Thermal Capsulorrhaphy

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Thermal capsulorrhaphy was introduced over the past decade and enjoyed several years of enthusiastic support. However, longer follow-up has demonstrated inconsistent clinical results and concern about major complications.

Heat treatment of the shoulder capsule can be traced back to Hippocrates who first suggested the use of a "white-hot poker" to surgically correct the unstable shoulder. The surgical techniques have evolved from the blind application of a hot poker into the shoulder to the use of thermal probes to achieve the same desired effect—shortening the glenohumeral capsule and the preventing recurrent instability.

Over the past decade, numerous investigations have demonstrated the successful result of heat-treated capsular tissue in animal models. A relative paucity of clinical data exists, and the long-term results of heat-treated tissue remain unclear. This article reviews the basic science, clinical applications and results, and complications and concerns of thermal capsulorrhaphy.

BASIC SCIENCE

Early studies in the 1990s demonstrated the potential application of non ablative laser stabilization procedures. Markel et al. showed that holmium:YAG laser treatment of New Zealand white rabbits' joint capsular tissue resulted in significant capsular shrinkage without detriment to the relaxation properties of the tissue. With the results of the basic science work of Markel et al., Hardy et al. performed laser-assisted capsular shrinkage in patients being treated for recurrent anterior instability. Follow-up was only 1 year but the early results were encouraging with no episodes of instability and relatively minimal loss of external rotation.

Pullin et al. investigated the intra-articular pressure and histologic observations of the holmium:YAG laser capsular shift in a canine mode and found no uniform joint capsule compliance and extensive histologic changes in magnitude and depth. Although enthusiasm for laser-assisted capsular shrinkage was high, concerns were raised about the potential negative sequelae of laser treatment including dispersion of laser energy, avascular necrosis, inexact capsular histologic findings that revealed significant thermal changes of collagen. Further studies by Obrzut et al. showed that radiofrequency energy's effect on the capsule was dependent on the temperature of the probe and that as the distance from the probe was increased, the tissue temperature decreased.

A comparative study of laser and radiofrequency ener-
gy on joint capsule, however, did not show significant differences with respect to tissue modification. In a sheep glenohumeral joint model, no significant differences were noted for tissue temperature, tissue thickness, or tissue shrinkage with laser or radiofrequency energy; however, laser treatment produced a steeper temperature increase accompanying its peak temperature.5

Although initial basic science investigations focused mainly on the gross and histological effects of radiofrequency treatment, a paucity of investigations determined the mechanical properties of the heat-treated tissue. Wallace et al9 investigated the effects of radiofrequency shrinkage in a lapine medial collateral ligament model and showed that cyclic and static creep strains thermal capsulorrhaphy with respect to volume reduction of the glenohumeral joint. Karas et al17 showed in a cadaver model that suture plication alone reduced the intra-articular volume by 19%. thermal capsulorrhaphy 34%, and combined plication and capsulorrhaphy 41%. Thermal capsulorrhaphy alone or in combination with plication produced significantly greater reduction in glenohumeral volume than plication alone (P<.0001).7

In another cadaveric study, Victoroff et al8 showed that capsular shrinkage resulted in reduction in anterior, posterior, and inferior translation but that loss of rotation was minimal (9° at 90° abduction). The mean percent reduction in capsular volume for all shoulders was 37%.8 Luke et al9 compared the volume reduction differences between open capsu-
damage to the axillary nerve. Gryler et al10 recently investigated this by placing four thermocouples along the axillary nerve (two anterior and two posterior to the 6 o’clock position). The study showed that heating of the axillary nerve can occur at temperatures >67°C during radiofrequency capsular shrinkage and this can damage neural tissue.10

**Clinical Applications and Results**

Levitz et al11 reported the successful results of using thermal capsulorrhaphy in conjunction with labral and rotator cuff debridement in 82 overhead athletes with internal impingement. They found that in those athletes treated with thermal capsulorrhaphy (n=31), a higher percentage (90% versus 67%, P=.01) were back to the same level of competition. Follow-up was only 30 months, therefore, long-term monitoring is necessary.11

Mishra and Fazton12 reported their results of thermal capsulorrhaphy performed in conjunction with arthroscopic labral repair in 42 patients with recurrent anterior instability. Three (7%) patients had a traumatic redislocation. Recurrent subluxation was not reported. Follow-up was short-term, with average 28-month follow-up reported.12 Levy et al13 reported their experience with laser-assisted capsulorrhaphy and radiofrequency capsulorrhaphy in 90 patients (99 shoulders) with multidirectional or capsular stretch-type instability. They reported a significant failure rate in both groups—36.1% for the laser group and 23.7% for the radiofrequency group. The mean follow-up for these patients was 40 months (laser) and 23 months (radiofrequency), respectively.13

Fitzgerald et al14 reported their experience with thermal capsulorrhaphy in 33 patients with multidirectional instability. At mean 36-month follow-up, 23 satisfactory results and 7 poor results were reported (3 patients were lost to follow-up). Twenty-three (77%) patients were able to return to full activity.14 Favorito et al15 reported their results with laser-assisted capsulorrhaphy on 28 patients (30 shoulders) with multidirectional instability. The overall success rate was 81.5% with average 28-month follow-up.15 Hawkins and Karas16 showed that laser-assisted thermal capsulorrhaphy performed for multidirectional instability in 59 patients (60 shoulders) was successful in 42 (84%) of 50 patients.

Although the success rates approximate 80% for most of the studies mentioned, caution must be used as none of the studies were prospective; they were all relatively short-term in follow-up; and no control groups existed with which to compare. However, none of the studies reported significant complications or major concerns with respect to thermal capsulorrhaphy.

**Complications and Failure With Thermal Capsulorrhaphy**

Thermal capsulorrhaphy was introduced as a potentially time-saving and outcome-
improving technique in the management of shoulder instability. Enthusiasm for its potential was manifested in its rapid clinical use in the mid- to late 1990s.\(^\text{17}\) The first report of a potential problem with thermal treatment of the shoulder capsule was presented by Rath and Richmond in 2001.\(^\text{18}\) They reported a 22-year-old woman who had undergone a thermal capsulorrhaphy with a bipolar device. She reported instability while in the sling 7 days postoperatively. Continued nonoperative management was unsuccessful, and she underwent revision arthroscopy where an obliterated posterooinferior capsule was identified. The tissue was friable and would not hold any sutures.\(^\text{18}\)

In a survey reported in 2001, the rates of recurrent instability after laser, monopolar radiofrequency, and bipolar radiofrequency capsulorrhaphy were 8.4%, 8.3%, and 7.1%, respectively. Of the 363 patients who required revision surgery, 81 (22%) patients had attenuated capsular tissue from the thermal procedure. Finally, 196 patients had a postoperative axillary neuropathy (93% sensory only). Of these patients with axillary nerve complications, 95% recovered completely, with the sensory deficits lasting an average of 2.3 months and the combined deficits an average of 4 months.\(^\text{17}\)

Anderson et al\(^\text{19}\) identified risk factors that may be associated with failure following thermal capsulorrhaphy. Of 106 patients who underwent capsular shrinkage, 15 patients with treatment failures were identified. Previous operations and multiple recurrent dislocations were negative prognostic factors (highly significant) whereas contact sports and multidirectional instability could not be conclusively included or excluded.\(^\text{19}\)

Patty et al\(^\text{20}\) reported the results of three patients who developed rapid glenohumeral joint destruction secondary to chondrolysis following shoulder arthroscopy.\(^\text{20}\) One patient had a thermal capsular shrinkage performed with a monopolar device and developed complete loss of the hyaline cartilage. The etiology of the chondrolysis remains unclear; however, we treated two patients with end-stage chondrolysis and osteoarthritis following thermal capsulorrhaphy in our practice.

Although the studies detailed above highlight acute complications, the only prospective study to evaluate thermal capsulorrhaphy with longer follow-up was recently reported by D’Alessandro et al.\(^\text{21}\) They prospectively evaluated (non-randomized) 84 shoulders with average 38-month follow-up and subdivided patients into 3 groups: traumatic anterior dislocation, recurrent anterior instability, and multidirectional instability. They found that 37% of all patients had unsatisfactory results and that most concerning, the multidirectional instability group had the highest failure rate. It was initially believed that the multidirectional instability group may be the “ideal” patients for this type of treatment—the failure rate is higher with open procedures, congenital laxity may return despite treatment, and perhaps a “minimally invasive” operation would be more beneficial. These perceptions were not borne out in advancement. Although it remains to be seen if these techniques will lead to good clinical outcomes, it appears that they more closely resemble the original operative procedure—anterior capsular shift.

The inexact nature of how much “shrinkage” is being performed has led surgeons to further develop surgical technique in capsular plication, shift, or advancement.

**REFERENCES**


6. Wallace AL, Hollinshead RM, Frank CB. Electrothermal shrinkage reduces laxity but alters creep behavior in a lapine


