Electrothermal Capsulorrhaphy in Glenohumeral Instability Without Bankart Tear

Jerome G. Enad, M.D., F. Daniel Kharrazi, M.D., Neal S. ElAttrache, M.D., and Lewis A. Yocum, M.D.

Purpose: The purpose of this study is to review the clinical results of electrothermal capsulorrhaphy (ETC) performed on 23 patients for the treatment of glenohumeral instability at a minimum follow-up of 2 years. Type of Study: Retrospective case series. Methods: Twenty-six patients with symptomatic unidirectional or multidirectional glenohumeral instability without Bankart tear were treated with ETC using a radiofrequency probe. No labral repairs were performed. A standard postoperative rehabilitation protocol was followed. Patients were evaluated with respect to motion, direction of instability, need for repeat surgery, return to overhead sports, and symptoms of pain and instability using various scores. Results: Twenty-three patients were available for follow-up evaluation at an average of 30 months. The overall average ASES and Rowe scores were 84.2 and 79.3, respectively. Recurrent instability requiring an open stabilization procedure occurred in 4 patients (17%), 2 with anterior and 2 with multidirectional instability. Seven of 14 overhead athletes (50%) reported inability to return to their previous level. According to Rowe scores, overall results were 11 excellent, 5 good, 4 fair, and 3 poor. No postoperative nerve complications occurred. Conclusions: The ETC procedure was safely performed to treat glenohumeral instability without Bankart lesions. The recurrence rate is similar to that for other arthroscopic procedures but higher than for open surgery. In the absence of Bankart tear, patients with multidirectional instability and overhead athletes may require something other than an isolated ETC procedure to address instability. Long-term results of ETC are needed to better define its surgical indications. Key Words: Electrothermal—Capsulorrhaphy—Shoulder instability—Bankart.

Glenohumeral instability is a relatively common condition among young, active adults. In most cases, attenuation of the glenohumeral joint capsule occurs as a result of either high-energy macrotrauma or gradual stretching with repetitive microtrauma. Although open surgical procedures address capsular redundancy and labral pathology,1-6 stiffness and failure to regain full motion postoperatively have resulted in limitations of function in overhead athletes and laborers. Interest has focused in recent years on using arthroscopic techniques to treat both unidirectional and multidirectional instability (MDI).7-18 Potential advantages include decreased surgical morbidity, less blood loss, less postoperative pain, improved cosmesis, and more rapid recovery. However, arthroscopic procedures designed to address capsular laxity can be technically demanding, relying on difficult suturing and knot-tying techniques to plicate the glenohumeral ligaments.

Recently, the use of thermal energy to shrink collagen tissue has been developed. Using a Holmium: Yag laser, Hayashi et al.19,20 noted predictable contraction and shortening of ligaments to thermal stimulation. Tissue shortening was noted to be dependent on duration of thermal treatment, quality of tissue, and density and direction of collagen fiber orien-
THERMAL CAPSULORRHAPHY IN GLENOHUMERAL INSTABILITY

Operative Technique

Each surgery was performed by 1 of 5 experienced shoulder surgeons in a single group practice. All patients underwent the diagnostic arthroscopy and ETC procedure under general anesthesia in the lateral decubitus position. The shoulder was placed in 30° to 45° of abduction and 15° to 30° of forward flexion with 5 to 15 lb of traction on the affected arm. The diagnostic arthroscopy of the glenohumeral joint was performed through a standard posterior portal and an anterior portal made at the rotator interval. Laxity of the glenohumeral ligaments, most commonly the anteroinferior band, and a positive drive-through sign was noted in each patient. Partial tears or fraying of the labrum, biceps anchor, or rotator cuff were debrided with a motorized shaver.

The thermal capsulorrhaphy was performed using a monopolar Oratec thermal probe (Oratec, Menlo Park, CA), with power set at 40 W and temperature at 65°C to 67°C. The probe was entered through the anterior portal and used to thermally shrink the glenohumeral ligaments, beginning along the inferior aspect of the inferior glenohumeral ligament, passing medial to lateral, and advancing superior to include shrinkage of the middle glenohumeral ligament. The superior glenohumeral ligament at the rotator interval was also shrunk if the capsular tightening was inadequate in preventing subluxation. The thermal probe was entered through an accessory posterior portal located 1.5 cm below the posterior arthroscopic portal for rotator interval shrinkage. Three to 5 stripes with variable intervals of normal tissue was routinely performed (such as striping or painting, but not crossing or cornrows). Visible darkening and contraction of the capsule with the shrinkage was noted. The drive-through sign was eliminated in each case, and subluxation of the humeral head was decreased. Wounds were closed with nonabsorbable suture. The affected arm was then placed into a sling, with the shoulder in slight abduction and internal rotation.

Postoperative Rehabilitation

A padded sling was maintained for 3 to 4 weeks after surgery. Patients with MDI or posterior instability were generally maintained longer than unidirectional anterior instability. During the period of immobilization, only active range of motion exercises of the wrist and elbow were permitted. Gentle Codman exercises of the shoulder were allowed. After the period of immobilization, range of motion of the shoulder was allowed to 20° of external rotation, forward flexion and abduction to 90°, and extension to 10° until 6 to 8 weeks postoperatively. After 6 to 8 weeks, aggressive range of motion and strengthening exercises were initiated. Passive stretching was limited to 10° to 20° less than the opposite shoulder in forward flexion, abduction, and external rotation. The patient was allowed to achieve the final end range of motion actively over time, with activity to minimize risk of

METHODS

Twenty-six patients who exhibited symptoms of glenohumeral instability (such as subluxation or dislocation) were treated with ETC between November 1997 and August 1999. The indications for surgical intervention were symptomatic involuntary glenohumeral instability with sport or activities of daily living (ADL) or reproducible pain localized to the glenohumeral joint when placed in a provocative position of instability. Symptoms were unresponsive to activity modifications, anti-inflammatory medications, and a minimum of 3 months of a comprehensive rehabilitative program emphasizing strengthening of the dynamic stabilizers of the shoulder. Excluded from the study were patients with previous shoulder surgery, patients who underwent concomitant boney procedures, and patients with complete Bankart tear or labral detachment requiring stabilization and repair. These exclusionary criteria permitted review of the results of an isolated ETC procedure only.

The amount of shrinkage was found to be time and temperature dependent, with ideal temperature ranging from 65°C to 75°C. In a cadaver model, Tibone et al. showed significant reduction in anterior and posterior translation of the humeral head after thermal shrinkage of the glenohumeral ligaments with a Holmium laser, and a similar response was later shown using a radiofrequency (RF) probe. Applying this model to the treatment of shoulder instability, Fanton described a surgical technique using a monopolar, temperature-specific RF probe to tighten the glenohumeral capsule in unidirectional and MDI. Published studies of this procedure are few, and long-term outcomes have not been reported. Currently, the indications for electrothermal capsulorrhaphy (ETC) and the postoperative rehabilitation are evolving. The purpose of this study is to review the results of ETC performed for the treatment of glenohumeral instability in shoulders without labral detachment with a minimum follow-up of 2 years.

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stretches the repair. Overhand sports or work activities, including throwing, were not allowed until a minimum of 12 weeks postoperatively.

**Evaluation and Analysis of Data**

Patients were evaluated by physical examination and a functional questionnaire based on the modified American Shoulder and Elbow Society (ASES) assessment. Postoperative function was also evaluated and graded based on the system of Rowe et al. Failures were defined as recurrent symptoms requiring further surgery for instability or a fair or poor result based on the criteria of Rowe et al.

All data were acquired on a Microsoft Excel spreadsheet (Microsoft, Redmond, WA). Mean values and standard deviation are presented for ranges of motion. Mean values and ranges are presented for all other continuous data. The small sample size precluded meaningful statistical analysis between descriptive parameters.

**RESULTS**

Twenty-three of 26 patients (88%) were available for evaluation at a mean of 30 months (range, 24 to 39 months). The preoperative demographic data are summarized in Table 1. The 3 patients who did not return requests for follow-up evaluation were similar to all other patients, except all 3 participated in competitive overhand sports. The mean age at treatment was 24.9 years (range, 15 to 37 years). There were 17 men and 6 women. The dominant extremity was involved in 18 cases, the nondominant side in 5 cases. Eight cases (35%) were associated with shoulder macrotrauma, 11 cases (48%) were associated with repetitive microtrauma (such as overhand throwing), and 4 cases (17%) were atraumatic. Fourteen patients (61%) were overhand athletes, including baseball or softball (13 patients) and volleyball (1 patient). Preoperatively, 11 patients (48%) presented with symptoms of only pain, while 9 reported symptoms of pain and instability (39%), and 3 reported instability only (13%). No patient had a history of frank dislocation requiring reduction by a clinician. Symptoms had been present for an average of 13 months (range, 3 to 46 months).

On physical examination, 13 patients had a positive anterior apprehension test. Twenty patients had relief of either the apprehension or pain with the relocation test. Each patient showed translational laxity of the involved shoulder of at least one grade higher than the uninvolved in one or more directions. Physical examination showed 13 patients to have unidirectional anterior instability, 9 MDI, and 1 posterior instability. Evidence of generalized ligamentous laxity based on the criteria of Marshall et al. was present in 4 patients with MDI.

Associated findings at arthroscopy are summarized in Table 2. One patient had both a partial anteroinferior labral detachment and a Hill-Sachs lesion, and 4 other patients had chondromalacia of the humeral head surface. Fraying of the labrum at the biceps anchor indicative of a SLAP tear, type 1, was noted in 11 patients. Fraying or partial-thickness tearing of the rotator cuff crescent overlying the posterosuperior labrum in the abducted externally rotated position, corresponding to the lesion of internal impingement, was noted in 8 patients.

**Overall Clinical Findings, ASES, and Rowe Scores**

At latest follow-up, forward flexion averaged $175^\circ \pm 9.3^\circ$ compared with $180^\circ$ on the contralateral side. External rotation with the arm at the side averaged $61^\circ \pm 8.8^\circ$ versus $65^\circ$ on the contralateral side.

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**Table 1. Preoperative Demographic Data**

<table>
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<th>Category</th>
<th>Value</th>
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<tr>
<td>No. of patients</td>
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<td>Age (mean, range)</td>
<td>24.9 yr, 15 to 37 yr</td>
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<tr>
<td>Sex</td>
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<tr>
<td>Male</td>
<td>17</td>
</tr>
<tr>
<td>Female</td>
<td>6</td>
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<tr>
<td>Symptoms duration (mean, range)</td>
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<td>Trauma</td>
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<td>Blunt trauma</td>
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<td>Repetitive overhand</td>
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<tr>
<td>None</td>
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<td>Predominant instability pattern</td>
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<td>Anterior</td>
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<td>Posterior</td>
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<td>Multidirectional</td>
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<td>Participation in overhand sports</td>
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<tr>
<td>Yes</td>
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<td>No</td>
<td>9</td>
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**Table 2. Intraoperative Findings**

<table>
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<th>Finding</th>
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<tr>
<td>Bankart*</td>
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<tr>
<td>Hill-Sachs</td>
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<tr>
<td>Humeral head chondromalacia</td>
<td>4</td>
</tr>
<tr>
<td>Internal impingement</td>
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</tr>
<tr>
<td>Full-thickness rotator cuff tear</td>
<td>0</td>
</tr>
<tr>
<td>Superior labral fraying</td>
<td>11</td>
</tr>
</tbody>
</table>

*The presence of a Bankart tear (i.e., anterior-inferior labral detachment) was an exclusionary criterion.
External rotation with the arm elevated averaged 95° ± 16.4° versus 95° on the contralateral side. Internal rotation averaged thumb reaching the eighth thoracic vertebral level ± 1.7 levels (versus T8 on the contralateral side).

The mean postoperative ASES score was 84.2 (range, 50 to 100), with average pain score of 42.0 (range, 15 to 50) and an average score for ADL of 42.2 (range, 28.3 to 50). The mean postoperative Rowe score was 79.3 (range, 40 to 100), yielding 11 excellent, 5 good, 4 fair, and 3 poor overall results. Seventy percent of the patients had good or excellent results (Table 3).

Functional Scores and Type of Instability

Thirteen patients with anterior instability had mean postoperative ASES and Rowe scores of 83.4 (range, 40 to 100) and 83.5 (range, 55.8 to 100), respectively. Nine patients with MDI had mean postoperative ASES and Rowe scores of 82.6 (range, 50 to 100) and 75.6 (range, 40 to 100), respectively. One patient with posterior instability had postoperative ASES and Rowe scores of 83.3 and 60, respectively. Eight patients with traumatic instability had mean postoperative ASES and Rowe scores of 80.3 (range, 55.8 to 100) and 80.0 (range, 40 to 100), respectively. Eleven patients with repetitive microtrauma had mean postoperative ASES and Rowe scores of 85.9 (range, 50 to 100) and 80.9 (range, 40 to 100), respectively. Four patients with atraumatic instability had mean postoperative ASES and Rowe scores of 87.2 (range, 83.3 to 98) and 73.8 (range, 40 to 100), respectively.

Results of Overhand Athletes

Fourteen overhand athletes had mean postoperative ASES and Rowe scores of 87.0 (range, 50 to 100) and 85.0 (range, 40 to 100), respectively. Only 7 of the 14 overhand athletes were able to return to their previous level of athletics. Three patients returned to a lower level of overhead sport because of continued symptoms in the shoulder. Four overhand athletes were unable to return to their sport because of continued shoulder symptoms. If the 3 overhand athletes who were lost to follow-up evaluation are included in this subset, it is possible that as many as 59% were unable to return to previous level. Two overhand athletes later required a second open procedure to address the recurrent symptoms of instability.

Complications

No surgical complications, nerve deficits, or wound infections occurred in any patient. At latest follow-up, 2 patients had external rotation lacking ≥10° fewer than the contralateral side, and 3 patients had forward flexion lacking ≥10° than the contralateral side.

Analysis of Failures

Four patients (2 with anterior instability and 2 with MDI) required an open surgical stabilization for recurrence. The mean postoperative ASES and Rowe scores for these patients were 70.2 (range, 50 to 84.2) and 45.0 (range, 40 to 60), respectively. Repeat surgery was performed an average of 13.5 months after the index procedure (range, 6 to 29 months). These results give an overall repeat surgery rate of 17% (4 of 23 patients). Seven patients (30%) had fair or poor results based on the grading of Rowe et al; 5 of these 7 had macroscopic trauma of the humeral head at arthroscopic inspection, including all 4 patients requiring repeat surgery. After open surgery, 1 patient returned to professional baseball 1 year postoperatively, 1 overhand and 1 contact athlete converted from competitive to recreational sports because of continued symptoms in their shoulders, and 1 patient who did not participate in sports was asymptomatic after 1 year.

DISCUSSION

The past several years have seen a rise in popularity of treating shoulder instability with arthroscopic thermal capsular shrinkage. However few studies have been prospective or published in the peer-reviewed literature. Fanton's original reports on the initial 120 patients treated with ETC, with or without arthroscopic capsulolabral repair, note a 90% success rate. However, patients with MDI had a lower satisfaction rate and ability to return to sports.

Open surgical treatment for instability of a capsular etiology have shown high success rates in the short term. Neer and Foster reported only one unsatisfactory result in 40 patients with MDI treated with an inferior capsular shift. Cooper and Brems reported
15% recurrence with worsening results over time in patients with MDI treated by inferior capsular shift. Altchek et al.\textsuperscript{1} noted 10% recurrence after T-plasty capsular shift for anterior-inferior MDI. In a subset of 34 patients with atraumatic instability treated with open capsular imbrication, Wirth et al.\textsuperscript{42} reported only 6% recurrence.

Arthroscopic treatment of capsular redundancy has had a slightly higher reported recurrence rate, comparatively. Arthroscopic capsular shift using a transglenoid suture technique to treat MDI has a reported recurrence of 5% to 12%.\textsuperscript{16,43} In a retrospective matched controlled study, Savoie and Field\textsuperscript{32} compared the results of arthroscopic capsular shift, laser-assisted capsulorrhaphy (LAC), and ETC for the treatment of MDI. They noted recurrence rates of 10%, 3%, and 6.7%, respectively. In that study, 80% of athletes in each group returned to their previous level of sport. The authors postulated that with true MDI, the lax joint capsule does not produce appropriate proprioception to the muscles of the rotator cuff to stabilize the shoulder. With thermal capsular tightening, the normal mechanical function and firing pattern of the rotator cuff is restored thereby restoring normal shoulder stability.

In a recent prospective study comparing LAC and ETC for the treatment of instability without Bankart lesion, Levy et al.\textsuperscript{35} reported recurrences of 36% after LAC and 24% after ETC. Griffin et al.\textsuperscript{44} noted a 12% recurrence after ETC for the treatment of MDI and suggested longer postoperative immobilization (at least 6 weeks) in this group. In a matched controlled study, Levitz et al.\textsuperscript{45} noted that the arthroscopic treatment of internal impingement in baseball players was more successful in returning to competitive play when ETC was performed to treat the associated microinstability.

The current study describes the minimum 2-year results of ETC for the treatment of shoulder instability with a predominant etiology of capsular laxity without Bankart lesion. Because of the small sample size, there was insufficient data to detect a discernible difference between patients treated for anterior instability and those treated for MDI based on ASES and Rowe scores. With the numbers involved, a tendency for higher failure and repeat surgery rate overall was seen for the MDI group. The importance of rotator interval closure when treating patients with MDI or overhead athletes may require treatment other than an isolated ETC procedure to address the instability. Therefore, current indications for ETC should be better defined, and further long-term results are needed before ETC can be determined whether its isolated use can be recommended.

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REFERENCES


