a tendon tear or the number of tendons torn. They did not take advantage of 3-dimensional information on tear pattern that is obtained from preoperative magnetic resonance imaging (MRI) or at arthroscopy to provide guidance on treatment technique such as end-to-bone repair, side-to-side repair, or interval slides. DeOrio and Cofield[2] used the length of the greatest diameter of the tear to categorize the tear into 1 of 4 groups: small, medium, large, or massive. However, a 1-dimensional description of a tear can be misleading because a complete cuff avulsion described as massive, implying a difficult repair and unfavorable prognosis, may in fact lie directly over the bed of the insertion site, be easy to repair, and have a predictably good result. The systems of Harryman et al.[3] and Gerber et al.[4] each characterized the status of the cuff based on the number of tendons torn. These systems

From Canyon Orthopaedic Surgeons (J.D.), Phoenix, Arizona, and The San Antonio Orthopaedic Group (S.S.B.), San Antonio, Texas, U.S.A.

The authors report no conflict of interest.

Received May 12, 2009; accepted July 6, 2009.

Address correspondence and reprint requests to Stephen S. Burkhart, M.D., The San Antonio Orthopaedic Group, 150 E Sonterra Blvd, Ste 300, San Antonio, TX 78258, U.S.A. E-mail: ssburkhart@msn.com

0749-8063/10/2603-9261$36.00/0
doi:10.1016/j.arthro.2009.07.009

Note: To access the video accompanying this report, visit the March issue of *Arthroscopy* at www.arthroscopyjournal.org.

TABLE 1. *Previous Cuff Tear Classification Systems*

System	Method of Classification	Downside
McLaughlin[1]	Transverse, vertical, retracted	Not widely recognized; created before MRI became available
DeOrio and Cofield[2]	Length of greatest diameter of tear	Not 3-dimensional; can overestimate difficulty of repair
Harryman et al.[3]	No. of tendons torn	Does not differentiate tear pattern or method of repair
Gerber et al.[4]	No. of tendons torn	Does not differentiate tear pattern or method of repair

do not differentiate specific tear pattern or method of repair (Table 1).

ROTATOR CUFF GEOMETRIC TEAR PATTERNS, METHODS OF REPAIR, AND PROGNOSIS

The geometric classification has 4 types (Table 2). Type 1, crescent-shaped tears are relatively short and wide.[5-8] The medial-to-lateral length of these tears is less than the anterior-to-posterior width. Type 1 tears are typically mobile from medial to lateral and can usually be repaired by fixing the tendon end directly to the bone bed on the greater humeral tuberosity (Fig 1). It has been shown that repair of crescent-shaped tears with end-to-bone techniques results in good to excellent modified University of California, Los Angeles (UCLA) scores (Table 3).[5] Tear patterns can be determined on preoperative MRI in the manner previously described and as summarized in Table 4 and Figs 2, 3, and 4.[6] An MRI scan showing a tear with a coronal length (L) that is less than or equal to the sagittal width (W) and a length less than 2 cm (L ≤ W, L <2 cm) predicts a crescent-shaped tear and an end-to-bone repair (Figs 5 and 6).[6] By recognizing a type 1, crescent-shaped tear pattern, the surgeon can anticipate an end-to-bone repair and a predictably good to excellent result.

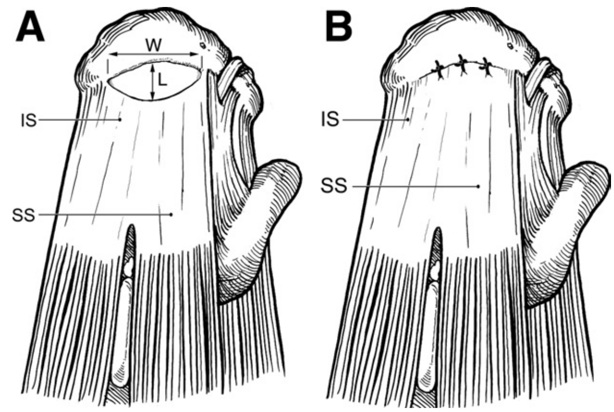


FIGURE 1. (A) A type 1, crescent-shaped tear is short and wide with a medial-to-lateral length (L) less than the anterior-to-posterior width (W). (B) Crescent tears can usually be repaired with a direct tendon end–to–bone technique. (IS, infraspinatus; SS, supraspinatus.)

Type 2, longitudinal (U-shaped and L-shaped) tears are relatively long and narrow (Figs 7 and 8).[5-8] The medial-to-lateral length of these tears is greater than the anterior-to-posterior width. Type 2, longitudinal tears are typically mobile in an anterior/posterior direction and can usually be repaired by a side-to-side/margin convergence technique. Attempting to laterally mobilize the medial apex of a longitudinal tear to the lateral bone bed can result in significant tensile stress in the middle of the repaired rotator cuff margin and lead to ultimate failure. Side-to-side closure of longitudinal tears has been shown to reduce the strain of the lateral free margin of the cuff in its converged configuration, by the biomechanical principle of margin convergence,[5,7,8,9] so that the "converged margin" can then be repaired to bone with suture anchors. It has been shown that repair of longitudinal tears with side-to-side/margin convergence techniques combined with tendon-to-bone repair results in good to excellent modified UCLA scores.[5] An MRI scan with length (L) greater than width (W) and

TABLE 2. *Geometric Classification*

Type	Description	Preoperative MRI Findings	Treatment	Prognosis	Reference
1	Crescent	Short and wide tear	End-to-bone repair	Good to excellent	5, 6
2	Longitudinal (L or U)	Long and narrow tear	Margin convergence	Good to excellent	5, 6
3	Massive contracted	Long and wide, >2 × 2 cm	Interval slides or partial repair	Fair to good	6, 9, 10
4	Cuff tear arthropathy	Cuff tear arthropathy	Arthroplasty	Fair to good	

width less than 2 cm (L > W, W <2 cm) predicts a longitudinal tear and side-to-side/margin convergence repair (Figs 9 and 10).[6] This classification system points out that a type 2, longitudinal tear should be fixed without tension side to side and leads to a predictably good to excellent outcome.

Type 3, massive contracted tears are long and wide (Fig 11). They are too long for the tendon end to be pulled laterally directly to bone and, similarly, are too wide for the edges to be closed directly side to side. Other repair techniques such as interval slides or partial repairs are necessary for this type of tear.[6,10-15] Treatment of massive contracted tears requiring interval slides results in good mean modified UCLA scores.[10] Treatment of massive tears with partial repair results in fair mean modified UCLA scores.[11] An MRI scan with a maximum length greater than or equal to 2 cm and maximum width greater than or equal to 2 cm (L ≥2 cm, W ≥2 cm) predicts that interval slides or partial repair is necessary in over 75% of cases and that direct end-to-bone or side-to-side repair is usually not possible (Figs 12 and 13). Similarly, an MRI scan with a maximum length greater than or equal to 3

Table 3. *Modified UCLA Scoring System*

Category	Points
Pain	
Present all of the time and unbearable; strong medication frequently	1
Present all of the time but bearable; strong medication occasionally	2
None or little at rest, present during light activities; salicylates frequently	4
Present during heavy or particular activities only; salicylates occasionally	6
Occasional and slight	8
None	10
Function	
Unable to use limb	1
Only light activities possible	2
Able to do light housework or most activities of daily living	4
Most housework, shopping, and driving possible; able to do hair and dress and undress, including fastening brassiere	6
Slight restrictions only; able to work above shoulder level	8
Normal activities	10
Active forward flexion	
>150°	5
120°-150°	4
90°-120°	3
45°-90°	2
30°-45°	1
0°-30°	0
Strength of resisted external rotation (manual testing)	
Grade 5 (normal)	5
Grade 4 (good)	4
Grade 3 (fair)	3
Grade 2 (poor)	2
Grade 1 (muscle contraction)	1
Grade 0 (nothing)	0
Satisfaction of patient	
Satisfied and better	5
Not satisfied and worse	0

NOTE. UCLA rating results: poor, 0 to 21; fair, 22 to 27; good, 28 to 33; and excellent, 34 to 35.

Table 4. *How to Predict Cuff Tear Pattern and Method of Repair on Preoperative MRI*

1. Measure maximum tear length (L) on T2-weighted coronal image.
2. Measure maximum tear width (W) on T2-weighted sagittal image.
3. L ≤W and L <2 cm predict a crescent-shaped tear and end-to-bone repair.
4. L >W and W <2 cm predict a longitudinal tear and side-to-side/margin convergence repair.
5. L ≥2 cm and W ≥2 cm predict that, in over 75% of cases, direct primary repair (end to bone or side to side) is not possible and that other techniques such as interval slides or partial repair are necessary.
6. L ≥3 cm and W ≥3 cm predict that, in all cases, direct primary repair (end to bone or side to side) is not possible and that other techniques such as interval slides or partial repair are necessary.

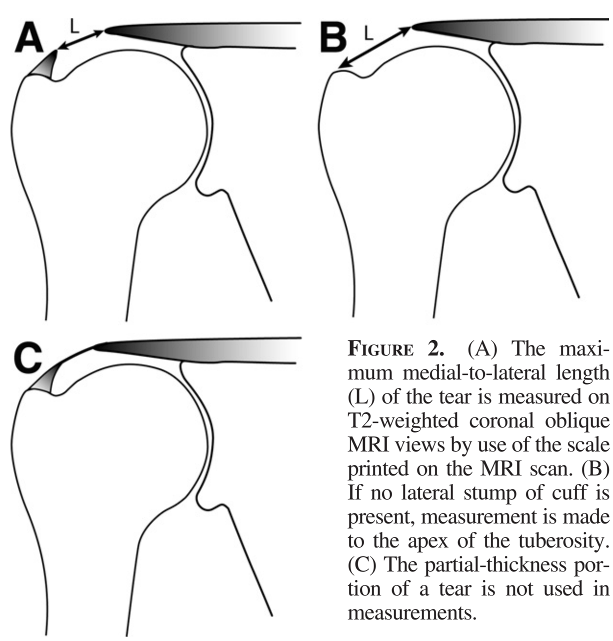
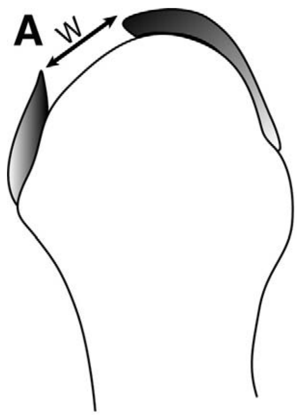
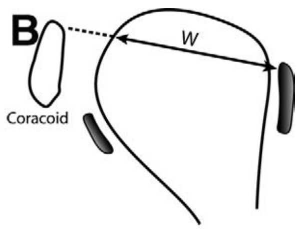


Figure 2. (A) The maximum medial-to-lateral length (L) of the tear is measured on T2-weighted coronal oblique MRI views by use of the scale printed on the MRI scan. (B) If no lateral stump of cuff is present, measurement is made to the apex of the tuberosity. (C) The partial-thickness portion of a tear is not used in measurements.





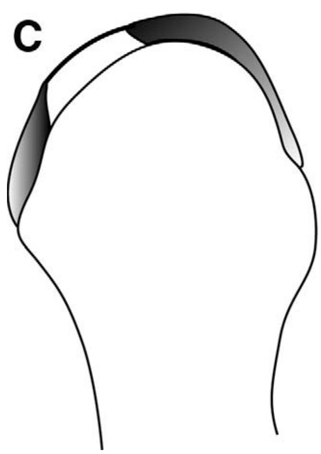


Figure 3. (A) The maximum anterior-to-posterior width (W) of a tear is measured on T2-weighted sagittal oblique MRI views using the scale printed on the MRI scan. (B) In a massive tear, if no anterior tissue is present, the shortest tangential line from the superior coracoid to the humeral head is used to approximate the location of the rotator interval. Measurement is made to this point. (C) The partial-thickness portion of a tear is not used in measurements.

cm and maximum width greater than or equal to 3 cm (L $\geq$3 cm, W $\geq$3 cm) predicts that interval slides or partial repair is necessary in all cases.[6] It should be recognized preoperatively that a 3 $\times$

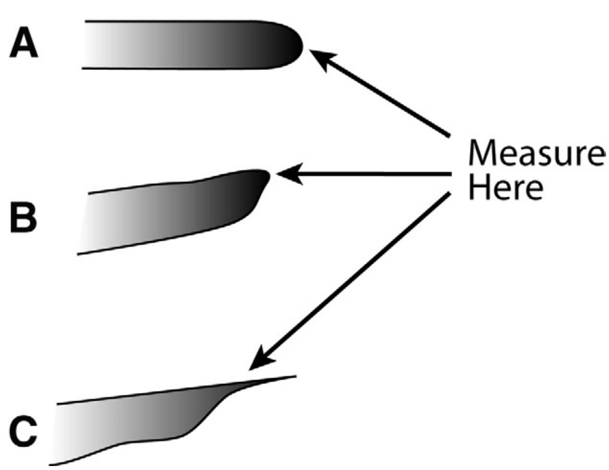


Figure 4. Tendon edges are characterized on MRI as (A) blunt, (B) tapered, or (C) wispy. Measurements are made as depicted.

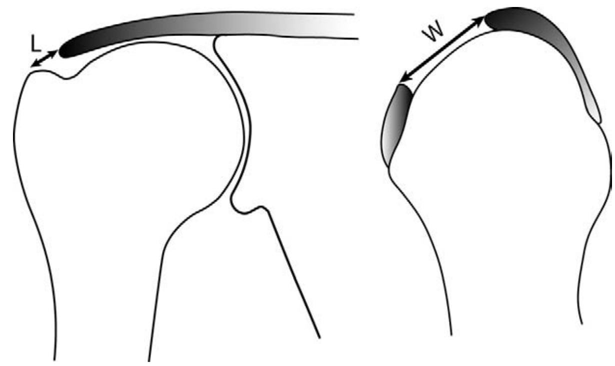


Figure 5. Type 1, crescent-shaped tear. The maximum medial-to-lateral length (L) measured on the T2-weighted coronal MRI images is less than or equal to the maximum anterior-to-posterior width (W) measured on the T2-weighted sagittal MRI images, and the length is less than 2 cm (L $\leq$W, L $<$2 cm).

3–cm massive contracted tear seen on MRI will require interval slides or partial repair for treatment and will have a less favorable outcome than a 1 $\times$ 3–cm crescent-shaped tear repaired directly to bone. Similarly, it will have a less favorable outcome than a 3 $\times$ 1–cm longitudinal tear repaired with margin convergence. In prior systems all of these tears would have been classified as 3-cm tears without distinction, failing to differentiate treatment method or prognosis.

Type 4, rotator cuff arthropathy tears are associated with significant glenohumeral arthrosis and complete loss of the acromiohumeral interspace. These tears are irreparable by arthroscopic or open methods. When addressed surgically, the current treatment is arthroplasty, with variable results and techniques reported in the literature. Imaging shows articulation of the humeral head with the undersur-

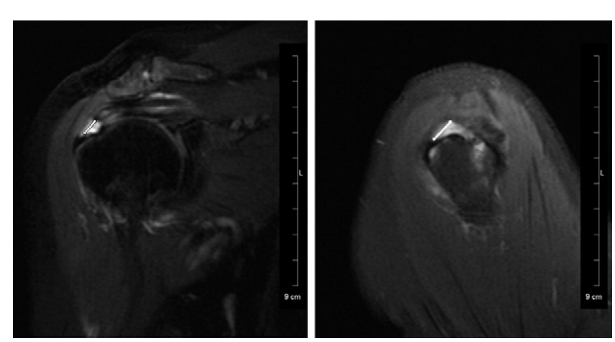
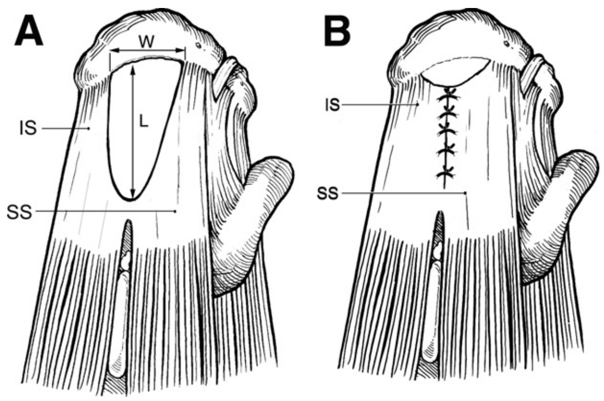


Figure 6. Clinical example of a type 1, crescent-shaped tear on MRI with maximum coronal length (left) less than maximum sagittal width (right).



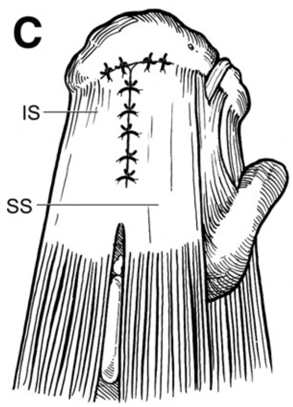
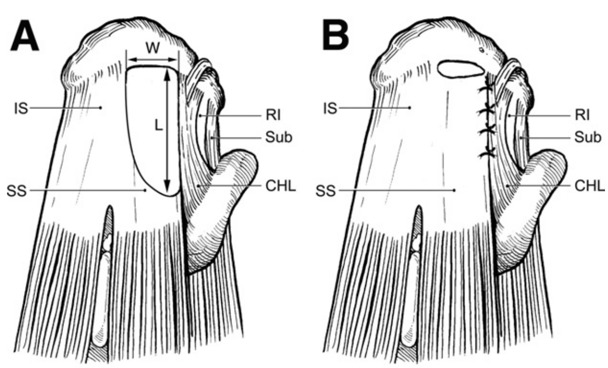


Figure 7. (A) Type 2, longitudinal tear. This U-shaped longitudinal tear is long and narrow. The medial-to-lateral length (L) is greater than the anterior-to-posterior width (W). (B, C) Longitudinal tears can usually be repaired with a side-to-side/margin convergence technique along with lateral suture anchors. (IS, infraspinatus; SS, supraspinatus.)



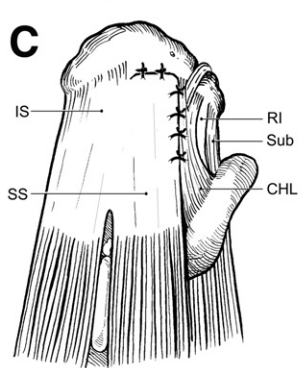


Figure 8. (A) Type 2, longitudinal tear. This L-shaped tear is long and narrow. The length (L) is greater than the width (W). (B, C) L-shaped tears can usually be repaired with a side-to-side/margin convergence technique along with lateral suture anchors. (IS, infraspinatus; SS, supraspinatus; RI, rotator interval; Sub, subscapularis; CHL, coracohumeral ligament.)

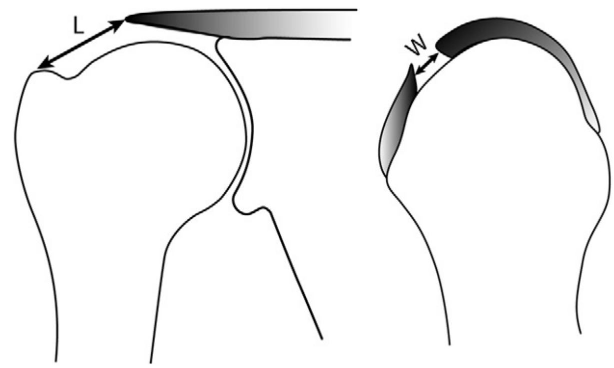


Figure 9. Type 2, longitudinal tear. The maximum length (L) measured on the T2-weighted coronal images is greater than the maximum width (W) measured on the T2-weighted sagittal images, and the width is less than 2 cm ($L > W$, $W < 2$ cm).

face of the acromion and end-stage glenohumeral arthrosis (Fig 14).

DISCUSSION

The geometric classification of rotator cuff tears will help orthopaedic surgeons communicate about tears of the supraspinatus, infraspinatus, and teres minor based on tear pattern recognition (Video 1, available at www.arthroscopyjournal.org). It provides important guidance for treatment and prognosis for each type of tear. The previous studies providing the foundation for this classification were performed by the same surgeon (S.S.B.) and assessed results by means of the same modified UCLA scoring system, allowing direct comparison of the results of the tear types described in this report.[5,6,10,11] Because the geometric classification uses preoperative MRI, it can be used in the surgeon's preoperative decision making and counseling of the patient. It consolidates and organizes current concepts in

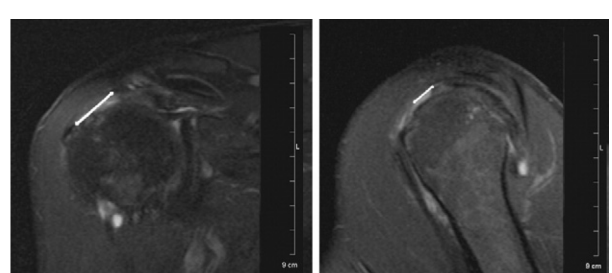
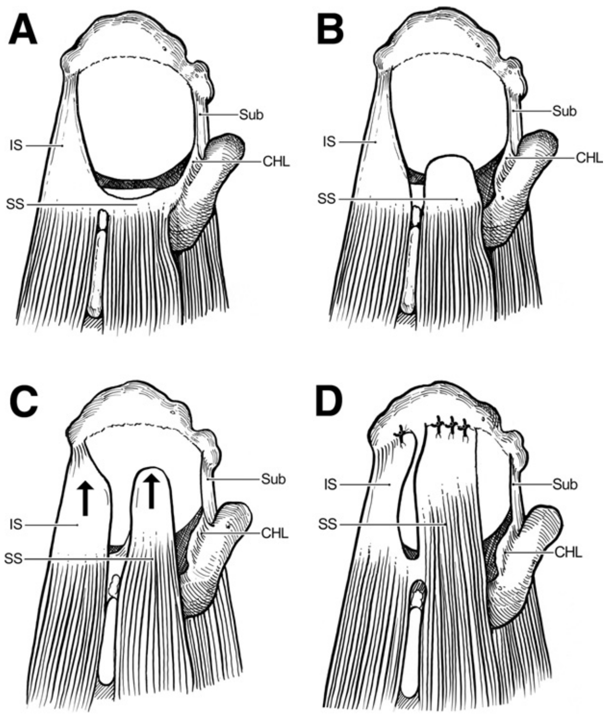


Figure 10. Clinical example of a type 2, longitudinal tear on MRI with maximal coronal length (left) greater than sagittal width (right).



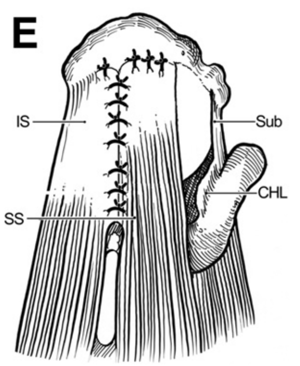


Figure 11. (A) Type 3, massive contracted tears are long and wide. Direct end-to-bone or side-to-side repairs are not possible. Interval slides are often required. (B) Anterior and posterior releases are made. (C) After release, there is improved tissue mobility. (D) The supraspinatus can then be repaired to the bone bed. (E) The posterior defect is closed with side-to-side sutures. (IS, infraspinatus; SS, supraspinatus; Sub, subscapularis; CHL, coracohumeral ligament.)

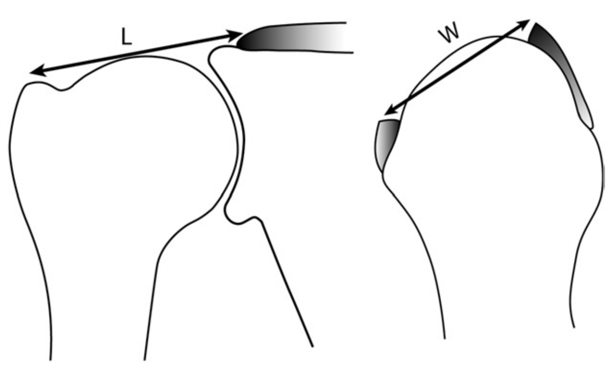


Figure 12. Type 3, massive contracted tear. Both the maximum length (L) measured on coronal MRI scans and the maximum width (W) measured on sagittal MRI scans are greater than or equal to 2 cm.

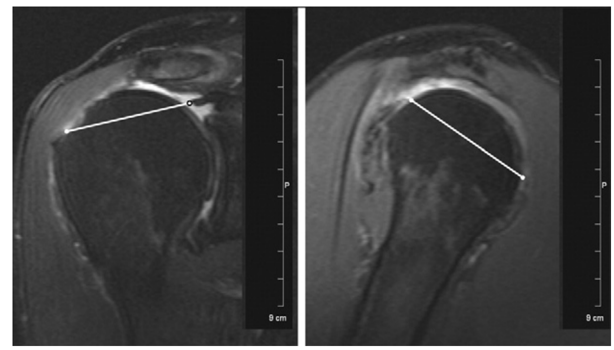


Figure 13. Clinical example of a type 3, massive contracted tear on MRI with maximum coronal length (left) and maximal sagittal length (right) both greater than 2 cm.

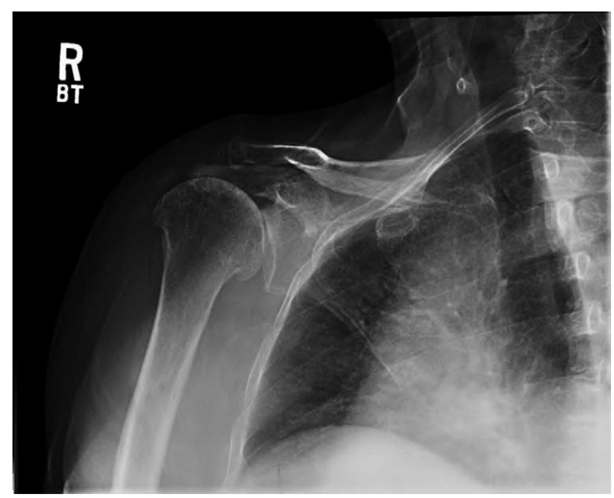


Figure 14. Radiograph of type 4, rotator cuff arthropathy. There is end-stage degeneration of the glenohumeral joint and articulation of the humeral head with the acromion.

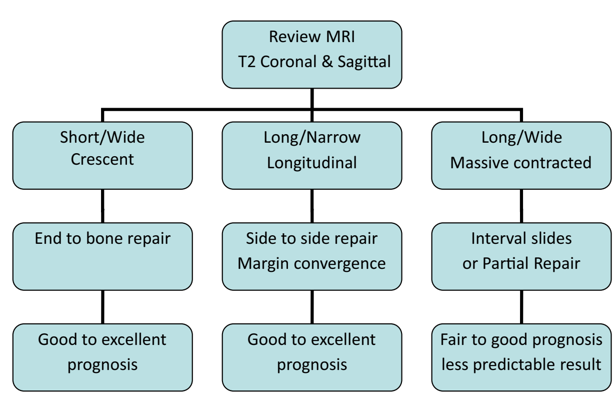


Figure 15. Treatment algorithm for rotator cuff tears.

Table 5. *Comorbidities of Cuff Tear Affecting Outcome*

Subscapularis tears
Biceps tendon tears
Biceps instability
Labral tears
Glenohumeral arthritis
Glenohumeral instability
Acromioclavicular joint disease
Cuff fatty degeneration

arthroscopic rotator cuff repair but can be applied to cuff tears in open surgery as well. It will allow appropriate future comparison and contrast of epidemiologic data and outcomes research of varying tear types (Table 4 and Fig 15).

For ease and practicality of use, this classification does not address numerous comorbidities such as subscapularis tears, biceps tendon tears or instability, labral tears, glenohumeral degeneration or instability, acromioclavicular joint disease, or cuff fatty degeneration, all of which should be considered in the treatment of shoulder disorders. These complicating features can be noted separately (Table 5). Though potentially valuable, a universal classification that addresses each facet of shoulder pathology would quickly become unwieldy, sacrificing the primary goals of simple description and categorization.

Several of these comorbidities will be considered. Subscapularis tears are frequently seen in conjunction with supraspinatus tears and are increasingly recognized as a source of pain and dysfunction.[16-22] In one study evaluating 40 patients with subscapularis tears, there were 7 isolated subscapularis tears and 33 subscapularis tears combined with supraspinatus tears and other rotator cuff tears.[16] Arthroscopic repair of these tears resulted in good mean modified UCLA scores.

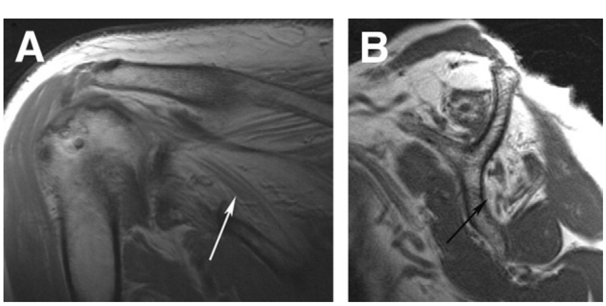


Figure 16. MRI scans showing fatty degeneration of greater than 75%. (A) T2-weighted coronal image with greater than 75% fatty degeneration of infraspinatus (arrow). (B) T1-weighted sagittal image with greater than 75% fatty degeneration of infraspinatus (arrow).

Table 6. *Fatty Degeneration: Results of Repair of Cuff Tear*

% Fatty Degeneration	Mean Modified UCLA Score
50%-75%	Good
>75%	Fair/unpredictable

Biceps tendon pathology is very commonly associated with subscapularis lesions and was encountered in 63% of cases in this study. In addition, radiographic evidence of glenohumeral degenerative change correlated with a less favorable outcome.

Similarly, SLAP tears and rotator cuff tears can be found concomitantly. In a study of type II SLAP lesions, rotator cuff tears were also found in 31% of cases.[23] Of the 53 SLAP lesions in overhead/throwing athletes in this study, there were 10 partial-thickness rotator cuff tears and 1 complete rotator cuff tear. Of the 49 SLAP lesions in the traumatic group in this study, there were 10 partial-thickness rotator cuff tears and 11 complete rotator cuff tears. Of note, it has been our observation that simultaneous repair of cuff and SLAP tears can result in an unacceptably high incidence of postoperative stiffness, and rehabilitation protocols may need to be accelerated to address this.

Rotator cuff tears can also be seen in conjunction with instability cases. In a study of 33 consecutive patients who underwent shoulder arthroscopy immediately before the modified Latarjet procedure, 2 rotator cuff tears were also encountered.[24] Furthermore, in a consecutive series of 61 arthroscopic Bankart repairs by the senior author, rotator cuff tears were

Table 7. *Points, Pearls, and Pitfalls*

- Preoperative MRI can alert the surgeon to cuff tear size, geometric shape, method of repair, and prognosis.
- T2-weighted MRI scans are better than T1-weighted MRI scans for determining cuff tear pattern. The intact cuff is dark, and the tear is bright.
- Some tears appear misleadingly massive on a single MRI view. It is important to characterize the tear on both coronal and sagittal views.
- The lateral arthroscopic viewing portal is best for determining tear pattern.
- Repairing a longitudinal tear side to side with margin convergence significantly decreases strain and tension on the repair.
- Tears that are both long and wide require interval slides or partial repair and cannot be repaired directly side to side or end to bone.
- High-quality MRI is necessary to make accurate measurements and determine tear pattern.

identified in 14 patients (23%), with a mean tear size of 2.6 cm (S.S.B., unpublished data, June 2006).

Fatty degeneration is estimated on coronal and sagittal MRI cuts as a percentage of fatty tissue in relation to normal muscle tissue in the supraspinatus and infraspinatus (Fig 16). Severe degrees of fatty degeneration of the rotator cuff, greater than 75%, have been found to unfavorably affect treatment outcome.[25] Fortunately, this high degree of fatty degeneration is uncommonly encountered. In a study of massive rotator cuff tears (classified by other methods), only 22 of 103 cuffs had fatty degeneration of 50% or greater and only 5 had fatty degeneration of 75% or greater.[25] Arthroscopic repair of tears with fatty degeneration of 75% or greater resulted in fair mean modified UCLA scores. Among 5 patients, the results were excellent in 1, fair in 1, and poor in 3. We concluded that surgery for cuff tears with fatty degeneration of greater than 75% may be worthwhile but that results are variable and that realistic expectations should be anticipated. However, arthroscopic repair or tears with fatty degeneration of 50% to 75% resulted in good mean modified UCLA scores. Among 17 patients, there were 7 excellent, 7 good, 3 fair, and no poor results (Table 6). In this study clinical improvement was observed in 86% of cases that would have previously been predicted as likely to fail by the Goutallier criteria.[25,26]

In conclusion, over time, the methods of treatment and prognosis associated with each tear pattern type in this system may improve with advances in orthopaedics, and these features of the classification will need to be updated. Recognition of the geometric tear patterns described in this classification will remain useful and serve as a basis for communication and comparison of treatment methods and outcomes (Table 7).

REFERENCES

1. McLaughlin H. Lesions of the musculotendinous cuff of the shoulder. *J Bone Joint Surg* 1944;26:31-51.
2. DeOrio JK, Cofield RH. Results of a second attempt at surgical repair of a failed initial rotator cuff repair. *J Bone Joint Surg Am* 1984;66:563-567.
3. Harryman DT, Mack LA, Wang K, Jackins SE, Richardson ML, Matsen FA. Repairs of the rotator cuff. Correlation of functional results with integrity of the cuff. *J Bone Joint Surg Am* 1991;73:982-989.
4. Gerber C, Fuchs B, Hodler J. The results of repair of massive tears of the rotator cuff. *J Bone Joint Surg Am* 2000;82:505-515.
5. Burkhart SS, Danaceau SM, Pearce CE. Arthroscopic rotator cuff repair: Analysis of results by tear size and by repair technique-margin convergence versus direct tendon-to-bone repair. *Arthroscopy* 2001;17:905-912.
6. Davidson JF, Burkhart SS, Richards DP, Campbell SE. Use of preoperative magnetic resonance imaging to predict rotator cuff tear pattern and method of repair. *Arthroscopy* 2005;21:1428.e1-1428.e10. Available online at www.arthroscopyjournal.org.
7. Burkhart SS. Current concepts: A stepwise approach to arthroscopic rotator cuff repair based on biomechanical principles. *Arthroscopy* 2000;16:82-90.
8. Lo IK, Burkhart SS. Biomechanical principles of arthroscopic repair of the rotator cuff. *Oper Tech Orthop* 2002;12:140-155.
9. Burkhart SS, Athanasiou KA, Wirth MA. Margin convergence: A method of reducing strain in massive rotator cuff tears. *Arthroscopy* 1996;12:335-338.
10. Lo IK, Burkhart SS. Arthroscopic repair of massive, contracted, immobile rotator cuff tears using single and double interval slides: Technique and preliminary results. *Arthroscopy* 2004;20:22-33.
11. Burkhart SS, Nottage WM, Ogilvie-Harris DJ, Kohn HS, Pachelli A. Partial repair of irreparable rotator cuff tears. *Arthroscopy* 1994;10:363-370.
12. Tauro JC. Arthroscopic rotator cuff repair: Analysis of technique and results at 2- and 3-year follow-up. *Arthroscopy* 1998;14:45-51.
13. Tauro JC. Arthroscopic "interval slide" in the repair of large rotator cuff tears. *Arthroscopy* 1999;15:527-530.
14. Cordasco FA, Bigliani LU. The rotator cuff: Large and massive tears. Techniques of open repair. *Orthop Clin North Am* 1997;28:179-193.
15. Codd TP, Flatow EL. Anterior acromioplasty, tendon mobilization and direct repair of massive rotator cuff tears. In: Burkhead WZ, ed. Rotator cuff disorders. Baltimore: Williams & Wilkins, 1996;330.
16. Adams CR, Schoolfield JD, Burkhart SS. The results of arthroscopic subscapularis tendon repairs. *Arthroscopy* 2008;24:1381-1389.
17. Burkhart SS, Brady PC. Arthroscopic subscapularis repair: Surgical tips and pearls A to Z. *Arthroscopy* 2006;22:1014-1027.
18. Burkhart SS, Tehrany AM. Arthroscopic subscapularis tendon repair: Technique and preliminary results. *Arthroscopy* 2002;18:454-463.
19. Bennett WF. Arthroscopic repair of anterosuperior (supraspinatus/subscapularis) rotator cuff tears: A prospective cohort with 2- to 4-year follow-up. Classification of biceps subluxation/instability. *Arthroscopy* 2003;19:21-33.
20. Bennett WF. Arthroscopic repair of isolated subscapularis tears: A prospective cohort with 2- to 4-year follow-up. *Arthroscopy* 2003;19:131-143.
21. Flury MP, John M, Goldhahn J, Schwyzer HK, Simmen BR. Rupture of the subscapularis tendon (isolated or in combination with supraspinatus tear): When is a repair indicated? *J Shoulder Elbow Surg* 2006;15:659-664.
22. Lafosse L, Jost B, Reiland Y, Audebert S, Toussaint B, Gobezie R. Structural integrity and clinical outcomes after arthroscopic repair of isolated subscapularis tears. *J Bone Joint Surg Am* 2007;89:1184-1193.
23. Morgan CD, Burkhart SS, Palmeri M, Gillespie M. Type II SLAP lesions: Three subtypes and their relationships to superior instability and rotator cuff tears. *Arthroscopy* 1998;14:553-565.
24. Arrigoni P, Huberty D, Brady PC, Weber IC, Burkhart SS. The value of arthroscopy before an open modified Latarjet reconstruction. *Arthroscopy* 2008;24:514-519.
25. Burkhart SS, Barth JR, Richards DP, Zlatkin MB, Larsen M. Arthroscopic repair of massive rotator cuff tears with stage 3 and 4 fatty degeneration. *Arthroscopy* 2007;23:347-354.
26. Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. *Clin Orthop Relat Res* 1994:78-83.