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SYMPOSIUM

Complications of Thermal Capsulorrhaphy

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Introduction

The treatment of glenohumeral instability with thermal energy continues to gain increasing attention since the first clinical series was reported in 1994 (G Thabit, MD, Squaw Valley, CA, unpublished data, 1994). The appeal of smaller incisions, decreased morbidity, and lack of retained instrumentation are some of the factors driving this trend. Along with the multiple benefits of an arthroscopic procedure as compared with an open procedure, thermal shrinkage also has its own particular complications—proven and theoretical. While there have been publications supporting the underlying basic science of thermal shrinkage, there have been few peer-reviewed publications discussing clinical trials. In addition, the clinical criteria and indications for its use are not well defined. Therefore, when examining potential complications of this procedure, the inherent risks of any arthroscopic shoulder instability surgery as well as those risks specific to this procedure should be examined. This chapter will discuss potential complications of capsular shrinkage and strategies to minimize or avoid these problems.

One or more of the authors or the departments with which they are affiliated have received something of value from a commercial or other party related directly or indirectly to the subject of this chapter.

Literature Review

Currently, there are few reported studies that specifically examine the complications and rate of failure of thermal capsular shrinkage. In 1999, Fanton and Wall[1] reported the results of 34 patients who were evaluated for a minimum of 1 year following radiofrequency (RF) thermal capsulorrhaphy. The patients had no associated labral or rotator cuff pathology. The average Bankart score improved from 24 to 93 (on a scale of 0 to 100). There was one patient with an axillary neuritis, involving the sensory portion of the nerve, that resolved 3 weeks following surgery. One patient developed adhesive capsulitis. Another patient had recurrence of instability that required revision open stabilization. At the time of revision, 9 months following the primary procedure, biopsy of the treated capsule revealed increased fibroblasts, dense collagenation, and increased vascularity along the synovial surface of the capsule.

Bradley presented the results of 60 patients who underwent thermal shrinkage with a 6-month minimum follow-up (average 12 months) (JP Bradley, MD, Orlando, FL, unpublished data, 2000). There were 12 shoulders with a history of a dislocation, 13 shoulders with a history of subluxation, and 35 shoulders with a history of multidirectional instability (MDI).

Among the 12 patients with a history of dislocation, there were 7 Bankart lesions and 2 superior labrum anterior and posterior (SLAP) lesions. At follow-up, there were seven excellent, three satisfactory, and two unsatisfactory results. Of the 13 patients with a history of subluxation, there were 3 SLAP lesions and 1 Bankart lesion. There were three excellent, eight satisfactory, and two unsatisfactory results. Of the 35 shoulders with MDI, there were 3 SLAP lesions and 1 Bankart lesion. There were 13 excellent, 12 satisfactory, and 10 unsatisfactory results. Among those patients with MDI, there was recurrent instability in four patients: one patient underwent a diagnostic scope with a deferred open shift and three patients underwent capsular shifts without recurrent instability after the shift. The author notes that a separate rehabilitation protocol for patients with MDI was designed after the first 60 patients and this modification has subsequently improved the outcome of MDI patients.

Additional surgery was performed on six shoulders overall. In one shoulder, arthroscopic release following thermal shrinkage with a SLAP repair was performed. In five shoulders with recurrent instability, the following additional surgical procedures were performed:

Table 1
Risk for failure of thermal capsulorrhaphy

Proposed Risk Factor	Group I (n=91)	Group II (n=15)
Prior surgery (frequency %)	6 (6.5%)	7 (46%)*
Multiple dislocations	10 (11%)	8 (53%)*
Contact sports	10 (11%)	6 (40%)
Multidirectional instability	4 (4.4%)	3 (20%)
Concurrent procedures	49 (54%)	9 (60%)

*$P = < .05$

diagnostic scope (one), anterior capsule labral reconstruction (one), and capsular shift (three). Additionally, there were two instances of axillary neuritis that resolved within 6 weeks.

Andrews reported on the results of 122 patients who underwent monopolar thermal shrinkage between July 1997 and October 1998 (JR Andrews, MD, Orlando, FL, unpublished data, 2000). There was one instance of a transient axillary neuritis that had completely resolved by 3 months from the time of surgery. Of the 122 patients, 26 throwing athletes with internal impingement were evaluated for a minimum of 9 months and completed a subsequent sports season. These 26 patients were compared with a group of 56 throwers who underwent surgery for internal impingement prior to the use of thermal shrinkage. Of those treated with thermal shrinkage, 79% returned to compete at the same or a higher level versus 61% who were treated prior to the use of thermal shrinkage.

Savoie and Field[2] studied the results of 30 patients with MDI who underwent RF thermal shrinkage from January 1997 to July 1997 using a monopolar temperature specific probe. The comparison group consisted of 26 patients with MDI who underwent an arthroscopic capsular shift from 1990 to 1993 with a transglenoid suture technique and 32 patients who underwent laser capsular shrinkage from 1995 to 1996. Twenty-eight of the 30 patients treated with RF capsular shrinkage had satisfactory results at a minimum follow-up of 22 months. There was recurrent instability in two patients. One patient underwent revision open capsular shift at another institution. According to the authors, the capsule appeared normal at surgery. The other patient underwent arthroscopic posterior capsule plication.

There was recurrent instability in one patient in the laser-treated group, with an average follow-up of 27 months. This patient underwent revision surgery without mention of the quality of the capsular tissue. Among those treated with suture fixation, there was recurrent instability in three patients. All three patients underwent revision surgery.

Jensen reported on a series of 15 patients in whom thermal capsulorrhaphy failed (KL Jensen, MD, Orlando, FL, unpublished data, 2000). Review of the patients' records revealed that prior to thermal shrinkage, four patients had no clinical evidence of glenohumeral instability, six had MDI, and five had traumatic instability in the setting of underlying asymptomatic MDI. At the time of revision surgery, the capsule was thin and friable in five patients and appeared normal in three patients. It was noted that thermal shrinkage may not have been the best treatment for these patients, and that successful management of a patient with a failed thermal shrinkage depends on the accurate determination of the initial injury and underlying diagnosis. In addition, near-complete absence of capsular tissue in several patients who have undergone revision surgery following a failed thermal shrinkage has been noted.

Recurrent Instability

The cause of recurrent instability following capsular shrinkage can be attributed to certain factors before, during, and after surgery.

Preoperative Factors

Failure to obtain an accurate history, perform a thorough physical examination, and obtain proper imaging studies can result in misdiagnosis and lead to failure of treatment. Accurately determining the direction (anterior, posterior, inferior, bidirectional, multidirectional) and magnitude of instability is critical.

In regard to proper patient selection, few clinical studies have identified which patients are at an increased risk for failure of thermal capsulorrhaphy. Therefore, the results of 106 patients who underwent thermal capsulorrhaphy at the Hospital for Special Surgery were reviewed (K Anderson, MD, Orlando, FL, unpublished data, 2000). From this group, 15 patients were identified to have failed capsular shrinkage. Failures were defined as re-dislocation, re-operation, or a L'Insalata shoulder rating score of less than 70 (range: 17 to 100).[3] The investigators proposed several potential risk factors for failure based on clinical observation and failure patterns in previous studies of instability (Table 1). Importantly, the risk factors were chosen prior to data analysis. The frequency of the risk factors was then compared between the failure group (n=15) and the nonfailure group (n=91).

Prior Surgery Reports on revision shoulder stabilization have indicated that prior surgery represents a risk factor for failure.[4,5] Therefore, previous surgery on the affected shoulder was chosen as a potential risk factor for failure of thermal shrinkage. In addition, it is believed that scar tissue may have more limited

Fig. 1 Arthroscopic view of a Bankart lesion (A), capsular laxity treated with Suretac fixation (B), and capsular shrinkage (C).

capacity for shrinkage. Early arthroscopic observations suggested a less dramatic response when scar tissue was treated with the thermal probe as compared with native capsular tissue. Presumably scar tissue, which is less organized than native capsular tissue, would have less capacity to shorten and maintain this new length.

A history of prior surgery on the affected shoulder was significantly more common among the patients in whom thermal shrinkage failed compared with those patients with a successful outcome. Of the 13 patients that presented after having had prior surgery, thermal capsulorrhaphy failed in 7 patients.

Multiple Preoperative Dislocations A history of multiple dislocations prior to treatment was seen more often in the failure group as compared with the nonfailure group. Patients with multiple preoperative dislocations have been shown to be at higher risk for failure with other arthroscopic stabilization procedures.[6,7] In this setting, multiple preoperative dislocations may indicate a higher degree of instability and capsular stretch that is beyond the limits of thermal capsulorrhaphy.

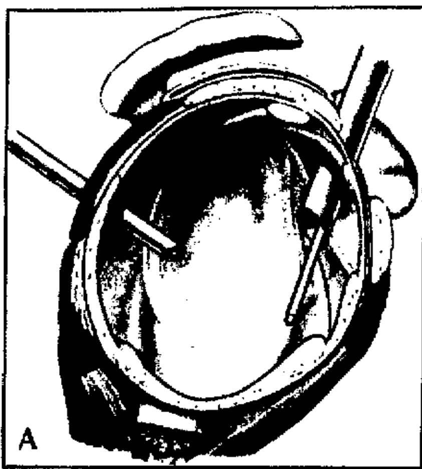
Contact Sports Participation Forty percent of the failure group participated in contact sports compared with less than 11% of the nonfailure group. This difference was not statistically significant; however, the numbers were too limited to exclude contact sports participation as a risk factor for failure. Contact sports participation has been suggested as a risk factor for failure in previous reports on arthroscopic stabilization procedures.[8] In a recent study, new trauma was a cause of failure in 17 of 49 patients who had undergone stabilization procedures.[4] The potential of a new traumatic event occurring while participating in contact sports is of particular concern when the biomechanical properties of the healed capsular tissue remain unknown. Additional research is needed before the advisability of return to contact sports after thermal capsulorrhaphy can be determined.

Multidirectional Instability In our study of failures, there appeared to be a larger percentage of patients with MDI among those in whom thermal shrinkage had failed compared with the nonfailure group. However, the numbers available were insufficient to statistically prove or exclude MDI as a significant risk factor. Some inconsistencies in the literature regarding the success of treatment of MDI with thermal shrinkage may be the result of a lack of uniformity in the diagnostic criteria for MDI. The primary direction of instability may be important in the outcome of these patients. Dramatic improvements have been noted in some patients with MDI. However, the surgeon should exercise caution when using thermal capsulorrhaphy alone in the treatment of patients with MDI.

Concurrent Procedures Patients undergoing a concurrent arthroscopic procedure (labral or biceps anchor repair) at the time of thermal shrinkage were not at an increased risk of failure. In fact, other studies have shown that the addition of thermal capsulorrhaphy to labral repair improved the rate of return to competitive activity at the same or higher level (JR Andrews, MD, Orlando, FL, unpublished data, 2000). The role of thermal capsulorrhaphy as an adjunct to other arthroscopic procedures may prove to be the most effective use of this technology (Fig. 1).

Intraoperative Factors

Proper instrumentation and adequate visualization must be obtained to optimize the results of thermal shrinkage. This includes proper patient positioning, satisfactory anesthesia, adequate fluid flow, and excellent hemostasis. In order for the physician to have optimum visualization, a particular sequence of thermal treatment is performed. The preferred technique for anterior instability involves placing the probe through



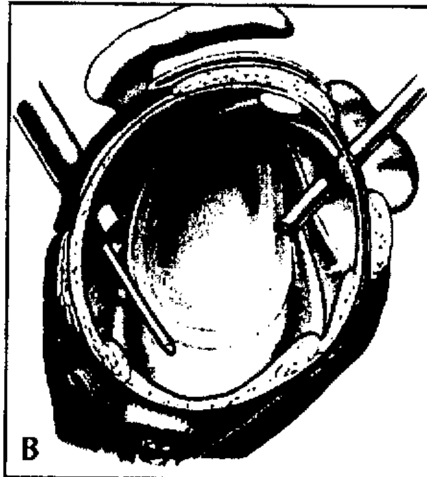


Fig. 2 A, Treatment of anterior instability. The probe is placed through the anterior portal with the scope viewing from the posterior portal. **B,** Treatment of posterior instability. The reverse portal set-up and shrinkage sequence are shown. (Reproduced with permission from Anderson KA, McCarty EC, Warren RF: Thermal capsulorrhaphy: Where are we today? *Sports Med Arthrosc Rev* 1999;7:117-127.)

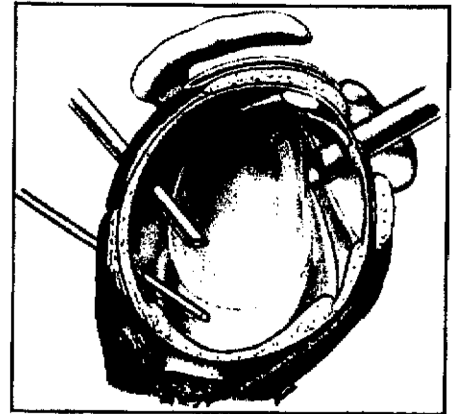


Fig. 3 Placement of an accessory posteroinferior portal can improve access to the inferior capsule. (Reproduced with permission from Anderson KA, McCarty EC, Warren RF: Thermal capsulorrhaphy: Where are we today? *Sports Med Arthrosc Rev* 1999;7:117-127.)

the anterior portal with the scope viewing from the posterior portal (Fig. 2, *A*). The probe is then advanced from the posterior axillary pouch toward the anterior capsular structures. Posterior thermal treatment is performed with the reverse portal set-up and shrinkage sequence (Fig. 2, *B*). MDI is addressed initially with the probe in the anterior portal. Following shrinkage of the anterior capsular structures, the probe is switched to the posterior portal with the arthroscope placed in the anterior portal. An accessory posteroinferior portal may be helpful to properly visualize the inferior capsule (Fig. 3). The temperature and duration of probe exposure must be carefully monitored during shrinkage in the axillary pouch.

Management of the rotator interval may not be adequately addressed with capsular shrinkage. Rotator interval insufficiency has been noted to be a component of inferior and posterior instability, and MDI.[9-11] There are no specific guidelines to determine when the rotator interval should be tightened. In the report by Savoie and Field,[2] thermal shrinkage was combined with tightening of the rotator interval in all cases. We have chosen thermal treatment of the rotator interval in cases of posterior instability or MDI.

Postoperative Factors

Failure to comply with immobilization or a therapy program after surgery may also be a cause for failure. An experimental study by Schaefer and associates[12] suggests that tissues may stretch out if exposed too early to physiologic loads. Wall and associates[13] have demonstrated that shrinkage increases with added energy; however, mechanical properties decline. Perhaps the amount of shrinkage necessary in some patients, while achievable, is at too great a cost in tissue strength.

Motion Restriction

Restricted motion has been reported following capsular shrinkage with both RF and laser devices.[14,15] Fanton[15] reported that one patient developed adhesive capsulitis following RF shrinkage requiring prolonged physical therapy. Thabit[14] suggested performing manipulation of the shoulder under anesthesia 3 to 5 months following surgery if motion has not recovered.

Current shrinkage techniques depend on direct visual response of the capsular tissue to gauge the amount of capsular shrinkage indicated. Moreover, there are no definitive guidelines to determine when adequate capsular contraction has occurred. Excessive capsular contraction with restricted motion may occur.

Following shrinkage, range of motion is restricted in patients with unidirectional instability for 4 weeks and in patients with MDI for 5 to 6 weeks.

Nerve Injury

Transient injury to the axillary nerve has recently been reported (JR Andrews, MD, and JP Bradley, MD, Orlando, FL, unpublished data, 2000). Because of the close proximity of the axillary nerve to the inferior aspect of the capsule, tightening between the 5 o'clock and 7 o'clock positions in patients with a thin capsule is not recommended.[1] In addition, in patients with "very hypermobile" MDI, the temperature and power setting should be lowered and gradually increased until the necessary capsular response is observed.[1] It was also noted that the arm should not be abducted more than 30° to

avoid pulling the axillary nerve closer to the inferior capsule.[1]

Potential nerve injury from capsular shrinkage raises an important technical concern: depth of thermal penetration. The depth of thermal penetration is a function of the quality of the target tissue, the time of exposure, the probe settings, the type of probe, and the method of application.[16] In a recent study, the temperature along the axillary nerve during RF-induced thermal capsular shrinkage was investigated (EC McCarty, MD, Orlando, FL, unpublished data, 2000). Thermometer probes were used to measure the temperature at various points along the axillary nerve in 16 specimens during capsular shrinkage with an RF probe (65°). The shoulders were tested in 0°, 45°, and 90° of abduction. At 0° of abduction, temperature increases above 50° along the teres minor branch of the axillary nerve were evident in 4 of 6 specimens at 0° of abduction, 4 of 5 specimens at 45° of abduction, and 3 of 4 specimens at 90° of abduction. Temperature within the axillary nerve proper was elevated only at 90° of abduction.

Failure to understand the neurovascular anatomy of the shoulder may also lead to injury during creation of the portal. Inattention to proper traction may lead to brachial plexus strains. To avoid injury to the cervical or brachial plexus, care also must be directed toward correct neck and head positioning.

Summary

As the popularity of thermal capsular shrinkage continues to increase, analysis of complications and failures will continue to provide helpful information in guiding patient selection and decreasing morbidity. Patients who are undergoing revision surgery or who have a history of multiple preoperative dislocations appear to be at higher risk for failure with thermal shrinkage surgery. Caution should be exercised for patients who participate in contact or collision sports, as well as those with MDI. Further study may determine whether thermal shrinkage is most appropriate for microinstability or used as an adjunct to other stabilization procedures.

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