Long-term Outcomes of Arthroscopic Debridement and Thermal Shrinkage for Isolated Partial Intercarpal Ligament Tears

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abstract

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A retrospective analysis was performed based on the medical records and imaging studies of 16 wrists (14 patients) with isolated partial intercarpal ligament tears (scapholunate ligament: 6 wrists, lunotriquetral ligament, 10 wrists) treated with arthroscopic debridement and thermal shrinkage. Three wrists had Geissler grade 1 tears and 13 wrists had grade 2 tears. Mean follow-up was 52.8 months. Overall pain visual analog scale scores improved significantly (P<.05) at rest and during activities of daily living and heavy manual work. Mean flexion-extension arc was 136.5°. Mean postoperative grip strength was 106 lb, which was significantly better than preoperative grip strength. Mean modified Mayo wrist score was 70 preoperatively and 94.7 postoperatively, a significant improvement. Overall functional outcomes according to the modified Mayo wrist score were rated as excellent in 13 wrists and good in 3. No patient had radiographic evidence of instability or arthritic changes. The scapholunate and lunotriquetral intervals in all patients were less than 3 mm on neutral and pronation grip radiographs. On lateral radiographs, no signs of intercalated segmental instability were seen, with a mean scapholunate angle of 55.3°.

The results of this study suggest that arthroscopic debridement and thermal shrinkage provide symptomatic pain relief and prevention of intercarpal instability for a significant period of time in patients with partial intercarpal ligament tear.

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Drs Lee (Jung Il), Nha, Lee (Guen Young), Kim (Baek Hyun), Kim (Jung Wook), and Park have no relevant financial relationships to disclose.

This study was approved by Korea University Medical Center Ansan Hospital Institutional Review Board (IRB No. AS11148).

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Partial intercarpal ligament tears are thought to be a possible cause of chronic wrist pain.\(^1,2\) Conservative treatments, such as immobilization, functional splinting, injections, and physical therapy modalities, are usually used as initial therapy. However, if conservative treatment fails, surgical treatment is indicated. Few data in the literature exist regarding treatment strategies for patients with symptomatic partial intercarpal tears, and most early reports deal with arthroscopic debridement with or without thermal shrinkage.\(^1,6\)

Short-term clinical outcomes after arthroscopic debridement with or without thermal shrinkage have been reported,\(^1,6\) but long-term outcomes have not. Recently, the use of radiofrequency probes for small joint arthroscopy has permitted another form of treatment for symptomatic soft tissue laxity or stretch injuries. Arthroscopic debridement and thermal shrinkage effectively provide pain relief and maintain stability as assessed radiographically.\(^5\) However, a longer follow-up period may be necessary to determine the ultimate efficacy of thermal shrinkage.

The purpose of this study was to evaluate the long-term outcomes of arthroscopic debridement and thermal shrinkage in the treatment of partial intercarpal ligament tears. The authors hypothesized that, in patients with partial intercarpal ligament tears, thermal shrinkage of the intercarpal ligament maintained intercarpal stability and provided long-term symptomatic relief.

**Materials and Methods**

A retrospective analysis was performed based on the medical records and imaging studies of 16 wrists (14 patients) with isolated partial intercarpal ligament tears (scapholunate ligament: 6 wrists; lunotriquetral ligament: 10 wrists) treated with arthroscopic debridement and thermal shrinkage using a bipolar radiofrequency probe between January 2006 and July 2008. Institutional Review Board approval was obtained for this study (IRB No. AS11148). The degree of intercarpal ligament tear in each wrist was classified according to Geissler et al’s arthroscopic grading system.\(^7\) Three wrists with Geissler grade 1 tears and 13 wrists with grade 2 tears that were diagnosed during arthroscopic evaluation were included in the study. Patients with a follow-up of at least 3 years were included. Patients with complete ligament tears, combined triangular fibrocartilage tears, and any carpal bone fractures associated with ligament tears were excluded.

The study group comprised 10 men and 4 women with a mean age of 30 years (range, 21-40 years). The dominant hand was involved in 11 patients, the nondominant hand in 1 patient, and both hands in 2 patients. All patients reported wrist pain during hard work or sports. Mean duration of symptoms before arthroscopy was 11.2 months (range, 4-36 months). Diagnostic evaluation consisted of imaging studies and physical examination, including point tenderness, instability tests such as the scaphoid shift test and the lunotriquetral shear test, wrist range of motion (ROM), and grip strength. Preoperative ROM and grip strength values are shown in the Table. All patients were unresponsive to initial conservative treatment with immobilization, nonsteroidal anti-inflammatory drugs and/or steroid injection, and physiotherapy.

Preoperative diagnostic imaging studies included plain radiographs in all patients, dynamic cine-arthrography in 13 patients, and magnetic resonance imaging (MRI) in 8 patients. Dynamic cine-arthrography was performed using 2 processes. First, contrast injection into the radiocarpal joint using fluoroscopic guidance was performed. Second, after passive wrist movement, the wrist joint was re-evaluated under fluoroscopy. Of

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Preoperative</th>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scapholunate interval, cm</td>
<td>1.04</td>
<td>1.21</td>
</tr>
<tr>
<td>Scapholunate angle, deg</td>
<td>53</td>
<td>55</td>
</tr>
<tr>
<td>Modified Mayo wrist score(^{ab})</td>
<td>70 (60-80)</td>
<td>94.68 (85-100)</td>
</tr>
<tr>
<td>Radiologic parameters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td>63 (45-70)</td>
<td>62 (50-70)</td>
</tr>
<tr>
<td>Extension</td>
<td>64 (20-80)</td>
<td>76 (50-85)</td>
</tr>
<tr>
<td>Radial deviation</td>
<td>22 (15-30)</td>
<td>21 (15-25)</td>
</tr>
<tr>
<td>Ulnar deviation</td>
<td>38 (30-45)</td>
<td>42 (35-45)</td>
</tr>
<tr>
<td>Grip strength, lb(^a)</td>
<td>81 (40-130)</td>
<td>104 (45-152)</td>
</tr>
<tr>
<td>Pain score(^a)</td>
<td>4.61</td>
<td>0</td>
</tr>
<tr>
<td>Activities of daily living(^a)</td>
<td>6.61</td>
<td>0.92</td>
</tr>
<tr>
<td>Hard work(^a)</td>
<td>8.22</td>
<td>1.78</td>
</tr>
<tr>
<td>ROM, deg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)P < 0.05.

\(^{ab}\)Preoperative pain and modified Mayo wrist scores obtained retrospectively.
the patients who underwent dynamic cine-arthrography, intercarpal ligament abnormalities were noted in all patients by a radiologist (G.Y.L., B.H.K.) (Figure 1). Magnetic resonance imaging was usually ordered by the referring physician and was not a routine component of preoperative assessment. No patient showed radiographic evidence of dynamic or static instability, such as widening of the scapholunate or lunotriquetral interval or abnormal scapholunate angle. All patients had predynamic intercarpal instability, and no patient had dynamic or static instability.

**Surgical Technique**

Arthroscopy was performed under general or regional anesthesia. The standard wrist arthroscopic setup was used, with distraction by finger traps and a wrist distraction tower (Linvatec, Largo, Florida). The 3-4 portal was used for viewing, and the 4-5 or 6R portals were used as the working portal. The wrist was examined from radial to ulnar, and scapholunate and lunotriquetral interval stability were examined by probing the joint (Figure 2). The midcarpal portal was used to further classify the tear in cases in which suspicion of a partial tear existed when probing. The torn, patulous portion of the ligament was then resected with a synovial resector and arthroscopic shaver (Linvatec), and a 2.3-mm bipolar radiofrequency probe (ArthroWand; ArthroCare Corporation, Austin, Texas) was inserted.

Thermal shrinkage of the intercarpal ligament rim was performed in its ablative setting. The radiofrequency probe was applied to all of the arthroscopically accessible portion of the intercarpal ligament, beginning at the distal end (dorsal and palmar parts) of the ligament and moving proximally to the membranous part. Changes in color and consistency of the ligament tissue were visually confirmed (Figure 3). After and during the arthroscopic shrinkage of the torn or lax ligament, it becomes more tight, and torn ligament fibers are cleared in real time on the arthroscopic view. The radiofrequency probe was applied intermittently for a few seconds at a time, and continuous irrigation was ensured throughout the entire procedure to prevent heat injury to the tissues about the joint. After the arthroscopic procedures, the portal wounds were repaired, and a short arm splint was applied.

Postoperatively, the splint was used full-time for 3 weeks, and a removable cock-up brace was used intermittently for another 2 weeks. Patients began rehabilitation programs, including wrist ROM and strengthening exercises, when the splint was removed.

Mean follow-up was 52.8 months (range, 37-68 months). Retrospective subjective pain scales were completed for patients’ preoperative and follow-up symptoms. Each patient was interviewed by an independent trained interviewer. Patients were asked to record their pain levels 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 the worst imaginable pain.

Range of motion and grip strength were measured at follow-up. Each patient was examined by 1 of 2 authors (J.I.L., J.W.K). Bilateral grip strength was recorded using the standard Jamar Hydraulic Hand Dynamometer grip strength measurement (B&L Engineering, Santa Ana, California). Radial and ulnar deviation, flexion, and extension were recorded bilaterally.

Radiographic evaluation consisted of standard posteroanterior, lateral, and pronation grip views. Two orthopedic surgeons (J.I.L., J.W.K.) measured radiographic parameters twice, and results were averaged to minimize inter- and intraobserver differences. All measurements were performed using the computer-aided measurement software included in the PACS system (PiViewSTAR; INFINITT Health Care, Seoul, Korea). The scapholunate and/or lunotriquetral interval on posteroanterior and pronation grip views and the scapholatu-
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Results

The results are summarized in the Table. All patients experienced complete resolution of their wrist pain at rest postoperatively. Three patients reported mild pain (pain score, 2–4) during activities of daily living, and 6 patients reported mild pain (pain score, 2–3) during heavy manual work. One patient reported moderate pain (pain score, 5) during heavy manual work. Overall, pain visual analog scale scores improved significantly (P < .05) at rest, during activities of daily living, and with heavy manual work. All patients were also satisfied with the results of the procedure.

Mean flexion–extension arc was 136.5°, and no significant changes from preoperative values were observed in ROM measurements. Mean postoperative grip strength was 106 lb, which was significantly better than the mean preoperative grip strength (P < .05). Mean preoperative modified Mayo wrist score was 70 (range, 60–80). Overall functional outcomes according to the modified Mayo wrist score were rated as good in 3 wrists, fair in 10, and poor in 3. Mean postoperative modified Mayo wrist score was 94.7 (range, 85–100), a significant improvement over preoperative scores (P < .05). Overall functional outcomes were rated as excellent in 13 wrists and good in 3. Twelve patients returned to the same or similar work duties and 2 to lighter duties.

No patient had radiographic evidence of instability and arthritic changes. The scapholunate and lunotriquetral intervals in all patients were less than 3 mm on neutral and pronation grip views. On lateral view, no signs of intercalated segmental instability were seen, with a mean scapholunate angle of 55.3° (range, 41°–64°). No significant differences in pre- or postoperative radiographic findings were noted.

Discussion

The results of this study demonstrate that arthroscopic debridement and thermal shrinkage in isolated partial intercarpal ligament tears led to good outcomes at more than 3-year follow-up. This procedure provides symptomatic pain relief and prevention of intercarpal instability for a significant period of time.

The results of arthroscopic debridement alone in partial intercarpal ligament tears have been reported in other studies.1,2 Weiss et al1 reported the results of arthroscopic debridement for partial and complete tears of intercarpal (scapholunate or lunotriquetral) ligaments, including 19 patients with partial intercarpal ligament tears. Of these patients, 17 had symptomatic relief at a mean 27-month follow-up. However, the patient sample had no isolated intercarpal ligament tears. Seven of the 19 patients with partial intercarpal ligament tears had central triangular fibrocartilage complex perforations.1 Ruch and Poehling2 reported that 11 patients had complete relief of symptoms of 14 partial intercarpal (scapholunate or lunotriquetral) ligament tears treated with arthroscopic debridement at a mean 34-month follow-up.

Other authors have reported good clinical outcomes after arthroscopic debridement in combination with thermal shrinkage.3,5 Darlis et al3 examined 16 patients with isolated partial scapholunate ligament tears treated by thermal shrinkage and reported 14 excellent or good results at a mean 19-month follow-up. Hirsh et al4 treated 10 patients with partial scapholunate ligament tears using thermal shrinkage and reported good results in 9 of 10 patients at a mean 28-month follow-up, but the patient sample had no isolated intercarpal ligament tears. Four of 10 patients had a concomitant triangular fibrocartilage complex tear or carpal tunnel syndrome.4 Shih and Lee4 treated 19 patients with chronic symptomatic scapholunate instability using thermal shrinkage and reported satisfactory results in 15 of 19 patients 28 months later. However, 6 of 19 patients had concomitant triangular fibrocartilage complex tears, and 14 of 19 patients had dynamic scapholunate instability (positive scaphoid shift test and widening of the scapholunate joint more than 3 mm).

Due to differences in patient samples, follow-up time, and surgical technique, meaningful direct comparisons between studies are difficult. However, the most consistent result of these studies is symptomatic relief. It is possible that some pain relief may have resulted from the treatment of concomitant intra-articular pathology, especially triangular fibrocartilage complex tears. However, in the current study and others,2,5 no concomitant pathology existed. The hypothesis that partially torn intercarpal ligaments can be a source of pain in the wrist was verified.1,3,5 It is possible that symptomatic relief may have resulted from (1) mechanical relief due to arthroscopic debridement of loose flap tissue, (2) tightening of loose intercarpal ligaments due to thermal shrinkage, providing mechanical stability, and (3) thermal denervation of some terminal branches of
the posterior interosseous nerve due to the proximity of the radiofrequency probe to the dorsal capsule.\textsuperscript{2,4}

Most previous studies reported symptomatic relief of isolated partial scapholunate ligament tears after arthroscopic debridement with or without thermal shrinkage, even if there was dynamic scapholunate ligament instability.\textsuperscript{3} However, one study by Westkaemper et al\textsuperscript{6} reported poor results in 4 of 5 patients with lunotriquetral tears after arthroscopic debridement. They postulated that debridement of lunotriquetral tears was not successful, and that reduction and pinning of lunotriquetral tears should be considered as an alternative to simple debridement. In their study, although patients with lunotriquetral tears had no preoperative instability, all patients had complete lunotriquetral tears as part of their arthroscopic findings. Their poor results seem to be based on the severity of the lunotriquetral tears, not the modality of treatment.

Recently, thermal shrinkage has been used widely in arthroscopic surgery. Thermal shrinkage has been used in experimental and clinical settings to alter capsuloligamentous mechanical properties of the joint capsule, ligaments, and tendons.\textsuperscript{11-13} The main clinical application of a radiofrequency probe for thermal shrinkage has been in the capsular and ligamentous tissues of the glenohumeral joint to treat shoulder instability.\textsuperscript{11,14} However, recent studies have reported poor long-term efficacy of thermal capsulorrhaphy and complications such as massive chondrolysis.\textsuperscript{15-17} Nevertheless, thermal shrinkage has been used widely in arthroscopic surgery as a supportive method of providing stability. The collagen fibers denature and shrink after thermal shrinkage, which results in a contracted collagen mass with increased stiffness of the tissue.\textsuperscript{4} Mechanically, thermal shrinkage tightens the supporting ligament and provides the ligament stability.\textsuperscript{18}

In the current study, intercarpal (scapholunate or lunotriquetral) stability in patients with intercarpal ligament partial tears was maintained a mean 52.8 months after arthroscopic debridement and thermal shrinkage. However, a recent study into the natural history of untreated isolated scapholunate ligament tears followed 11 patients with Geissler grade 1 and 2 scapholunate ligament partial tears and found no radiologic signs of instability at an average 7-year follow-up (range, 2.5-13 years).\textsuperscript{19} Based on that study, it is unclear whether the maintenance of stability observed in the current study is simply the natural history of this disease or due to thermal shrinkage. Nevertheless, the patients in the natural history study continued to report pain, ROM limitation, grip weakness, and other functional limitations. Even with no further radiologic instability, isolated intercarpal ligament partial tears have poor natural history in terms of symptoms. In the current study, patients treated by arthroscopic debridement and thermal shrinkage experienced successful pain relief and improvement of grip strength and ROM with no instability. Furthermore, good clinical outcomes were maintained for a relatively long time compared with previous studies. It is presumed that good long-term clinical outcomes were due to augmentation of ligament stability by thermal shrinkage.

Chronic wrist pain in the presence of normal plain radiographs is a common clinical problem encountered by hand surgeons and is frequently refractory to conservative management. Although the most sensitive and specific way to evaluate the pathologic lesion is via wrist arthroscopy, patients are commonly evaluated by wrist arthrography, conventional magnetic resonance imaging, and computed tomography or magnetic resonance arthrography to make the diagnosis and for surgical planning. Magnetic resonance arthrography has been widely performed instead of conventional wrist arthrography, but it is expensive and time consuming. In the current study, 13 of 14 patients underwent dynamic cine-arthrography. Conventional radiocarpal arthrography was performed after radiocarpal injection under fluoroscopy guidance with several different views. Cine-arthrography takes an image every 5 seconds during intra-articular contrast injection under fluoroscopy.

Dynamic cine-arthrography was performed using 2 processes. First, contrast injection into the radiocarpal joint using fluoroscopic guidance was performed. Second, after passive wrist movement, the wrist joint was re-evaluated under fluoroscopy. This is a new technique developed at the authors’ institution,\textsuperscript{20} which evaluates the wrist twice under fluoroscopy. Conventional direct arthrography has been regarded as being effective for evaluating triangular fibrocartilage complex tears.\textsuperscript{21} However, if contrast is seen at the midcarpal joint, it is often difficult to determine which intercarpal ligament is torn, the scapholunate or the lunotriquetral ligament. Therefore, dynamic cine-arthrography was assumed to be helpful for evaluating the intercarpal ligament or triangular fibrocartilage complex by continuous fluoroscopic evaluation, especially for the evaluation of scapholunate and lunotriquetral ligament injuries. Because contrast leakage into the midcarpal joint may develop during or after passive wrist movement on dynamic cine-arthrography, partially healed intercarpal ligament tears or flap tears are expected to be more detectable because they show delayed contrast leakage into the midcarpal joint or distal radioulnar joint. Dynamic cine-arthrography may not only provide better delineation of carpal ligaments, but also demonstrate the presence or absence of contrast leakage through carpal ligament tears.\textsuperscript{22}

The current study had some limitations, mostly stemming from the small sample size and retrospective design. However, the sample size does not significantly differ from the sample sizes of other comparable studies dealing with partial scapholunate or lunotriquetral tears. The results of this study suggest that
arthroscopic debridement and thermal shrinkage provide symptomatic pain relief and prevention of intercarpal instability for a significant period of time in patients with partial intercarpal ligament tears.

REFERENCES


