Arthroscopic treatment of scapholunate ligament tears in patients with chronic wrist pain

Khaled M. Abu-Elnasr

Department of Orthopaedic Surgery, Faculty of Medicine, Suez Canal University, Ismailia, Egypt

Correspondence to Khaled M. Abu-Elnasr, MD, Department of Orthopaedic Surgery, Faculty of Medicine, Suez Canal University, 42111 Ismailia, Egypt
Tel: +20 100 683 2778; fax: +066 3324500; e-mail: khaboelnasr@gmail.com

Received 5 April 2011
Accepted 10 May 2011

Egyptian Orthopedic Journal 2012, 47:253–259

Background
Scapholunate ligament tear is one of the important causes of pain in patients with chronic wrist pain. The aim of the present study was to review the results of the arthroscopic management of patients with persistent wrist pain and scapholunate ligament injury as documented on arthroscopic examination after the failure of nonoperative management of at least 6 months.
Patients and methods
Thirteen patients were treated arthroscopically between 2006 and 2008 for chronic wrist pain and instability of the carpal bone because of partial scapholunate ligament tears. The scapholunate ligament injury was graded according to the Geissler system. The modified Mayo wrist score classification was recorded preoperatively and postoperatively for all patients.
Results
Four patients had Geissler type-I, seven patients had Geissler type-II, and two patients had Geissler type-III injury. The preoperative modified Mayo score was 56.3 (range, 35–90). The average early postoperative score, recorded at the time of routine follow-up at an average of 3 months after surgery, was 91.6 (range, 65–100) ($P<0.001$) and improved to 93.8 at the late follow-up at 11 months. Two of the 13 patients had a score in the fair range.
Conclusion
The arthroscopic treatment of scapholunate tears in patients with chronic wrist pain is very likely to result in the resolution of patients' pain.

Keywords:
arthroscopic, chronic wrist pain, scapholunate with chronic wrist pain

Egypt Orthop J 47:253–259

1110-1148

Introduction

Scapholunate (SL) dissociation is the most frequent pattern of carpal instability occurring alone and in association with wrist fractures [1–5]. Without treatment, this injury leads to progressive arthritis [6–11]. Many surgical procedures have been designed to treat SL dissociation. However, no procedure has been effective as yet in restoring normal wrist kinematics and function. The carpal bones are supported by a complex array of ligaments. Extrinsic ligaments connect the distal radius and ulna to the carpus, whereas intrinsic ligaments have their origins and insertions within the carpus [12]. Extrinsic ligaments are stiffer, whereas the intrinsic ligaments are capable of greater elongation before permanent deformation occurs [13]. The palmar wrist ligaments are considered to be the chief stabilizers of the carpus; a static SL dissociation will not occur without the disruption of the palmar ligaments [14,15]. Those ligaments believed to be responsible for supporting the SL joint include the radioscaphocapitate ligament, the long radiolunate ligament, the radioscapholunate (RSL) ligament (ligament of Testu), and the short radiolunate ligament. The RSL ligament has been described as a band of tissue different from the contiguous radiocarpal ligaments [16]. SL injury is considered as a part of a spectrum ranging from dynamic instability to a complete ligamentous disruption [17–19]. The palmar intrinsic ligaments include the palmar SL interosseous ligament (SLIL), which is one of the three portions of the SLIL. This palmar portion seems to play a minor role in conferring stability to the SL joint [20,21].

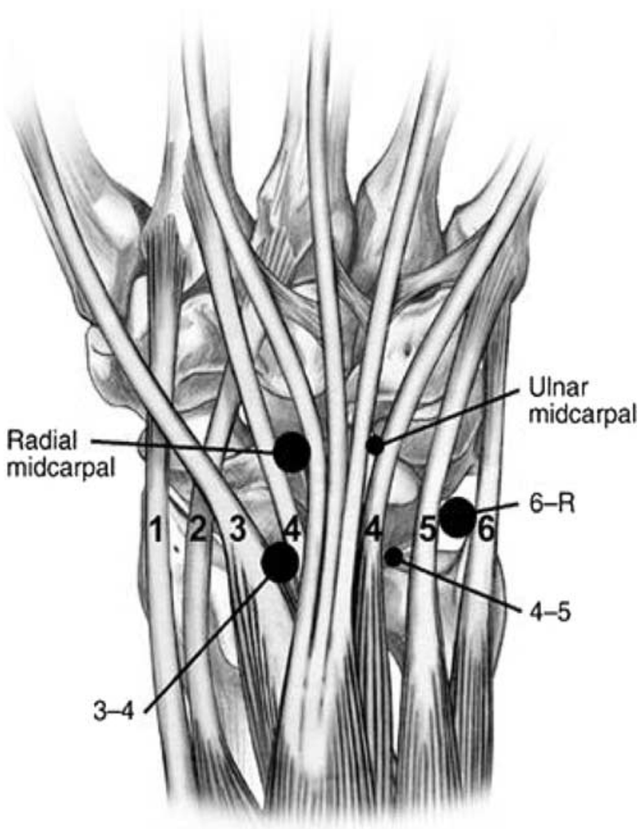
The dorsal SLIL (DSLIL), an intrinsic ligament, is believed to play a major role in SL instability. Injury to the DSLIL alone does not create a static SL dissociation pattern; however, it may cause dynamic instability [22,23]. The treatment for SL dissociation has remained a dilemma for most hand surgeons, and, to date, there is no gold standard. There are a multitude of treatment options for this condition; many authors consider injury chronicity most important in determining treatment [24].

The aim of the present study was to review the outcomes of the arthroscopic management of patients with persistent wrist pain and SL ligament injury as documented on arthroscopic examination who had a failure of at least 6 months of nonoperative management.

Patients and methods

Thirteen patients were treated arthroscopically between 2006 and 2008 for chronic wrist pain and instability of the carpal bone because of partial SL ligament tears. The average time from the injury or the onset of symptoms until the time of the initial presentation was 3.1 months (range 2.3–4.9 months). All patients were men. The chief complaint at the time of presentation was wrist pain in all patients, with three patients also noting a clicking sensation with wrist motion. The mechanism of injury was usually consistent with a dorsiflexion ulnar-deviation injury with an element of axial compression. Diagnostic evaluation consisted of a physical examination including identification of the point of maximum tenderness, determination of the range of motion, strength-testing, a positive Watson's maneuver (palpable clunk when the wrist was brought from ulnar deviation into radial deviation while pressure was applied to the palmar aspect of the scaphoid tubercle) [25], determination of the neurovascular status, and performance of provocative tests for instability as well as imaging studies including plain radiographs (all patients), and instability stress views and contralateral comparison views. Preoperative MRI scans, carried out for 11 patients, indicated a SLIL tear in nine patients, and normal findings in two patients. Arthrograms were not used in this series because of their invasive nature.

Figure 1



Commonly used arthroscopic portals on the dorsum of the wrist. 1, extensor carpi radialis brevis; 2, extensor carpi radialis longus; 3, extensor pollicis longus; 4, extensor indicis proprius and extensor digitorum communis; 5, extensor digiti minimi; 6, extensor carpi ulnaris.

The initial treatment protocol consisted of 4–6 weeks of cast immobilization, followed by supervised physiotherapy. The therapy protocol included range-of-motion exercises and progressive resistive exercises to strengthen the intrinsic musculature of the hand as well as the forearm flexors and extensors, which provide active stabilizers for the wrist. Surgical intervention was delayed for 6 months, during which time nonoperative therapy led to symptomatic relief in most of the patients who presented with these or similar symptoms during the study period. As we attempted to achieve the best results with the use of the most conservative path, this seemed to be a reasonable amount of time to wait for the chronic wrist pain to resolve. Failure was defined as persistent pain or the inability to return to the preinjury level of function. Patients with persistent wrist pain, particularly those with clinical and radiographic findings consistent with a localized wrist abnormality, were selected for wrist arthroscopy.

The average interval between the injury and the arthroscopic treatment was 9.5 months (range, 6–11.4 months). All patients had an acute traumatic event. All patients were evaluated for SLIL tenderness, and all had localized discomfort. Testing for triangular fibrocartilage complex injury and other wrist abnormalities was performed and recorded on an individual basis. Diagnostic intraoperative evaluation of ligamentous, chondral, and triangular fibrocartilage complex injuries was performed using standard three to four and four to five portals for wrist arthroscopy (Fig. 1), and midcarpal arthroscopy was performed to further classify the tear. The SL ligament injury was graded according to the Geissler system [26] (Table 1). Patients who had a Geissler type-IV tear (a positive drive-through sign, that is, the ability to pass the arthroscope between the midcarpal and the radiocarpal joints through the SL interval) underwent an immediate open reconstruction with capsulodesis and pinning and were thus excluded from the study. Fibrous scarring of partial ligament tears was débrided through the four to five portals with an arthroscopic shaver to a stable base, loose bodies were removed, and then electrothermal stabilization to the SL ligament was carried out using a monopolar probe (Fig. 2).

The modified Mayo wrist score classification [27,28] (Table 2) was recorded preoperatively and postoperatively for all patients. All patients were seen for a postoperative examination at a time interval of less than 3 months. Patients were followed up for 1 year (average 13.1 months) after the initial surgical procedure to assess whether the early follow-up results were sustained over time. All patients underwent a clinical follow-up evaluation. The paired *t*-test was used to obtain *P* values. The level of significance was set at *P* less than 0.05.

Table 1 Geissler classification system

Grades	Description
I	Attenuation or hemorrhage of interosseous ligament as seen from the radiocarpal space. No incongruity of carpal alignment in the midcarpal space
II	Attenuation or hemorrhage of interosseous ligament as seen from the radiocarpal space. Incongruity or step-off of the carpal space. There may be a slight gap (less than the width of a probe) between carpal bones
III	Incongruity or step-off of carpal alignment as seen from both radiocarpal and midcarpal space. Probe may be passed through the gap between carpal bones
IV	Incongruity or step-off of carpal alignment as seen from both radiocarpal and midcarpal space. There is gross instability with manipulation. A 2.7-mm arthroscope may be passed through the gap between carpal bones ('drive-through sign')

The Wilcoxon signed-rank test was used to analyze paired categorical data on the basis of good or excellent as opposed to fair or poor Mayo wrist scores.

Results

SL ligament tears were graded intraoperatively according to the Geissler system. Four patients had Geissler type-I, seven patients had Geissler type-II, and two patients had Geissler type-III injury. Chondral injuries were noted in three patients and were graded according to the region with the most severe damage. The location of chondral injury was the lunate fossa in two patients but also included the lunate bone in one patient.

Figure 2

(a) Symptomatic patient with a scapholunate (SL) gap on clenched-fist-view radiograph. (b) Patulous, lax SL ligament. (c) Thermal stabilization with a monopolar probe.

Table 2 Modified Mayo wrist score

Findings	Score[a] (points)
Pain	
None	25
Mild or occasional	20
Moderate	15
Severe or intolerable	0
Functional status	
Return to regular activities, same level	25
Return to regular activities, restricted level	20
Return to different activities, low demand	15
Unable to play/work/play sports	0
Flexion/extension[b] (deg.)	
≥120 (90–100%)	25
100–119 (80–89%)	20
90–99 (70–79%)	15
60–89 (50–69%)	10
30–59 (25–49%)	5
0–29 (0–24%)	0
Pronation/supination[b] (deg.)	
≥145 (90–100%)	25
130–144 (80–89%)	20
110–129 (70–79%)	15
80–109 (50–69%)	10
40–79 (25–49%)	5
0–39 (0–24%)	0

[a]The score is classified as excellent (91–100 points), good (81–90 points), fair (71–80 points), or poor (≤70 points).
[b]The values are expressed as the total range of motion (deg.), with the percentage of normal in parentheses.

Table 3 Relation between the Geissler classification and the postoperative Mayo score

Geissler classification Mayo score	Type I	Type II	Type III	Total
Excellent	3	5	–	8
Good	1	2	–	3
Fair	–	–	2	2
Total	4	7	2	13

The preoperative modified Mayo score was 56.3 (range, 35–90). The average early postoperative score, recorded at the time of routine follow-up at an average of 3 months after surgery, was 91.6 (range, 65–100) ($P<0.001$) and improved to 93.8 at the late follow-up at 11 months. Two of the 13 patients had a score in the fair range. One of the two patients with a fair score at the time of the early postoperative examination originally had sustained an isolated gymnastics injury and had a Geissler type-III SL tear that was noted at the time of the operation. The symptoms worsened over time postoperatively, and 12 months later, the patient underwent a dorsal capsulodesis and further debridement of a chondral injury because of persistent wrist pain. The other patient with a fair score had a Geissler type-III SL ligament tear and also required open reconstruction for the treatment of persistent symptoms. There was a significant relationship between Geissler type and the postoperative Mayo score (Table 3).

Patient satisfaction

Ten of the 13 patients stated reported that the wrist arthroscopy surgery had been worthwhile and they were satisfied with the results. They improved clinically. One patient, who did not believe that the arthroscopy had been worthwhile, had had a previous open distal radial fracture and had neuropathic pain that had persisted postoperatively. Two patients required subsequent open reconstruction using a dorsal capsulodesis for the treatment of instability and were disappointed that the arthroscopy procedure did not result in long-term symptomatic relief.

Wrist motion

At the last visit, the objective range of wrist movement showed postoperative movement in all patients. The mean range of movement was 93% of the normal side.

Grip strength

Postoperative grip strength improved significantly in 11 patients and remained unchanged in the other two patients.

Discussion

SL injuries have traditionally been classified as acute or chronic and static or dynamic. However, the definitions and treatment are under increasing scrutiny. The term acute is difficult to define, and many surgeons favor SL ligament repair, if there is adequate tissue, irrespective of the time that has elapsed since injury. The management of dynamic instability has been highly variable, including capsulodesis, bone–ligament–bone autografts, and scaphocapitate fusions. There is growing dissatisfaction with the treatment of static SL dissociation using a dorsal capsular reconstruction for an injury that includes both dorsal and palmar ligaments. There is also an evolution in the evaluation of SL joint injuries. Treatment for SL dissociation has been a dilemma for most hand surgeons, and, to date, there is no gold standard. There are a multitude of treatment options for this condition; many authors consider injury chronicity most important in determining treatment. Open reduction and internal fixation can be carried out using a dorsal approach, a palmar approach, or a combined dorsal–palmar approach. An open technique allows direct visualization of the reduction and direct repair of the ligaments. Some authors believe that the palmar ligaments are the most important ligaments to be repaired, as a static deformity cannot be created unless the palmar ligaments are torn [12,15,29]. Repair of the dorsal SLIL can be accomplished with suture through bone or with bone anchors. If the remnant of SLIL is not substantial, the repair can be reinforced with a local capsule. Lavernia *et al.* [30] performed a direct repair of the SL ligament dorsally with the membranous portion, with or without dorsal capsulodesis. Twenty of 21 patients regained near-normal grip strength, and wrist motion was almost normal, lacking 17° of flexion. Radiographs showed minimal degenerative changes in three patients; at an average follow-up of 3 years, none went on to develop wrist arthritis.

The term chronic is arbitrary. It has been used to describe ligament tears diagnosed anywhere from 3 weeks to longer than 3 months after injury. The major concerns with chronicity of this injury are whether the ligaments can be directly repaired, whether the joint is reducible, and whether the joint has developed arthritis. The term dynamic is, similarly, difficult to define. For most authors, the criteria are wrist pain with a tender SL joint, pain with provocative maneuvers, and normal static radiographs. Abnormal stress radiographs or cineradiography are believed to be supportive but not necessary for the diagnosis.

There are many techniques to treat chronic dynamic and static SL joint injuries, ranging from arthroscopic debridement to SLIL repair, repair with capsulodesis, repair with tendon weaves and bone–retinaculum–bone or bone–ligament–bone autografts, and limited intercarpal fusions.

Weiss *et al.* [31] showed that, in patients with a suspected intercarpal ligament tear and normal radiographs, arthroscopy was useful for both diagnosis and treatment. Arthroscopic debridement provided improvement or symptom resolution in 10 of 15 patients with complete tears and 11 of 13 patients with partial tears.

Although the DSLIL has a high tensile strength, several authors have concluded that the palmar ligaments are the primary stabilizers of the SL joint. Berger *et al.* [24] have reported that surgical correction of rotatory subluxation of the scaphoid or static deformity seems unlikely to be successful by SL ligament reconstruction alone. Short *et al.* [32] confirmed that no change in carpal alignment was present after SL sectioning alone. Weiss [33] indirectly confirmed the importance of palmar support for the widened SL joint in a study in which the DSLIL was reconstructed using a bone–retinaculum–bone autograft from the third dorsal compartment. Twelve of 14 patients with dynamic instability had no pain, and only two of five patients with static instability were pain-free. Weiss [33] concluded that surgical reconstruction of the dorsal SLIL yielded satisfactory results in patients with dynamic SL instability, but was unpredictable in patients with static deformities. Similarly, Wintman *et al.* [34] showed dorsal capsulodesis to be an effective treatment for patients with an examination indicative of an SL lunate injury and normal radiographs.

Wyrick *et al.* [35] evaluated SL ligament repair and dorsal capsulodesis for static SL dissociation and found that no patients were free of pain at an average follow-up of 30 months. Wrist motion averaged 60% and grip strength was 70% of the normal contralateral wrist. The experience of Wintman *et al.* [34] and Wyrick *et al.* [35] suggests that dorsal capsulodesis is more predictable for patients with dynamic instability than for those with static instability. Maintenance of the normal relationships of the scaphoid and lunate after SL dissociation remains a challenge. Tendon weaves and tenodesis have been attempted, with variable success. Dobyns *et al.* [36] attempted to weave a strip of tendon through interosseous drill holes in the scaphoid and lunate to attempt to reconstruct the SLIL, with disappointing results. The large holes required to pass tendon grafts led, in some cases, to carpal fractures [37]. Almquist *et al.* [38] reported on a four-bone tendon weave in which a strip of extensor carpi radialis brevis was woven through the capitate, scaphoid, lunate, and radius. Eighty-six percent of patients returned to their previous work, and no radiographic evidence of arthritis was found at the 4.8-year follow-up. Reconstruction using tendon weaves has been described with varying success; Green and O'Brien [39] described their experience as 'not particularly rewarding'. Glickel and Millender [40] noted that only two of 21 patients were pain-free, and motion was decreased in all patients. Dunn and Johnson [41] described a ligament reconstruction in a cadaver model using free tendon grafts and suture anchors to reconstruct the radioscaphocapitate, palmar SLIL, and RSL ligaments in a 'simpler' manner.

SL fusion would seem to be a logical method to place and hold the scaphoid and lunate in reduced position; however, fusion rates have been unacceptably high. Hom and Ruby [42] achieved fusion in one out of nine patients. Watson *et al.* [43] warned that 'bony fusion between the scaphoid and lunate is difficult to achieve and when successful fusion is obtained, there must be adequate bone volume at the fusion site to carry the necessary loads or pain will result' [43]. This has led many authors to search for alternative methods to retain a near-normal SL relationship.

Patients with chronic wrist pain without evidence of static carpal instability can be managed by conservative means, which includes a course of immobilization to decrease the inflammatory process, followed by supervised range-of-motion and progressive resistive exercises. Patients whose symptoms resolve can return to work and other activities. In patients who fail to respond to nonoperative management, an MRI scan may be helpful for further evaluation. After the failure of conservative treatment and the evaluation of chronic and persistent pain with MRI, we have chosen to proceed directly to arthroscopy to facilitate further diagnosis and treatment.

The rationale behind the arthroscopic debridement of partial SL ligament tears is based on the ligament's anatomical and biomechanical properties. The SLIL is divided anatomically into a central 'membranous' region as well as dorsal and volar portions. The dorsal and volar regions are similar in composition and histologic appearance to any capsular ligament. The membranous portion, however, contrasts markedly. It is comprised of fibrocartilage, with few collagen fascicles, and the tissue is devoid of vascularity and innervations [44,45], making spontaneous healing unlikely. Biomechanically, each of these areas is distinct as well. The proximal membranous region is the weakest and the dorsal portion is the strongest, requiring 10 times the tensile load to induce failure. According to Mayfield's [46] description of SL ligament tear progression [47], the volar portion fails first, followed by the membranous region, and finally the dorsal portion. With partial tears, the dorsal region is left intact, resulting in only minor alterations in carpal kinematics [48]. Thus, augmentation or reconstruction of a partial tear is arguably unnecessary. Tears or attenuation of the proximal aspect of the membranous region can be a source of pain.

This pain is secondary to impingement of the injured SL ligament on the chondral surface of the lunate fossa. Given that this area of the ligament has poor healing potential and is responsible for a lesser amount of wrist stability, arthroscopic debridement has been considered as an excellent means of relieving symptoms. In the present study, the principles of surgical management previously introduced for patients who had had a failure of nonoperative treatment on the basis of the hypothesis that they would be effective and that this more conservative surgical approach would not preclude open reconstruction or capsulodesis in the future if it failed. Thermal stabilization was used to shrink the redundant SL ligament after arthroscopic debridement. The use of thermal energy has recently been proposed as a technique to shrink redundant or lax connective tissues through the well-established mechanism of collagen denaturation [49,50]. Although the ultimate application of thermal modification of connective tissue is yet to be completely defined, its current role appears to be that of a low-level stimulant for inducing a biologic repair response rather than an aggressive mechanism for primary tissue shrinkage [51]. Also, application of thermal energy to shrink connective tissue is very subjective and still relies on the visual conformation of the tissue response. Studies have suggested that at least 3 months are required for thermally modified tissue to fully recover its biologic properties [52].

The present study showed that arthroscopic debridement and thermal shrinkage of Geissler type-II SL tears was effective as determined at the time of both early follow-up and longer-term follow-up in the majority of patients. Because only two patients had a Geissler type-III tear, we cannot draw any firm conclusions on the treatment of these lesions. Our recommendation is to proceed to open reconstruction in patients with Geissler type-III injuries. On the basis of the findings of wrist arthroscopy, partial tearing of the SL ligament appears to lead to impingement and impaction of the scar tissue and torn ligament on the chondral surface, which in turn may lead to chondral injury. We believe that it is critical to address all abnormalities that are noted at the time of arthroscopy and that, because pain was reduced and functionality was improved in our patients after surgery, debridement was at least a part of an effective treatment protocol. In a study of arthroscopic debridement for the treatment of partial tears in adults, Ruch and Poehling [53] found less relief in patients who had substantial chondral injury. This may be because of the presence of more severe chondral damage in adults or to less healing potential in older patients. Finally, some patients who do well initially after arthroscopic debridement may have recurrent symptoms. In those patients, open treatment can still be effective for achieving pain control and return to activity. Therefore, initial arthroscopic treatment did not have a negative effect on the outcome of the subsequent treatment of these patients.

Wrist arthroscopy offers our patients a less invasive method of treating carpal pathology. The arthroscopic treatment of SL tears in patients is very likely to result in the resolution of patients' pain.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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