

Rotator interval closure: inconsistent techniques and its association with anterior instability. A literature review

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Abstract

The Rotator interval (RI) is an anatomic space in the anterosuperior part of the glenohumeral joint. An incompetent or lax RI has been implicated in various conditions of shoulder instability and therefore RI has been frequently touted as an area that is important in preserving stability of the shoulder. Biomechanical studies have shown that repair of RI ligamentous and capsular structures decreases glenohumeral joint laxity in various directions. Clinical studies have reported successful outcomes after repair or plication of these structures in patients undergoing shoulder stabilization procedures. Although varieties of methods have been described for its closure, the optimal surgical technique is unclear with various inconsistencies in incorporation of the closure tissue. This in particular makes the analysis of the RI closure very difficult. The purposes of this study are to review the structures of the RI and their contribution to shoulder instability, to discuss the biomechanical and clinical effects of plication of RI structures in particular to anterior glenohumeral instability, to delineate the differences between an arthroscopic and open RI closure. Additionally, we have proposed a new classification system describing various techniques used during RI closure.

Introduction

The Rotator interval (RI) is a triangular anatomical space bounded superiorly by supraspinatus (SS), inferiorly by subscapularis (SSc), laterally by intertubercular groove of humerus and medially by base of coracoid. Contents of the RI are coracohumeral ligament (CHL), superior glenohumeral ligament (SGHL), middle gleno-

humeral ligament (MGHL), long head of biceps tendon, and joint capsule. The RI is considered by some authors to have a role in shoulder stability, and therefore, as one of the potential co-pathologies in recurrent instability, have advocated addressing it during Bankart repair.¹ An intact and competent RI is also necessary for maintaining negative intra-articular pressure, which augments glenohumeral stability.^{2,3} Various techniques of RI plication have been described with each incorporating different structures and different amount of RI capsule for its closure.⁴⁻⁷ These inconsistencies make it difficult for surgeons worldwide to compare and analyze the results of RI plication.

Purposes

Overall contribution of the Rotator Interval to the stability of shoulder joint remains controversial. The purpose of this article is: to investigate the anatomy and function of RI, to discuss various biomechanical outcomes of RI plication done with different techniques, to review the literature to determine clinical outcomes of shoulder stabilization with and without RI plication and to propose a new classification system to describe various techniques used during RI closure.

Materials and Methods

A review of literature was done from PUBMED and MEDLINE for anatomy of RI, its function, biomechanical effects on glenohumeral kinematics and clinical outcomes after Bankart reconstruction with consideration of RI plication.

Search terms included: Rotator Interval, glenohumeral, shoulder, instability, Bankart repair, Bankart lesion, and biomechanics.

Anatomy of the rotator interval

The RI, as described by Neer,⁸ is a triangular-shaped anterosuperior space between supraspinatus (SS) and subscapularis (SSc) tendons. It is also known as the foramen of Weitbrecht.⁹ Its contents include SGHL, MGHL, CHL, a thin layer of capsule, and long head of the biceps tendon (LHBT). Base of the triangle is coracoid process and apex is intertubercular groove. The triangular borders and its contents define RI.¹⁰ The presence and prominence of structures and foramen within the RI exhibit considerable variability.

Jost *et al.*¹¹ described the layers of RI.

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They differentiated the medial RI (2 layers) from the lateral RI (4 layers). Laterally, layer 1 consists of the CHL fibers following SSc and SS tendons to their respective insertions into the humeral tuberosities. Layer 2 comprises meshing fibers of bounding rotator cuff musculature and CHL. Layer 3, is primarily deep fibers of CHL inserting on greater tuberosity. The deep layer 4 is composed of joint capsule and SGHL. Medially, CHL makes up the superficial layer and the deeper layer is comprised of the SGHL and joint capsule.

The CHL originates at the base of coracoid and splits laterally into 2 bands. One band of the CHL inserts on the anterior edge of the SS tendon and greater tuberosity; while the other inserts on the SSc, transverse humeral ligament, and lesser tuberosity.^{12,13} Some authors have argued that the CHL is just a thickening of the anterosuperior capsule¹², while others maintain that the CHL is its own entity.¹⁴⁻¹⁶ Unlike the SGHL and MGHL, the CHL is an extra-articular structure which is not visible during glenohumeral arthroscopy.

Capsule of the RI is a very thin structure measuring 0.06 to 0.1 mm and is of variable quality.¹⁷ A cadaveric study by Cole *et al.*¹⁸ demonstrated that the RI capsule can be as a

continuous or discontinuous layer with the rest of joint. Histologic examination revealed that the capsule is a thin loose collagenous tissue, poorly organized with a sparse population of fibroblasts and is considered relatively weak.

The SGHL is relatively smaller than the CHL, originating from glenoid labrum adjacent to supraglenoid tubercle, crossing the floor of the RI deep to the CHL, and inserting on fovea capitis on the lesser tuberosity.^{12,19} The LHBT is located between the CHL and SGHL.²⁰

The dimensions of the RI vary with arm rotation.^{11,19} The RI decreases in size with internal rotation, emphasizing the concept that if the RI is closed with upper extremity held internally rotated (or less than 30° of external rotation), significant losses of external rotation may result.^{12,21}

Function of RI

The overall contribution of the RI to shoulder stability is under debate with no general consensus. Many authors believe, as whole, RI prevents inferior translation of the adducted arm,²²⁻²⁴ with inconsistent

reports of the most critical individual structure contributing to these RI function. In a classic cadaveric study, Harryman *et al.*¹² reported that the function of the RI was to (1) act as a restraint against extreme flexion, extension, adduction, and external rotation; (2) stabilize humeral head against inferior translation while in adduction; and (3) stabilize humeral head against posterior translation while in flexion or external rotation with abduction.

While some authors emphasize the importance of individual structure like the SGHL²⁵ or the CHL¹⁵ in resisting inferior translation of shoulder, others argue that both the SGHL and CHL ligaments work together as a unit to prevent inferior and posterior translation of the humeral head.^{17,22} Itoi *et al.*³ noted that the CHL was a primary restraint to inferior translation in external rotation & negative intra-articular pressure when the arm was in neutral and internal rotation. Warner *et al.*²² determined that the SGHL was primary restraint to inferior translation of the adducted shoulder, and that the anterior and posterior portions of the inferior glenohumeral ligament became more involved in preventing translation with increasing amounts of abduction.

The capsule or thin synovial layer of the RI is believed to create a sealed barrier that may contribute in maintaining negative intra-articular pressure^{2,3} and concavity compression effect of glenohumeral joint.²⁵ Any defects in the RI, without pathology to the CHL or SGHL, may compromise overall shoulder stability.²⁵

Finally, the RI contributes to the stability of the LHBT. Specifically, the CHL, SGHL, and SSC tendons are components of the biceps pulley system responsible for the anatomic position of biceps tendon.²⁶⁻²⁹

Biomechanical studies of RI closure and its effects on GHJ

Biomechanical data supporting open or arthroscopic RI plication have conflicting results in respect to stabilization and post-operative stiffness. The surgical approach (open or arthroscopic) and specific technique utilized must be carefully evaluated. The majority of arthroscopic techniques involve a superior-inferior shift within the RI. A summary of the biomechanical studies of Open and Arthroscopic techniques of RI closure is presented in Table 1.^{4-7,12,20,30,31}

Table 1. Summary of biomechanical studies of RI closure on glenohumeral translation and range of motion.

Author & Year	Technique	Anterior Translation (p<0.05)	Posterior translation	Inferior translation	Loss of External Rotation (ER)	Type as per proposed classification
Harryman ¹² (1992)	Open M-L imbrication (1cm) of CHL	Equivocal	Decreased	Decreased	37.7° ± 20.8° (mean±SD)	Type 4
Provencher ⁴ (2007)	Open M-L Imbrication vs. Arthroscopic SGHL-MGHL	Open technique: Decreased Arthroscopic technique: Decreased	Not improved by either approach	Open technique: Decreased	Greater loss in open technique for neutral position and in arthroscopic technique for abducted position	Type 4 vs. Type 2
Plausinis ⁵ (2006)	Arthroscopic SSC±MGHL to capsule anterior to SSP (single vs. double suture)	Decreased	No significant reduction	Not tested	10°(mean)	Type 3c
Yamamoto ⁶ (2006)	Arthroscopic SGHL to MGHL vs. SGHL to SSC	Decreased in neutral position in both methods. Reduced in 60° abduction and 60° ER in SGHL-MGHL technique.	Decreased with SGHL-MGHL technique	No significant changes	6° for SGHL-SSC and 11° for SGHL- MGHL	Type2 vs. Type 3B
Mologne ²⁰ (2008)	Arthroscopic SGHL- MGHL (2 sutures)	Decreased	No Improvement	Did not improve sulcus stability	28°	Type 2
Farber ⁷ (2009)	Arthroscopic SGHL-MGHL vs. M-L imbrication.	Decreased in both groups at 60° of abduction and 90° of ER	Decreased with M-L RI closure at 60° abducted/90° ER position.	No significant changes	Reduced ER	Type 2 vs. Type 4
Sodl ³¹ (2016)	Arthroscopic RI capsular closure inferior to SSP till superior to SSC	Decreased in neutral abduction.	Decreased	No significant changes	Reduced ER	Type 1

Open RI closure

Harryman *et al.*¹² analyzed the role of the RI in shoulder stability by assessing glenohumeral motion and translation using the scapular axis as neutral in 3 different testing conditions: (1) intact RI, (2) sectioned CHL in the RI, and (3) open CHL imbrication in a medial to lateral direction (pants-over-vest fashion) by 1cm. Imbrication decreased both glenohumeral range of motion (ROM) as well as posterior and inferior translation of the humeral head. This study has been used to support routine plication of RI structures in cases of posterior and multidirectional instability.³⁰ It is noteworthy that the authors considered the plane perpendicular to the scapular axis as neutral rather than the coronal plane which may influence the anterior and posterior capsular tension, and affect the translation of the humeral head.

Provencher *et al.*⁴ in a biomechanical comparison of open versus arthroscopic RI plication found that the open technique, as described by Harryman *et al.*, was not same as the arthroscopic technique in which the MGHL is sutured to the SGHL. Specifically, they found that, even by using a technique similar to Harryman, arthroscopic RI closure (SGHL-MGHL) did not improve posterior translation in either a neutral or flexed internally rotated position. Arthroscopic RI closure did not have a significant effect on sulcus translation. However, they found that anterior translation was significantly reduced in the neutral position after open RI repair compared to a reduction of anterior translation in the abducted and externally rotated position with arthroscopic repair.

Arthroscopic RI closure

Plausinis *et al.*⁵ demonstrated that arthroscopic RI closure with 1-2 sutures significantly reduced A-P glenohumeral translation by 17% at neutral rotation (with respect to forearm) and at 0° abduction. Authors did not observe significant reduction in posterior translation.

Yamamoto *et al.*⁶ compared arthroscopic RI closure of the SGHL to the MGHL vs. the SGHL to the SSc and found reduced anterior translation and loss of external rotation with both techniques. In addition, SGHL/MGHL closure decreased posterior translation at 0° of abduction. However, as the reduction of external rotation at 60° of abduction was greater in SGHL/MGHL closure than in SGHL/SSc closure the authors suggested that to preserve rotation especially in overhead throwing athletes that SGHL/SSc closure may be better than SGHL/MGHL closure.

Mologne *et al.*²⁰ in a cadaveric study

investigated the effects of arthroscopic RI closure on anterior and posterior stability. They concluded that the addition of RI closure (SGHL to MGHL) provided enhanced anterior stability after an anteroinferior capsulolabral repair and but had no effect on inferior or posterior stability. They also noted a loss of external rotation after RI plication of 28° in adduction compared to 5° in abduction.

Farber *et al.*⁷ in a biomechanical analysis compared traditional superior-inferior arthroscopic RI closure (SGHL-MGHL) with a novel Medial-Lateral technique (with an anchor in humeral head). The medial-lateral shift was an attempt to arthroscopically replicate the work of Harryman *et al.*¹² Author concluded that anterior translation was reduced in both groups and medial-lateral RI closure significantly decreased posterior translation in abduction and external rotation as compared to superior-inferior RI closure.

A study by Sodl *et al.*³¹ determined effects of stepwise arthroscopic anterior plication and arthroscopic-equivalent RI closure on glenohumeral ROM, kinematics, and translation in the setting of anterior instability. They determined that for unidirectional anterior instability, anterior plication alone was sufficient for maintenance of rotational ROM. However, RI closure played an important role in translational stability with RI closure decreasing AP translation to less than the intact state at 0° of abduction and 30° of ER.

Several other authors have shown a decrease in anterior translation after cadaveric studies on RI repair or imbrication.³²⁻³⁵

Clinical studies

Multiple stabilization studies with RI closure are available in literature (Table 2).³⁶⁻⁴³ RI closure is mostly used as an adjunctive measure in various forms on shoulder instability (anterior, posterior or MDI). Though the use of RI closure in anterior instability is deemed to improve recurrence rates, it has not been fully tested fearing postoperative loss of external rotation.³⁰ Moreover, the indications for plication of any of RI capsuloligamentous tissues remain loosely defined.³⁶

Studies with isolated RI closure

Nobuhara and Ikeda³⁷ described open RI closure in 106 shoulders with an intact but lax RI. The majority of these patients had predominantly anterior instability. Open repair was performed with the shoulder in external rotation between SSP-SSc with imbrication of CHL over the top. The authors reported a 96% good to excellent

results with 70% of shoulders having no residual instability.

Field *et al.*³⁸ in a retrospective study on 15 patients with recurrent instability who underwent open surgical imbrication or closure of an isolated RI defect, achieved good or excellent results. Most patients demonstrated increased anterior translation and a positive sulcus sign pre-operatively, suggesting a component of multidirectional instability. Intraoperative assessment showed no other defects or lesions requiring additional stabilization procedures. Authors believed that closure of the defect added significant tension on anterior and inferior capsule. To avoid loss of external rotation, the arm was placed in 45° of external rotation and abduction before closure.

Shoulder stabilization with RI closure as an adjunctive stabilizing measure

Garstman *et al.*³⁹ reported good to excellent results in 92% (49 of 53) patients who underwent arthroscopic treatment for antero-inferior instability after a minimum follow-up of two years. They performed arthroscopic anatomical repair of the anterior, superior, and inferior parts of labrum, corrected capsular elongation and repaired the RI when necessary. The RI plication (SSP-MGHL) was considered if the shoulder demonstrated persistent, excessive anteroinferior translation after labral repair, and capsular tensioning. The RI repair was considered a critical factor in fourteen of the fifty-three shoulders.

Lino *et al.*⁴⁰ performed an arthroscopic labrum repair, reduction of capsular volume and suture of rotator cuff interval in 27 patients with traumatic anterior and anteroinferior shoulder instability. Rotator cuff interval suture was performed by bringing the superior SSc tendon border close to the anterior SS tendon border with a No. 5 Ethibond suture. After a mean follow-up period of 32.4 months all shoulders remained stable with improvement in Rowe and ASES scale.

Imhoff *et al.*⁴¹ in a retrospective analysis studied the functional results and redislocation rate of arthroscopic repair of antero-inferior glenohumeral instability using different anchors. Closure of the RI was performed in cases with associated hyperlaxity (positive sulcus sign persisting in external rotation), with 2 PDS sutures. They reported good to excellent results and believed this was due to the choice of labral fixation, the ability to perform an anatomic repair of anteroinferior labrum and treating concomitant lesions such as RI insufficiency or capsular laxity.

Yamamoto *et al.*⁴² analyzed clinical out-

come of open (51 patients) and arthroscopic (49 patients) Bankart repair and investigated its results in contact and non-contact athlete. RI capsule was always closed in open Bankart repair group (all 51 patients) with two or three interrupted sutures. In arthroscopic group RI closure was done after Bankart repair, if there was anterior laxity of the glenohumeral joint compared with contralateral side by imbricating SGHL and SSC tendon (17/49 patients). They reported good to excellent results with improved Constant and Rowe scores in both groups.

Aboalata *et al.*⁴³ evaluated 180 shoulders with antero-inferior instability, stabilized arthroscopically using different suture anchors, with a minimum of 10-year follow-up. RI closure and capsular plication were also performed using absorbable sutures when there was anterior laxity of the glenohumeral joint under anesthesia compared to contralateral side. With this long-term follow-up study, authors concluded a favorable outcome with an overall re-dislocation rate of 18.18%.

Shoulder stabilization with RI closure vs. without RI closure

A few studies are available to review which actually compare shoulder stabilization with and without RI closure (Table 3).^{44,45}

Chechik *et al.*⁴⁴ in a retrospective case control study compared patients with recurrent anterior shoulder dislocations who underwent arthroscopic Bankart repair (ABR) with and without arthroscopic RI closure (ARIC). RI closure between the

Table 2. Summary of Clinical studies.

Author & Year	Technique	Results	Post op ROM	Type as per proposed classification
Nobuhara and Ikeda ³⁷ (1987)	Open Repair of SS to SSC in external rotation, with imbrication of CHL over it	96% good to excellent results	Limitations in 9% of patients No mention of type of limitations	Type 1
Field <i>et al.</i> ³⁸ (1995)	Open Approximation or imbrication of defect margins	Good to excellent results in all patients	Decreased ER	N/A
Garstman <i>et al.</i> ³⁹ (2000)	Arthroscopic closure SSP- MGHl for excessive inferior-anterior translation and Closure between capsule edges at SSP–SSC for excessive inferior or inferior-posterior translation	Good to excellent result in 92 % (49/53 patients)	-	Type 3A and Type 1
W Lino Jr <i>et al.</i> ⁴⁰ (2006)	Arthroscopic closure by bringing superior SSC tendon close to the anterior SSP tendon	Good to excellent result, except one with adhesive capsulitis.	Decreased ER	Type 1
AB Imhoff <i>et al.</i> ⁴¹ (2010)	Arthroscopic RI closure (2 PDS sutures) into capsule at superior margin of SSC to capsule at anterior margin of SSP	Good to excellent results with no redislocation in 170/191 patients	Minimal Decrease in ER	Type 1
N Yamamoto <i>et al.</i> ⁴² (2016)	RI closure: SSP-SSC in all 51/51 open bankart repair group. SGHL-SSC in 17/49 arthroscopic bankart repair group	100% good to excellent results (both groups). 8% overall recurrence more in contact athletes	Decreased ER with some reduction in elevation in both groups	Type 1 (Open) Type 3B (Arthroscopic)
Aboalata M <i>et al.</i> ⁴³ (2016)	Arthroscopic closure between capsule at SSP and SSC tendon edges	Overall dislocation rate 18.8 % at min 10 year FU	Decreased ER	Type 1

Table 3. Clinical studies comparing anterior stabilisation with and without Rotator Interval closure.

Author & Year	Control vs. cases	Tech used for RIC	Results- ROM	Conclusions	Type as per proposed classification
O Chechik <i>et al.</i> ⁴⁴ (2010)	46 ABR (28% hyperlax) vs 37 ABR+ARIC (41% hyperlax)	Arthroscopic SSP-SSC	Limitation of ROM greater in ARIC group but not significant	ARIC improves shoulder stability without systemic joint hyperlaxity and delays recurrence with hyperlaxity.	Type 1
Eran Maman <i>et al.</i> ⁴⁵ (2017)	20 ABR vs 19 ABR+ARIC	Arthroscopic SSP-SSC	Final limitation of ROM similar in both groups	ARIC+ABR showed no superiority in attaining value-added stability compared to ABR.	Type 1

SSP and SSC was performed with the arm positioned in 30° external rotation.

3/37 ABR+ARIC patients had a re-dislocation at 42±16 months, all of whom had joint hyperlaxity. 6/46 ABR patients re-dislocated at 13±14 months, 3 whom had joint hyperlaxity. Joint hyperlaxity was significantly associated with recurrent dislocation and poor functional outcome.

They concluded that ARIC, could be performed as an adjunct to ABR in order to improve stability and reduce the risk of recurrent dislocations in patients with established unidirectional instability. It may be associated with decreased ROM. ARIC improves shoulder stability in patients without joint hyperlaxity and delays recurrence in patients with hyperlaxity.

Maman *et al.*⁴⁵ in a prospective randomized control study evaluated outcomes of ABR (20 patients) alone compared to combined ABR+ARIC (19 patients) and identified risk factors related to failure of each procedure. Remplissage was performed in all patients that presented with an engaging Hill-Sachs lesion, leading to significantly more Remplissage procedures in the ABR only group as compared to ABR+ARIC [12 (60%) vs. 4 (21%), P=0.013]. They showed that re-dislocation rate was higher in the ABR +ARIC group (3 vs. 0, P=0.06) at a mean follow-up of 4.2 years; whereas more subluxations were found in the ABR only group (2 vs.1; P=0.58). Final limitation of ROM compared to preoperative state was similar in both groups. They concluded that ARIC+ABR showed no superiority in stability compared to ABR alone, highlighting Remplissage as a source of possible bias.

paramount in maintaining a stable joint. With most antero-inferior instability, reconstituting the labrum is first priority. In addition, capsular laxity must be addressed and careful examination of the joint will help determine if all areas of instability have been addressed. Some authors have deemed RI lesions as one of the co-pathologies for recurrent shoulder instability and have advocated addressing it during Bankart repair.²

Although the structure and contents of the Rotator Interval are well agreed on in literature, the contribution of RI to glenohumeral stability is less well understood. The overall function of RI and effectiveness of RI closure is described inconsistently by authors in literature with no general consensus. Some believe it stabilizes humeral head

against posterior translation^{6,12} others believe it prevents inferior translation of adducted arm.^{4,22} Furthermore, most biomechanical studies suggest RI plication stabilizes humeral head against anterior translation at the expense of external rotation (Table 1). Many believe an intact and competent RI is also necessary for maintaining negative intra-articular pressure, which augments glenohumeral stability.^{3,8}

Importantly, the medio-lateral RI imbrication is not same biomechanically as the superior-inferior plication. The increase in anterior stability seen in the open medio-lateral RI closure group may be caused by tensioning of the tissue in this area (CHL), which possesses greater stiffness and ultimate load than the SGHL.²⁴ Also, the CHL imbrication effectively closes down the

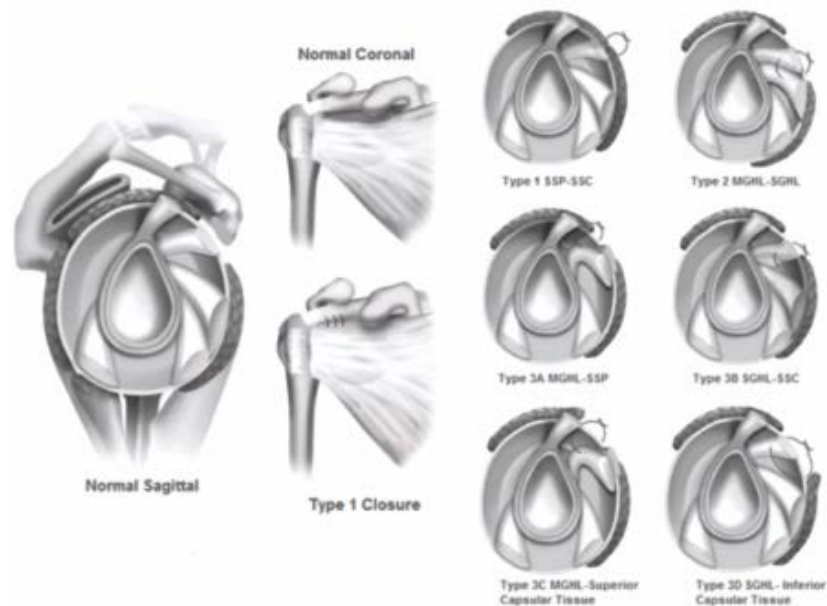


Figure 1. Classification Diagram.

Discussion

The labrum and capsule complex are

Table 4. Classification of Rotator Interval Closure Techniques.

Vertical Closure*	Type 1	Rotator cuff interval closure between SSP and SSC tendon edges or adjacent capsular tissue. (e.g. Nobuhara ³⁷ , Lino Jr ⁴⁰)
	Type 2	RI Closure between SGHL and MGHL (Ligament to Ligament) (e.g. Provencher, ⁴ Farber ⁷)
	Type 3 (Hybrid closure)	3A: MGHL +/- Capsular tissue sutured to SSP tendon (Ligament/capsule to Tendon) (e.g. Treacy <i>et al.</i> ⁵³) 3B: SGHL +/- Capsule tissue sutured to SSC (Ligament/capsule to Tendon). (e.g. Yamamoto ^{6,42}) 3C: MGHL/SSC to Superior capsular tissue adjacent to SSP (Ligament to Capsule) but sparing SGHL or in absent SGHL scenario. (e.g. Plausinis, ⁵ Mologne ²⁰) 3D: SGHL +/- Capsule tissue to inferior capsular tissue adjacent to SSC (Ligament to capsule). (e.g. Cole <i>et al.</i> ⁵⁴ , Krynych ⁴⁶)
	Type 4	Horizontal Imbrication i.e. Medial-Lateral or Oblique - Sutures +/- Anchors (e.g. Harryman ¹² , Provencher ⁴ , Farber ⁷)

*Can be partial or complete Partial (Medial or Lateral) consists of only 1-2 sutures over a distance 1cm or less. Complete would be closure over a distance of greater than 1cm with 2 or more sutures.

space of the RI, which may allow for an improved soft-tissue barrier preventing the shoulder from subluxating anteriorly.³² The beneficial therapeutic effect of vertical closure (superior to inferior) results from a decrease in capsular volume and capsular tensioning.^{46,47} Other authors believe it tensions the CHL,^{24,32} while still others think it improves anterior tension of the SGHL, a barrier effect of the SS and SSc tendons, and a sealed capsular effect.⁷

Many clinical studies with isolated RI closure or RI closure used as adjunctive procedure have reported successful outcomes (Table 2). There are very few clinical studies comparing the results of capsulolabral repair with and without RIC (Table 3). Different structures are imbricated for RI closure, using different techniques, making comparison of results and systematic review of clinical studies more difficult.

Some authors have suggested that the indications for RI closure be considered when the following conditions arise clinically: (1) anterior instability with an positive sulcus finding that persists in external rotation; (2) symptomatic instability and laxity in the inferior direction that does not disappear in external rotation with the arm at the side; (3) significant laxity and a large sulcus in the setting of MDI; and (4) patients with posterior instability that have an incompetent RI.³⁶

Although, technique and structures imbricated for RI closure may vary between surgeons, there are a few points that many authors have consensus for. Firstly, the sulcus test is used to assess the integrity of the RI.^{39,41} It is performed by pulling the arm inferiorly in zero degrees of abduction and neutral rotation. The test is positive if the humeral head subluxates inferiorly, a depression will form between the head and acromion. If the sulcus sign disappears when repeating the test in external rotation then the Rotator Interval is deemed competent.⁴⁸ Secondly, if interval closure is performed, tensioning the closure in 30° of external rotation may avoid motion limitations.⁴⁹ Finally, findings consistent with a lesion of the rotator interval are:⁴⁹⁻⁵² i) redundancy/tearing of the capsule between SSC and SSP tendons, ii) damage/flattening/subluxation of LHBt, iii) tearing of SGHL and iv) fraying of superior border of SSC tendon.

Some surgeons believe that, during arthroscopic shoulder repair, placing two portal cannulas in the interval capsule also creates large capsular defects and that these defects may contribute to interval pathology leading to recurrence of instability after arthroscopic shoulder reconstruction.⁵⁰

With the multitude of different tech-

niques of Rotator Interval closure that have evolved there is need for consistency and reproducibility when comparing different studies. To facilitate this, we propose a simple classification to describe the various closure techniques. We would encourage comparison between studies to utilize these different descriptors to maintain validity in any comparison between authors (Table 4 and Figure 1).^{4-7,12,20,37,40,42,46,53,54}

Conclusions

More experimental and clinical experience is required with usage of the Rotator Interval closure when combined with other procedures in the management of recurrent instability. Given the growing number of critically important biomechanical studies and ongoing clinical studies on Rotator Interval closure, orthopedic surgeons need to have a working knowledge of how different techniques influence these outcomes and utilize an agreed classification of the technical options for closure. Subtle changes in the technique of RI closure have different clinical implications on glenohumeral stability, postoperative motion and ultimately clinical outcome.

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