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Arthroscopic Treatment of Shoulder Instability: A Systematic Review of Capsular Plication Versus Thermal Capsulorrhaphy

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Objective: Shoulder instability is a common disorder of the shoulder that can result in debilitating pain and decreased function. Poorly treated cases of instability result in excessive mobility, possibly leading to labral tears and degenerative arthritis. The purpose of my systematic review was to compare the effectiveness of 2 popular arthroscopic techniques used to reduce shoulder instability: capsular plication and thermal capsulorrhaphy.

Data Sources: Articles were retrieved from PubMed, Cochrane Library, and Ovid/MEDLINE searches using the terms *capsular plication*, *capsular shift*, *capsular shrinkage*, *shoulder capsulorrhaphy*, and *treatment of shoulder instability*.

Study Selection: I sought cohort studies, case reviews, and randomized controlled trials published from 2000 through March 2013 that evaluated the outcomes of the 2 surgical procedures, which resulted in a total of 12 studies.

Data Extraction: Outcome measures were range of motion, satisfaction, and return to previous activity level.

Data Synthesis: The overall success rates of the reviewed studies were 91% for arthroscopic capsular plication and 76.5% for thermal capsulorrhaphy.

Conclusions: Arthroscopic capsular plication had a higher rate of success than thermal capsulorrhaphy. However, postoperative management varied more among the thermal capsulorrhaphy studies and was generally less conservative than management involving standardized capsular-plication protocols. Future authors should investigate operative techniques and postoperative management, which may help to improve thermal capsulorrhaphy outcomes.

Key Words: upper extremity, capsular shift, shoulder rehabilitation outcomes

Shoulder instability is a common disorder that often results in loss of function and pain in the shoulder.[1] Pathologic processes such as capsular laxity, labral detachment, rotator interval defect, and bony defects of the glenoid or humeral head can contribute to instability.[1,2] These conditions are often the result of either traumatic injury, caused by subluxation or dislocation of the shoulder, or repetitive or atraumatic stress to the joint. Although shoulder instability can affect people of any age, it is typically seen in the most recreationally and vocationally active: those in their late teens to mid-thirties.[3]

Conservative management is often attempted first, but if it fails, a variety of surgical interventions may be considered. Recent decades have seen the growth and refinement of surgical options from the open capsular shift to the less invasive procedures of arthroscopic capsular plication and thermal capsulorrhaphy.[3] These 2 arthroscopic procedures have become more popular as an alternative to the open capsular shift, even as they have been clinically debated over the past decade. My intent was to review the existing literature to compare the 2 arthroscopic procedures, based on technique, postoperative management, and outcome.

BACKGROUND

Shoulder instability is generally classified by whether it developed from a traumatic injury or atraumatically and whether it occurs involuntarily or can be reproduced voluntarily by the patient. It is further classified by the direction of the instability (anterior, posterior, or multidirectional) and by the duration of the disorder (acute, chronic, or recurrent).[3] Definitions of multidirectional instability (MDI) found in the literature vary among authors, from instability occurring in more than 1 direction to instability occurring in all 3 directions (anterior, posterior, and inferior) and determined by a combination of patient history, physical examination, and examination under anesthesia.[4,5] Instability becomes a more serious problem over time because excessive movement in the socket can result in labral lesions. With increased frequency of dislocations, these Bankart lesions become less reparable and may spread to the inferior, posterior, or multiple aspects of the joint, creating more instability and further altering glenohumeral mechanics, which may ultimately lead to progressive osteoarthritis.[2]

Researchers and clinicians agree that the best management of shoulder instability begins with conservative treatment of rehabilitative shoulder strengthening that includes proprioceptive training. Supervised rehabilitation after atraumatic instability has a success rate of 80%.[6,7] If conservative management fails, surgical intervention may be considered, depending on the needs of the patient and the techniques used by the treating physician.

In 1980, Neer and Foster[8] first proposed an open anteroinferior capsular-shift procedure to correct MDI. The procedure involved incising, overlapping, and suturing the capsule to reduce redundancy. It has come to be regarded as the gold standard for correcting shoulder instability, with a variable failure rate of 4% to 39%.[3,9] Generally, any new techniques developed for the surgical

Table 1. Rehabilitation Protocols and Outcomes After Arthroscopic Capsular-Plication Outcomes

Study	No. of Shoulders	Instability	Immobilization, wk	Begin Active Range of Motion, wk	Success Rate, %	PEDro Rating
Baker et al[4]	43	Multidirectional	4–6	4–6	86	6
Kim et al[2]	24	Anterior	4	4	75	6
Westerheide et al[7]	71	Anterior	3–6	6	90	5
Schamblin and Snyder[14]	30	Multidirectional	4–6	6	97	4

Abbreviation: PEDro, Physiotherapy Evidence Database.

treatment of shoulder instability are compared against the open capsular shift.

Still, arthroscopic techniques remain a leading surgical option, because they require less operative time, shorter hospitalization, and less postoperative narcotic use.[10] Other advantages to arthroscopic repair over an open procedure include decreased blood loss, better preservation of external rotation, reduced scarring, avoidance of complications such as involvement of the subscapularis and infraspinatus, and the ability to address injuries that would otherwise be inaccessible with the open approach.[7,11] Therefore, arthroscopic techniques, specifically thermal capsulorrhaphy and the arthroscopic version of the open capsular-shift procedure through capsular plication (CP), continue to grow in popularity.

Thermal capsulorrhaphy, also termed thermal capsular shrinkage (TCS), was introduced in the early 1990s with the use of a laser. However, the device delivered high bursts of energy that were difficult to control and the procedure had high failure rates due to rebound ligament stretching. Other concerns included its high initial and maintenance costs and technical difficulties. In response to the problems with the laser technique, monopolar radiofrequency TCS was introduced clinically in 1996; it was promoted as having the advantages of the thermal arthroscopic technique but allowing more control than the laser technique. The TCS procedure involves the introduction of thermal energy through a heat probe into the capsular ligamentous tissue, which denatures collagen and shrinks the redundant tissue. The remaining fibroblasts and vascular cells subsequently repair the tissue, improving its mechanical properties.[3,12]

Arthroscopic capsular-shift procedures that use CP have also been developed to mimic the gold-standard open procedure. Techniques vary, with the use of different suture or tack applications, plication and pleating variations, humeral- or glenoid-based shifts, direction of approach, and posterior "pinch-tuck" methods.[2,6,7,11] The most appropriate capsular-shift technique for a particular patient depends on the presence of labral lesions and the direction of instability or capsular redundancy. These techniques are patient specific and often determined during examination under anesthesia just before the procedure begins. Regardless of the technique, the overall goal is to reduce capsular redundancy while addressing capsular volume and tissue abnormalities.[9,10]

METHODS

I conducted a search of PubMed, the Cochrane Library, and Ovid/MEDLINE between July 2012 and March 2013 for articles published from 2000 through March 2013 on surgical procedures to treat shoulder instability. Search terms were *capsular plication*, *shoulder capsular shift*, *shoulder capsular shrinkage*, *thermal capsulorrhaphy*, and *treatment of shoulder instability*. Cohort studies, multiple case reviews, and randomized controlled trials were included. Data extraction consisted of study size, patient demographics and inclusion criteria, surgical technique, postoperative management, and any available outcome measures. Only studies that specifically investigated the outcomes of arthroscopic capsular shift through plication and thermal capsulorrhaphy were eligible.

All data were tabulated for review and grouped according to procedure and similar patient criteria (Tables 1 and 2). I evaluated each study according to the Physiotherapy Evidence Database (PEDro) rating-scale criteria to compare internal validity among studies; the results are included in each table.[13] Included studies were typically rated at 5 to 6, owing to the difficulty of conducting blinded prospective research involving surgical procedures.

I compared studies based on outcome measures such as range-of-motion (ROM) measurements, satisfaction scores, return to previous level of activity, and rate of recurrence. Outcome measurements were also compared when available, including the Rowe score, Western Ontario Shoulder Instability Index, and American Shoulder and Elbow Surgeons (ASES) score. Outcomes were categorized by procedure, type of instability, and specific surgical technique. I further analyzed trends in postoperative management compared with outcomes. Because return to previous activity level and rate of recurrence were the most common outcome measures, I used them to determine success rates.

RESULTS

A total of 12 studies focusing on the treatment of shoulder instability were retrieved from the search and met the criteria: 4 articles on arthroscopic capsular plication and 8 studies on TCS. Of the TCS investigations, 2 were retrospective case reviews and 6 were prospective cohort studies. Articles on arthroscopic CP were 2 retrospective case reviews and 2 prospective cohort studies. In my review, a total of 358 shoulders were treated with TCS and 168 shoulders were treated with CP. In the studies, patient ages ranged from 19 to 27 years; the youngest was age 14 years and the oldest was age 57 years. Cases were stratified according to procedure and further by similarities in design, as the articles described only anterior instability, MDI, or groupings of various degrees of instability.

Capsular-Plication Studies

Of the 4 studies on CP, 2 described only the treatment of anterior instability and 2 described only the treatment of MDI.[2,4,7,14] The procedures consisted of treating redundant capsular tissue with pleating and pinch-tuck methods, placing sutures in the posterior, inferior, and anterior

Table 2. Operative Techniques for Thermal Capsulorrhaphy, Rehabilitation Protocols, and Outcomes

Study	No. of Shoulders	Instability	Operative Technique	Immobilization, wk	Begin Active Range of Motion	Success Rate, %	PEDro Rating
Toth et al[12]	80	Mixed	Unspecified	4	Unspecified	69	5
Miniaci and McBirnie[15]	19	Multidirectional	Adjacent passes with minimal tissue left	3	6 wk	53	6
Frostick et al[9]	33	Multidirectional	Painting	3	3–6 wk	88	6
Mishra and Fanton[16]	42	Anterior	Not specific	2	4–6 wk	90	6
Savoie and Field[17]	30	Multidirectional	Single passes, rotator interval plication	1–3	Day 3	93	6
D'Alessandro et al[18]	84	Mixed	Initial painting, later change to striping with tissue remaining between	2–4	Varied	63	6
Terry et al[19]	40	Anterior	Linear striping	3	2 wk	93	5
Fitzgerald et al[20]	30	Multidirectional	Painting with single passes	6	6 wk	76	5

Abbreviation: PEDro, Physiotherapy Evidence Database.

capsule as needed, with a total of 3 to 8 sutures in each shoulder. Labral tears and other associated pathologic processes that did not meet the exclusion criteria were addressed before plication. A total of 168 shoulders were included in these 4 studies; of these, 8 had postoperative traumatic dislocations, and 5 had continued complaints or symptoms. Of the 159 patients who desired to return to their previous level of sport activity, 144 did so, for a success rate of 91%.

Anterior instability was present in 95 shoulders treated in the CP studies.[2,7] Of these, 88 patients reported returning to their previous level of sport or activity. There were 5 postoperative traumatic dislocations and 3 patients who had continued complaints. In the article by Kim et al,[2] the average loss of external rotation (ER) was 20%, pain on the visual analog scale decreased from 7 to 2, and the average Rowe score improved from 30 to 85. Although all of these patients returned to their normal work and activities, only 4 (17%) returned with no limitations, 14 (58%) returned with mild limitations, and 6 (25%) returned with moderate limitations; no returns with severe limitations were reported. In a study of 71 patients, Westerheide et al[7] noted that 60% returned with full ROM and the remaining 40% returned with 75% or better ROM compared with the opposite shoulder. Although 90% returned to their previous level of sport, 30% continued to exhibit mild apprehension and 10% continued to exhibit moderate apprehension. However, the satisfaction rate was 100%, the average final WOSI index was 85.6, and the average final Rowe score was 85.

Kim et al[2] reported postoperative management of immobilization for 4 weeks, followed by active-assisted ROM (AAROM) exercises, active ROM (AROM) at 6 weeks, and restriction of combined abduction-ER movements until 3 months. Westerheide et al[7] immobilized their patients in neutral position for 3 to 6 weeks, initiating rehabilitation if progression was slow or ER was less than 35° and starting a throwing program at 3 months.

Authors of 2 CP studies evaluated only patients presenting with MDI, for a total of 73 shoulders.[4,14] Of the 64 patients who planned on returning to sport participation at their previous level, 54 succeeded. Three postoperative dislocations occurred from traumatic injury, and 2 shoulders were considered failures owing to ASES scores of less than 70. Yet 98.6% of patients reported being extremely to mostly satisfied. Schamblin and Snyder[14] described an average ER loss of 5.9° in the supine position and 8.7° while standing. Both studies involved postoperative protocols that included immobilization for 4 to 6 weeks. Schamblin and Snyder[14] allowed isometric exercises to begin at 6 weeks, restricted forced ER and internal rotation, began sport-specific conditioning at 3 to 4 months, and allowed a return to high-risk sport at 6 months. Baker et al[4] allowed some passive ROM, AAROM, and isometric exercises during the immobilization period, progressing to full passive ROM, AROM, and isotonic exercises by 2 to 3 months. Strengthening was advanced by 4 months, and return to sport was allowed when strength was equal to the unaffected side.

Thermal Capsular-Shift Studies

I retrieved 8 TCS studies: 4 included only patients experiencing MDI, 2 including those with anterior instability, and 2 stratified groups of patients experiencing different degrees of instability.[9,12,15–20] In addition to the different types and degrees of instability among the studies, surgical technique varied from a painting style that left no remaining tissue between the treated areas to a striping technique that left minimal tissue between passes. Postoperative management also varied in the period of immobilization and progression of exercises. Overall, 358 shoulders were described in the 8 studies, with 274 being considered successful, for an overall success rate of 76.5%.

Two groups investigated a total of 82 shoulders with anterior instability. Mishra and Fanton[16] did not specify the TCS technique used, whereas Terry et al[19] used a linear-striping technique but did not discuss leaving tissue between passes. Return to the desired level of activity was accomplished in 75 shoulders (91%); 3 (4%) experienced postoperative traumatic dislocations. Terry et al[19] found that 3 athletes were unable to return to their prior level of sport: 1 due to death (cause not reported), 1 did not desire to return, and 1 continued to experience popping and weakness.[19] Mishra and Fanton[16] observed that 11 shoulders (26%) had a mild loss of ER. Terry et al[19] described 5 shoulders (13%) with a mild loss of internal rotation. Mishra and Fanton[16] immobilized patients for 2 weeks, allowing pendulums and submaximal isometric exercises, followed by passive ROM, AAROM, and isotonic exercises at 4 to 6 weeks, dynamic strengthening and aggressive stretching at 7 to 12 weeks, and a return to sport by 13 to 16 weeks. Terry et al[19] immobilized patients for 3 weeks, allowing AAROM to 90° of forward flexion and 30° of ER with the arm at the

side during the first 2 weeks. Scapular stabilization, proprioception, and AROM started at 2 weeks, followed by achieving full ROM and beginning concentric and eccentric strengthening at 3 to 6 weeks and allowing plyometric exercises, throwing, and return to high-load activities at approximately 3 months if all goals were met.

Studies that involved only MDI included a total of 112 shoulders, and 91 (81%) successfully returned to activity.[9,15,17,20] Surgical techniques varied slightly from the direction of the technique to tissue passes. In 1 investigation,[15] 9 of 19 failures (47%) were attributed to instability at an average of 9 months, including 100% (n = 4) of those presenting with voluntary instability. Another group[9] noted 3 of 33 failures (9%), with 14 patients satisfied, 6 satisfied but not meeting expectations, and 4 reporting no benefit. These authors reported 100% success (n = 8) in patients who were also treated for a labral repair. Savoie and Field[17] described 28 of 30 patients (93%) as being satisfied; 1 did return to activity but continued to have complications due to poor compliance with postoperative care, and 1 experienced a subluxation 8 months after surgery. Fitzgerald et al[20] observed that of 30 shoulders, outcomes were excellent in 3 (10%), good in 20 (67%), and poor in 7 (23%), with no postoperative dislocations. Of the 7 poor outcomes, 4 were due to pain and 3 were due to subluxations. Twenty-three patients reported being satisfied and returning to full activities.

Authors of the 2 studies on TCS for MDI immobilized their patients for 3 weeks, starting pendulums and AAROM afterward, followed by strengthening at 6 weeks.[9,15] Savoie and Field[17] immobilized their patients for 1 week and allowed ER to neutral and flexion in the scapular plane to 90° at day 3. These patients began an extensive rotator cuff and periscapular program at 3 to 4 weeks, proprioceptive exercises at 6 to 8 weeks, and plyometrics and sports conditioning at 12 to 16 weeks, with a return to full activity once ROM and strength goals were met at approximately 3 to 6 months.[17] Fitzgerald et al[20] immobilized their patients for 6 weeks with daily performance of pendulum exercises and began active ER to neutral position at 2 weeks, full AROM at 6 weeks, and rotator cuff strengthening once full ROM was achieved. Their patients returned to full activity once the strength of the operative shoulder was equal to the contralateral side, at approximately 4 to 6 months.

Two sets of investigators grouped patients by presentation of instability. In 1 study,[12] patients were categorized by instability direction: anterior (53%), posterior (6.3%), or MDI (40%), for a total of 80 shoulders, with 25 failures (31%). Surgical techniques were not reported and the only postoperative management described was 4 weeks of immobilization. In the other study,[18] patients were grouped as MDI, recurrent or atraumatic anterior subluxation, or traumatic or recurrent anterior dislocation, for a total of 84 shoulders, with 31 failures (37%). Outcomes were reported as excellent in 33 (39%) and good in 20 (24%) based on criteria that included the ability to return to work or sport, recurrent instability, ASES score, and a visual analog scale satisfaction score. An *excellent* score indicated full return with no instability, an ASES of 85 or better, and a satisfaction score of 9 out of 10. Of 68 athletes, 47 (69%) returned with few to no difficulties, including 9 of 10 from the dislocation group, 12 of 18 from the atraumatic group, and 26 of 40 from the MDI group. However, it is important to note that both surgical techniques and postoperative management changed during the study, without the changes being correlated with outcome data. The authors[18] reported changing from a painting technique, in which all tissue was treated, to striping and leaving some untreated tissue between passes owing to concerns about excessive capsular injury. They also changed the rehabilitation protocol because it was initially overaggressive.

Summaries of the extracted data from each study are found in Table 1 for CP and in Table 2 for TCS. When comparing immobilization periods and initiation of AROM, I noted no trends that indicated possible effects on success rates. Variations in the TCS surgical techniques and postoperative rehabilitation protocols limited the cumulative analysis.

DISCUSSION

Review of the literature indicates that improvements in arthroscopic techniques to treat shoulder instability are beginning to reach the standards set by the open anteroinferior capsular-shift technique. Although the technique must vary depending on the patient's injury, many of the arthroscopic techniques discussed in the literature have resulted in considerable success. Yet the arthroscopic CP seems to offer greater satisfaction and a higher success rate than TCS.

The TCS literature suggests that the procedure is not indicated for patients presenting with voluntary dislocations or moderate levels of instability, but those who initially present with mild instability may still be considered candidates. Failure rates were significantly lower for those patients who underwent labral repair in conjunction with TCS and in those patients who underwent TCS for the capsular tissue and plication for the rotator cuff interval.

Review revealed a discrepancy in the operative and postoperative management of TCS patients. Frostick et al[9] reported that the histologic effects of TCS resulted in a decrease in tissue stiffness at 2 weeks postoperatively that returned to normal levels between 6 and 12 weeks. However, only 1 of the 8 study designs used an immobilization period of 6 weeks.[18] Six of the study designs used a 2- to 4-week immobilization period, and the remaining study allowed some patients to discontinue immobilization at 1 week. One study protocol restricted combined movements of abduction with ER, whereas another restricted all passive ROM by a physical therapist or athletic trainer.[9,17] The success rates from these studies were 88% and 93%, respectively. Considering the decrease in tissue stiffness and the stated purpose of the procedure to reduce capsular laxity, I recommend that future authors specifically address postoperative rehabilitation protocols. From this review, I could not determine the degree to which postoperative management affected success owing to the variance in both surgical techniques and rehabilitation protocols between studies.

Additionally, Toth et al[12] reported that leaving viable tissue between heat-treated regions, such as in a grid or stripe technique, improved the healing process after TCS. Researchers in 2 studies[15,18] specifically noted that minimal to no tissue was left during the procedure. However, 1 group changed surgical technique late in the study owing to thermal-injury concerns. The success rates of these studies ranged from 53% to 63%. Again, further study on TCS should identify specific techniques related to successful outcomes.

The literature on arthroscopic CP indicated much greater satisfaction rates and fewer incidences of recurrence. Return to the previous level of activity was accomplished by 75% to 97% of patients.[2,4,7,14] However, the postoperative management for this procedure was more conservative, with the immobilization period lasting for at least 4 to 6 weeks and active stretching and strengthening not beginning until after 6 weeks. One study design also prohibited abduction and ER combinations for 3 months but resulted in an average decrease of 20° of ER, which was not considered a failure according to Neer standards.[2,11] Overall, the results of these studies indicate that the arthroscopic CP procedure had an outcome comparable with that of the open capsular shift.

Although I reviewed functional and symptomatic outcomes, complications associated with both CP and TCS outside of general surgical risk, recurrent instability, and loss of ROM have been reported. With CP procedures, patients have complained of pain associated with friction caused by knot placement, which may be addressed later with surgical removal.[6,11] Complications associated with TCS include axillary nerve dysesthesias, adhesive capsulitis, and rare cases of thermal capsular necrosis, glenohumeral ligament disruption, and capsular ablation.[19] The risks of these complications are greatly reduced with appropriate surgical technique and postoperative management.

CONCLUSIONS

In comparing the 2 arthroscopic procedures of CP and TCS, I determined that the capsular-shift procedure has generally better outcomes and should be used in patients with moderate to greater-than-moderate instability when indicated. The existing evidence supports the use of arthroscopic CP over TCS based on patient satisfaction and success rates. Outcomes of arthroscopic CP have been more successful and better mimic the outcomes of the gold-standard open capsular-shift procedure.

It should be acknowledged, however, that further study into the postoperative management of TCS procedures is necessary, as no widely accepted protocol for surgical technique or postoperative management has been established. The variations in operative technique should be further evaluated, as these differences potentially affect the success rates of the procedure. Additionally, revisions of operative and rehabilitative protocols and the establishment of a standardized protocol may improve the outcomes of this procedure for those who elect to continue using this approach to treat shoulder instability.

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