Partial Scapholunate Ligament Injuries Treated With Arthroscopic Debridement and Thermal Shrinkage

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Purpose: To present the early results of arthroscopic debridement and thermal shrinkage using radiofrequency probes for partial (Geissler grades I and II) scapholunate (SL) interosseous ligament injuries of the wrist.

Methods: Sixteen patients with a mean age of 34 years (range, 18–54 y) presenting with chronic dorsoradial wrist pain unresponsive to initial conservative treatment for a mean period of 12 weeks were included in this study. No patient showed radiologic signs of static dissociation (SL interval, <3.5 mm; mean SL angle, 49°) before surgery. Diagnostic arthroscopy showed a partial SL tear in 14 patients and redundancy of the ligament in 2. Partial SL tears involved the membranous (proximal) and volar part of the ligament. All lesions were debrided and treated with thermal shrinkage using a bipolar radiofrequency probe.

Results: The mean follow-up period was 19 months (range, 9–34 mo). Fourteen patients experienced substantial pain relief whereas in 2 the pain remained unchanged. Eight patients were completely pain free. The mean flexion-extension arc was 142° and the mean grip strength was 78% that of the unaffected side. No patient showed radiologic signs of arthritis or static or dynamic instability after surgery (SL interval remained <3.5 mm; mean SL angle, 53°). Based on the modified Mayo wrist score there were 8 excellent, 6 good, 1 fair, and 1 poor result.

Conclusions: Partial SL ligament tears can be a source of radial-sided wrist pain. Scapholunate ligament debridement and thermal shrinkage effectively provided pain relief for most of the patients treated. Stability was maintained radiographically. No complications were noted from the use of radiofrequency probes. These reasonably favorable short-term results should be viewed cautiously. A longer follow-up study is necessary to determine the ultimate efficacy of this procedure. (J Hand Surg 2005;30A:908–914. Copyright © 2005 by the American Society for Surgery of the Hand.)

Key words: Partial tear, radiofrequency probes, scapholunate ligament, thermal shrinkage, arthroscopic debridement.
Chronic wrist pain in the presence of normal plain radiographs is a common problem in the practice of hand surgeons. Pain localization in the ulnar or radial aspect of the wrist is helpful in narrowing the possible differential diagnoses. When physical examination is inconclusive and an initial trial of conservative measures fails, wrist arthrography, magnetic resonance imaging, and often diagnostic arthroscopy are used in an attempt to determine the underlying cause of pain. Partial scapholunate (SL) interosseous ligament tears often are identified during diagnostic arthroscopy.1–9

Complete ruptures of the SL ligament are thought to lead to static dorsal intercalated segment instability and to result in arthritis in the wrist, which follows the scapholunate advance collapse pattern.10 The significance of partial SL ligament tears is more obscure. Watson et al11 identified this injury as one of the main causes of dorsal wrist pain in the absence of radiographic findings (what they called dorsal wrist syndrome). In the arthroscopic classification of wrist interosseous ligament instability by Geissler and Freeland2 (Fig. 1) partial lesions are included. It should be noted that this classification quantifies the resultant instability and not the actual size of the tear, although grade III and IV instability is thought to be the result of complete SL tears. Attempts at arthroscopic debridement alone using synovial resectors for such lesions3,4 have yielded satisfactory initial results. This was attributed to the stabilizing effect of scar tissue formation after the debridement and to the partial denervation of the wrist.5 Concerns remain, however, about the possibility of long-term SL instability secondary to a partial SL ligament lesion treated with debridement alone.3,4 In addition symptomatic redundant SL ligaments pose a dilemma for the surgeon because there is no frank tear to debride.

Recently the availability of radiofrequency (RF) probes for small-joint arthroscopy has permitted a more direct approach to the problem of partial SL ligament tears. Thermal shrinkage has been shown to be feasible in experimental settings for various collagenous tissues including the joint capsule (glenohumeral, patellofemoral), ligaments (medial collateral ligament of the knee), and tendons (patellar and extensor tendons, Achilles’ tendon) although concerns over creep and reduced laxity of the treated tissues remain.12–15 The main clinical application of RF probes for thermal shrinkage has been in the capsular and ligamentous tissues of the glenohumeral joint to treat shoulder instability.13,14 Recently concerns have been raised about the long-term efficacy of thermal capsulorrhaphy, with a high failure rate (37%) reported at an average follow-up time of 38 months.16 Other researchers have voiced similar concerns.17,18 The ability of RF probes to both debride and shrink tissues make them an attractive alternative to mechanized resector debridement of partial SL ligament tears as a means of offering additional stability to the SL joint. We present the initial results of this procedure in 16 patients treated with arthroscopic debridement and thermal shrinkage of the SL ligament using a bipolar RF probe.

**Materials and Methods**

A retrospective review of the records of patients who had had arthroscopic debridement and thermal shrinkage of the SL ligament in the practice of the senior author (D.G.S.) identified 22 such procedures in 21 patients. In 3 patients the primary complaint was ulnar-sided wrist pain; a concomitant triangular fibrocartilage complex (TFCC) tear was debrided and 1 of these patients had bilateral ulnar-shortening osteotomies. These patients were excluded from this study because the TFCC injury was considered the primary source of their pain. Two more patients were lost to follow-up study.

Sixteen patients (10 men, 6 women) with a mean age of 34 years (range, 18–54 y) were included in this study. Sixteen wrists (9 dominant, 7 nondominant) were treated. All patients complained of wrist pain that was localized radially and dorsally. Thirteen patients could recall an injury to the wrist with a mean interval from injury to surgery of 5.4 months (range, 3–14 mo). Among them there were 4 patients with well-healed distal radius fractures. Three patients could not recall a traumatic event. All patients were unresponsive to initial conservative treatment (with immobilization and/or steroid injection and physiotherapy) for a mean period of 12 weeks (range, 6–18 wk). Five patients were involved in workers’ compensation cases.

On physical examination before surgery all patients had pain to palpation dorsally over the SL interval. Additionally 5 patients had pain to palpation over the radial styloid, 2 had pain with radial deviation of the wrist, and 2 had pain to palpation over the flexor carpi radialis tendon palmarly. The Watson scaphoid shift test result was positive for pain in 13 patients and in 1 patient the clunk of scaphoid subluxation was felt bilaterally although it was painful only at the affected side. The preoperative range of motion (ROM) and grip strength values are presented in Table 1.
The preoperative radiographs of all patients were reviewed. No patient had signs of SL dissociation in the neutral and ulnar deviation posteroanterior views with an SL interval less than 3 mm. On the lateral views no signs of dorsal intercalated segment instability were found, with a mean SL angle of 49° (range, 35°– 63°). Grip views were available for 11 patients. The SL interval was less than 3.5 mm in all patients. All measurements were performed using computer-aided design tools on digitized images (Medstrat; Medstrat Inc., Downers Grove, IL). Magnetic resonance imaging was performed in 12 patients and SL ligament abnormalities were noted by the radiologist in 9; however, a frank tear was diagnosed only in 6. Widening of the SL interval was not observed on magnetic resonance imaging in any of the patients. A wrist arthrogram was performed in 4 patients; it was interpreted as a possible SL ligament tear in 1.

Wrist arthroscopy was performed using a standard

Figure 1. Geissler’s arthroscopic classification of scapholunate ligament instability. (A) Grade I, redundancy of the SL ligament. The ligament shows a V sign (arrow) on inspection from the radiocarpal joint. (B) Grade II, partial tear of the SL ligament with minimal gapping between the carpal bones. (C) Incongruence and gapping of the SL ligament. A probe can be passed between the scaphoid and the lunate (view from midcarpal portal). (D) Gross instability. A 2.7-mm arthroscope (or in this case a 3.5-mm shaver) can be passed through the gap in the SL interval. Only grade I and grade II injuries were treated with arthroscopic debridement and thermal shrinkage in this study. LUN, lunate; SCP, scaphoid; CAP, capitate; P, probe; S, shaver.
technique with the arm supported on a tower distraction device and 4.5 to 6.5 kg of distraction applied to the wrist. The 3-4 portal was used for viewing, the 6U portal was used for outflow, and the 4-5 and 6R portals were used for instrumentation. The wrist was examined from radial to ulnar and the SL interval stability was examined by probing the joint. In cases in which SL stability was doubtful midcarpal arthroscopy was performed (in 7 patients in the series) and stability was assessed from the midcarpal portal as well. The SL ligament was considered stable in all patients—that is, the probe could not be passed through the SL interval either from the radiocarpal or from the midcarpal side of the joint. Once the SL joint was deemed stable the SL ligament partial tear first was debrided with a synovial resector, and then a 2.3 mm bipolar RF probe (Vapr; Mitek, Westwood, MA) was introduced and thermal shrinkage of the SL ligament rim was performed (Fig. 2). The 4-5 portal provides easier access to the SL ligament for this procedure. Redundant SL ligaments were treated with thermal shrinkage alone. All the partial tears were located in the membranous (proximal) and volar portions of the SL interosseous ligament. Thermal shrinkage included the torn rim of the volar and proximal SL ligament and also extended to part of the dorsal portion (which was intact in all patients in this study). Thermal shrinkage was performed by applying the probe to the intact part of the ligament in a paintbrush fashion and confirming visually the changes in color and consistency of the tissue without causing ablation. Concomitant central TFCC tears were treated with debridement using the same RF probe. The RF probe was applied intermit-

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<th>Parameters</th>
<th>Preoperative Mean (range)</th>
<th>Follow-Up (N = 16) Mean (range)</th>
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<td>Range of motion (deg)</td>
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<td>76 (60–90)†</td>
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<td>Pronation</td>
<td>72 (50–90)</td>
<td>80 (60–90)†</td>
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<tr>
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<td>Heavy manual work</td>
<td>8.4§</td>
<td>5.2‡</td>
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*p = .02.
†Not significant.
‡p < .001.
§Preoperative visual rating obtained retrospectively.

tently for a few seconds at a time and adequate outflow was ensured throughout the procedure to avoid overheating of the joint. At the end of the procedure the wrist was immobilized in a short arm splint.

After surgery a splint was used full time for 2 weeks and a removable cock-up splint was used intermittently between physiotherapy sessions for another 4 weeks. Range-of-motion exercises were initiated in the second postoperative week and strengthening exercises were introduced after the fourth week. Patients were allowed to return to light-duty work at the end of the sixth week.

Diagnostic arthroscopy showed a Geissler grade II

Figure 2. The Geissler grade II partial SL ligament tear shown in Figure 1B after it was treated with thermal shrinkage using an RF probe. SCP, scaphoid; Lnt, lunate.
partial SL tear (Fig. 1B) in 14 patients whereas in 2 the ligament was attenuated (Geissler grade I) (Fig. 1A). All lesions were types I or II in the Geissler classification. Three patients had a concomitant small central TFCC tear. All SL lesions were treated with thermal shrinkage using a bipolar RF probe and all TFCC lesions were debrided using the same probe. None of the patients with concomitant TFCC lesion in this series complained of ulnar-sided wrist pain; patients with TFCC lesions and ulnar-sided wrist pain were excluded from this study. Chondral lesions of the scaphoid were detected in 3 patients and synovitis was detected in 12.

At follow-up examination patients were asked to record their pain level at rest, during everyday activities, and during heavy manual work on a 10-point visual analog scale in which 0 indicated no symptoms and 10 indicated pain as bad as it possibly could be. The patients also were asked to record their preoperative pain levels. The wrist ROM was measured and grip strength was measured both in the affected and the contralateral extremity with a hydraulic dynamometer (Jamar; Sammons Preston, Bolingbrook, IL). Standard posteroanterior, lateral, and grip view radiographs of the affected wrist were obtained. The SL interval on the posteroanterior views and the SL angle on the lateral views were measured and both views were assessed for joint space narrowing and sclerosis indicative of arthritis. The modified Mayo wrist score was used to assess results. Statistical analysis was performed using the Student t test to compare preoperative and postoperative values; p values less than .05 were considered statistically significant.

Results
The mean follow-up period was 19 months (range, 9–34 mo) (Table 1). Fourteen patients experienced substantial pain relief whereas in 2 the pain remained unchanged. Eight patients were completely pain free. Six patients reported pain only with strenuous activities; among them 2 recalled a new injury to the wrist. Overall pain visual analog scale scores improved significantly (p < .001) both during rest and during activities. The mean flexion-extension arc was 142° and the mean grip strength was 78% that of the unaffected side. No statistically significant changes over preoperative values were observed for ROM measurements other than wrist flexion, which improved marginally (p = .02). Grip strength improved significantly over preoperative values (p < .001).

No perioperative complications occurred. During the follow-up period 1 patient developed carpal tunnel syndrome of the affected extremity that was treated with splinting until the last follow-up evaluation. Another patient developed de Quervain’s tenosynovitis, which was treated with local steroid injection.

No patient had radiographic deterioration (exhibited as arthritis or static or dynamic instability). In all patients the SL interval remained less than 3.5 mm at the latest follow-up evaluation, including the 2 patients who had sustained a new injury to the wrist. The mean SL angle on the lateral view remained within normal limits (mean, 53°, range, 45°–68°).

In the modified Mayo wrist score there were 8 excellent, 6 good, 1 fair, and 1 poor result. Of the 11 patients who were employed at the time of the procedure, 6 returned to the same or similar work duties and 3 to a lighter duty. One patient is unemployed for reasons unrelated to the surgery and another patient is currently on disability. A young professional tennis player was unable to return to competitive sporting activity although he had excellent ROM, pain only when playing tennis, and a good overall result. The 1 fair result was that of a 33-year-old female patient with mild pain and stiffness but severe limitation of grip strength. A 54-year-old truck driver continued to complain of severe pain during activities after the procedure and was unable to return to work, constituting a poor result. That patient was involved in workers’ compensation litigation. His radiographs remained unremarkable at the final follow-up evaluation and he declined further investigation or treatment.

Discussion
The most consistent finding of this study is symptomatic relief. Although there are limitations to retrospective visual analog scale pain assessment, 14 of 16 patients reported substantial pain relief after arthroscopic debridement and thermal shrinkage of the partially torn SL ligament. Patients with a concomitant TFCC tear and ulnar-sided wrist pain were excluded from this study to avoid overlap of the 2 procedures. This study verifies the view that a partially torn SL ligament can be a source of pain to the wrist. Although partial degenerative tears have been found in 19% of cadaveric wrist dissections the average age of the specimens in that study was 78 years, which is much older than the mean age of our patients (34 y). Partial SL ligament tears are found in the proximal and volar portion of the SL ligament. Compared with the dorsal portion the proximal and...
The patient population in the study by Ruch and Poehling was somewhat different than ours. Most of the patients in our study had a tear extending to the volar portion of the ligament and mechanical impingement was an infrequent complaint. The study by Weiss et al presented limited data on pain assessment (symptomatic improvement was referred to cumulatively as “symptoms resolved or improved”). Given these differences no meaningful direct comparison can be made with this series. Our approach with debridement and thermal shrinkage yielded satisfactory results regarding pain relief. It is unclear how much thermal shrinkage alone contributed to pain relief. The fact that the 2 patients with partial SL ligament tears treated with thermal shrinkage alone had complete pain relief is indicative of such a contribution. The main purpose of thermal shrinkage, however, is to prevent instability.

The limitation of all available studies (including ours) is the short follow-up time. Scapholunate interval stability should be interpreted with caution because a recent study on the natural history of untreated Geissler types 1 and 2 SL ligament tears found no radiologic signs of instability at an average follow-up time of 7 years. Nevertheless the patients in that study continued to experience considerable pain, restriction in the flexion-extension arc (mean, 80°) and functional limitation. It is clear that the natural history of these lesions is not favorable. The patients in our study achieved a mean flexion-extension arc of 142° and significantly improved grip strength. After surgery improvement in ROM reached statistical significance only for flexion but good preoperative ROM was maintained in all other planes. Range of motion was found to be almost full in both of the 2 aforementioned studies and in this study.

Diagnosis of partial SL ligament tears can be difficult. Plain radiographs can be unremarkable; arthrography has only 60% sensitivity on SL ligament tears and cannot differentiate complete from partial tears. Magnetic resonance imaging can be helpful in differentiating other sources of chronic wrist pain but its role in diagnosing SL ligament tears has been questioned, with its sensitivity reported to be between 37% and 63% compared with arthroscopy. This also has been our experience in this study. In our practice pain to palpation dorsally over the SL interval and pain with Watson’s scaphoid shift test in a patient with chronic wrist pain may be diagnostic of a partial SL ligament tear. Wrist arthroscopy should be considered with these findings.

Radiofrequency probes work by creating a high-frequency alternating current between their tips. Heat is generated by friction of ions in the tissue treated as they try to follow this alternating current. The only limitation to their use is in patients with pacemakers or other implantable electronic devices. In the tissue treated a very narrow rim of heating typically occurs (<1 mm). When the temperature in that tissue rim reaches approximately 60°C the collagen triple helix unwinds, leading to reduction of the length of the molecule and tissue shrinkage. When the temperature exceeds 100°C water in the tissue treated is vaporized and ablation of the tissue occurs. In contrast to the electrocautery devices the RF probe itself is not heated but heat is generated in the tissue. The amount of heating that occurs is determined by the distance from the probe, the size of the probe, the temperature and flow rate of the arthroscopic irrigation, and the duration of application. Current systems rely on visual inspection of the tissues to determine adequate probe application. Overzealous RF probe application should be avoided when tissue shrinkage is required because the same probes are used for tissue ablation and thermal shrinkage.
small joints became available and offer additional safety for the procedure because they do not exceed ablation temperatures.

The healing response of the tissues treated with thermal modification is considered important in maintaining its strength. Concerns over the biomechanical properties of the treated tissues have been expressed, especially concerning creep and reduced elasticity, in experimental studies. It seems that the extent to which these phenomena occur is influenced by multiple factors such as the type of tissue treated, the amount and duration of thermal energy delivery, and the extent of tissue shrinkage. The change in biomechanical properties is reversible and the recovery period is reported to be between 2 and 12 weeks. Thus it is important to protect the treated tissues (the SL ligament in this case) from overloading during the first postoperative weeks. From the results of this study it appears that these phenomena do not play a clinically significant role in SL ligament thermal shrinkage because stability of the SL interval was maintained in all cases.

The initial results of debridement and thermal shrinkage for partial SL ligament injuries indicate that this approach is efficient in providing pain relief for the majority of patients treated. Radiofrequency probe application for thermal shrinkage was found to be safe with no complications noted. Although the short-term results presented in this study are favorable longer follow-up study is necessary to determine the ultimate efficacy of thermal shrinkage in maintaining stability of the SL interval.

References