

Dorsal Wrist Capsular Tears in Association with Scapholunate Instability: Results of an Arthroscopic Dorsal Capsuloplasty

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J Wrist Surg 2013;2:160–167.

Abstract

Purpose The purpose of this study is to report the association of dorsal wrist capsular avulsion with scapholunate ligament instability and to evaluate the results of an arthroscopy-assisted repair.

Methods We retrospectively reviewed 10 patients with a mean age of 39.1 years suffering from chronic dorsal wrist pain. They underwent a wrist arthroscopy with an evaluation of the scapholunate ligament complex from the radiocarpal and midcarpal compartments. An avulsion of the dorsal intercarpal ligament (DICL) from the scapholunate interosseous ligament (SLIL) was visible from the radiocarpal compartment in all cases, while the SLIL was intact. The DICL tear was repaired with an arthroscopy-assisted dorsal capsuloplasty. Patients were assessed preoperatively and postoperatively by the *QuickDASH* (Disabilities of the Arm, Shoulder, and Hand) questionnaire, by the Visual Analog Scale (VAS) for pain, and by a clinical and radiological examination.

Results Preoperatively, all patients had reduced flexion and radial deviation of the affected wrist. On the lateral radiograph, 5 of the 10 patients showed an increase of the scapholunate angle (60 to 85°). The scapholunate instability was graded as Messina–European Wrist Arthroscopy Society (EWAS) II in five cases and as grade IIIB in five cases. A tear of the ulnar part of the triangular fibrocartilage complex (TFCC) was found in seven cases. At a mean followup of 16 months, the wrist range of motion (ROM), the grip strength, the *QuickDASH*, and the VAS of pain improved significantly. The scapholunate angle was normalized in all cases.

Discussion Isolated tears of the DICL at its insertion from the dorsal part of the SLIL can be associated with scapholunate instability in the absence of an injury to the SLIL. The diagnosis is made arthroscopically. The arthroscopic dorsal capsuloplasty is a minimally invasive technique that provides short-term satisfactory results. Further studies are needed to determine whether repair of the DICL tear could prevent secondary destabilization of the scapholunate ligament complex.

Level of evidence IV (case series) Diagnosis

Keywords

- ▶ dorsal intercarpal ligament
- ▶ scapholunate instability
- ▶ scapholunate ligament
- ▶ wrist arthroscopy
- ▶ dorsal capsulodesis

Scapholunate dissociation is the commonest cause of carpal instability. If untreated, it can lead to wrist osteoarthritis. Impairment of the scapholunate interosseous ligament (SLIL) in association with injury to the extrinsic ligaments is known to lead to rotatory subluxation of the scaphoid, dorsal intercalated segment instability (DISI), and, finally, scapholunate advanced collapse (SLAC).¹

The scapholunate ligament complex comprises intrinsic and extrinsic elements. The intrinsic component includes the three portions of the SLIL: volar, midsubstance, and dorsal (the dorsal component being considered the most important biomechanically).² The dorsal intercarpal ligament (DICL) is considered a secondary extrinsic stabilizer along with the dorsal radiocarpal ligament and volar radiocarpal ligaments.³⁻⁸ Recent anatomical studies have emphasized the key role of the DICL in scaphoid rotatory stability and of the radiocarpal ligaments in lunate stability.^{4,5} The purpose of this study is to report the association of dorsal capsular avulsion with scapholunate instability, in the absence of a lesion of the SLIL, which has not been previously described. An additional purpose is to analyze the results of an arthroscopy-assisted dorsal capsuloplasty previously described for the repair of SLIL tears⁶ in a series of 10 patients.

Material and Methods

We retrospectively reviewed a series of 10 patients presented with chronic dorsal wrist pain and diagnosed arthroscopically as having a dorsal wrist capsular tear between 2009 and 2011. The mean age of the patients was 39.1 years (range, 25 to 52 years). There were six men and four women. Two of the 10 patients were heavy manual workers (one cleaning lady and one plumber). The dominant hand was involved in six patients. Every patient underwent a thorough clinical and radiographic examination, and arthroscopic findings were noted. Informed consent was obtained from each patient, but our institution does not require institutional review board approval.

Preoperative Assessment

The duration of the pain, the history of wrist injury, and the previous treatments were recorded. The preoperative ranges of motion (ROMs) of both wrists were measured: flexion, extension, and radial and ulnar deviations. The grip strength was measured on the affected side and the contralateral side with the Jamar dynamometer (Preston, Cambridge, MA, USA). A thorough clinical examination for scapholunate instability was performed, including the Watson test and the ballottement test, and compared with the contralateral side. In the Watson test the examiner places four fingers behind the radius, and the thumb is placed on the tuberosity (distal pole) of the scaphoid. The other hand is used to move the wrist passively from ulnar to radial deviation. In ulnar deviation, the scaphoid is extended and assumes a position more in line with the forearm. In radial deviation, the scaphoid is flexed. Pressure on the tuberosity while the wrist is moved from ulnar deviation to radial deviation prevents the scaphoid from flexing. In such circumstances, if the scapho-

lunate ligaments are completely insufficient or torn, the proximal pole subluxates dorsally out of the radius, inducing pain on the dorsoradial aspect of the wrist. When pressure is released, a typical “clunking” may occur, indicating self-reduction of the scaphoid over the dorsal rim of the radius. We also performed the scapholunate ballottement test, in which the lunate is firmly stabilized with the thumb and index finger of one hand, while the scaphoid, held with the other hand (thumb on the palmar tuberosity and index on the dorsal proximal pole), is displaced dorsally and palmarly with the other hand. A positive result elicits pain, crepitus, and excessive mobility of the scaphoid.

Quality of life was evaluated using the quick Disability of the Arm, Shoulder, and Hand (*QuickDASH*) score. The pain was quantified using the Visual Analog Scale (VAS) (range 0 to 10, 0 being graduated as “no pain”).

Radiographic Assessment

Standardized static X-ray images of the wrist were obtained from every patient in order to analyze the scapholunate interval on the posteroanterior (PA) view and the scapholunate angle on the lateral view. The scapholunate angle was measured between a line tangential to the two proximal and distal convexities of the palmar aspect of the scaphoid and the line perpendicular to a line connecting the palmar and dorsal tips of the lunate. An angle greater than 65° was considered to be consistent with a dorsal intercalated segment instability (DISI) pattern.⁹ Moreover, the radiolunate angle was measured (between the perpendicular to the tips of the lunate and the axis of the radial shaft) and considered abnormal when superior to 10° (normal values between -25 and 10°). All the patients underwent magnetic resonance imaging (MRI) arthrography, and 7 of the 10 patients had a computed tomography (CT) arthrogram for further evaluation of the distal radioulnar, radiocarpal, and midcarpal compartments.

Arthroscopic Staging of Lesions

Wrist arthroscopy was performed under regional anesthesia with an upper arm tourniquet. The elbow was flexed to 90° and the hand was suspended using “Chinese finger traps” with countertraction of 3 to 5 kg. After injection of 3–5 mL normal saline solution into the wrist, standard radiocarpal portals, including the 3–4, 6R, and midcarpal radial (MCR) and ulnar (MCU) portals, were used to enter the joints. Débridement of an exuberant synovitis was often necessary to visualize the dorsal capsular attachment. To avoid an iatrogenic lesion of the dorsal capsule that would mimic a tear, the shaver was not directly applied to it but rather was placed between the distal radius and the first carpal row so that the “synovial fringe” was sucked up.

The intraoperative findings were recorded, including the condition of the membranous and dorsal portions of the SLIL and the presence or absence of osteoarthritis and associated lesions of the triangular fibrocartilage complex (TFCC). The latter were graded according to the Atzei–European Wrist Arthroscopy Society (EWAS) classification.¹⁰ To assess the dorsal joint capsular reflection on the dorsoproximal surfaces of the scaphoid and lunate, the arthroscope was inserted in

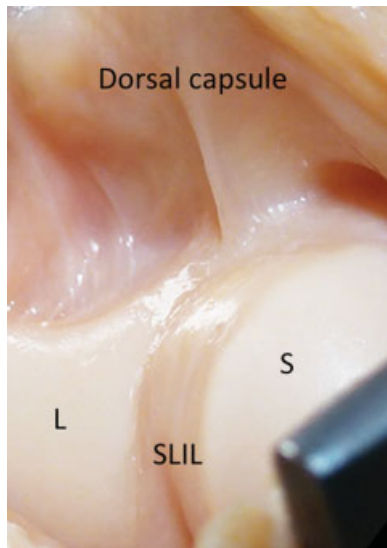


Fig. 1 Synovial fold tightened between the dorsal portion of the SLIL and the dorsal capsule in a fresh cadaver. The left bone is the lunate, the right one the scaphoid. The dorsal capsule is retracted toward the edge of the picture.

the 6R portal and the probe in the 3–4 portal. The probe was then applied on the dorsal capsule near the scapholunate joint and pushed dorsally. We have called this diagnostic test the “push-test.” If an avulsion or tear of the dorsal capsular reflection was present, no resistance was encountered and the probe could pass through the capsule at the dorsal aspect of the SLIL toward the midcarpal joint. Furthermore, in these cases the dorsal synovium of the capsule lost its usual “bow” or dome-shaped aspect (►Fig. 1) at the level of the SLIL.

The stability of the scapholunate ligament complex was evaluated through midcarpal portals using a dynamic test and graded according to the Messina-EWAS classification (►Table 1), a modification of the Geissler classification.¹¹ Briefly, to test for instability, the hook-probe was pushed into the scapholunate interosseous space from the MCR portal toward the radiocarpal joint. The probe was then rotated to look for any diastasis between the two bones.

Operative Technique

We used the technique initially described by the senior author for the repair of chronic tears of the SLIL.⁶ Briefly, two hypodermic needles loaded with 3.0 PDS II (Ethicon,

Somerville, NJ) suture threads are passed under visual control in the 3–4 portal through the dorsal capsule and the SLIL near the scaphoid and the lunate, respectively. Then the ends of the two suture threads are pulled out through the MCU portal. A knot is tied between the two threads and drawn back inside the midcarpal joint at the deep side of the dorsal scapholunate ligament. After the traction is released, while the wrist is maintained in extension, the other ends of the threads are tied on the superficial side of the capsule in the 3–4 incision, thus creating a capsuloplasty between the dorsal capsule, the DCL, and the scapholunate ligament. The wrist is then immobilized in a splint for 2 months. Gradual physiotherapy is initiated thereafter to restore wrist ROM.

Postoperative Assessment

At final follow-up, an independent reviewer examined the patients. The postoperative pain, the *QuickDASH* score, the wrist ROMs, and the grip strength were recorded. Standard PA and lateral X-ray images were taken to measure the radiolunate and scapholunate angles. Finally the satisfaction of the patient was recorded by asking the patients to grade their postoperative results as excellent, good, or poor.

Statistical Analysis

A statistical analysis was performed using a paired *t* test to compare preoperative and postoperative values. A *P* value of less than 0.05 was considered statistically significant.

Results

All patients presented with chronic pain on the dorsal aspect of the wrist that was aggravated by strenuous work and was refractory to conservative measures. Eight patients had been previously treated in a splint; two of them had multiple cortisone injections in the wrist.

Only five patients were able to recall a traumatic injury (four sports injuries during football or motorcycling, one work accident). In these cases, the mechanism was a forceful extension of the wrist, a fall on the wrist, or a direct impact. The average duration of wrist pain prior to surgical treatment was 10 months (range, 7 to 25 months).

Preoperative Clinical Findings

All patients had pain on palpation of the dorsal aspect of the wrist over the scapholunate interval.

Table 1 Arthroscopic Messina-EWAS classification of scapholunate instability, from the midcarpal joint

Stage I	No scapholunate incongruency. The tip of the probe cannot enter the scapholunate space.
Stage II	The tip of the probe or the whole probe can go through the scapholunate space.
Stage IIIA	Anterior widening of the scapholunate space when turning the probe.
Stage IIIB	Posterior widening of the scapholunate space when turning the probe.
Stage IIIC	Complete widening of the scapholunate space. Bones completely resume the correct position at the removal of the probe.
Stage IV	The arthroscope can go through the scapholunate space in the radiocarpal joint.

The hook-probe is pushed into the scapholunate interosseous space from the MCR portal toward the radiocarpal joint. The probe is then rotated to test for any diastasis between the two bones.

The mean wrist flexion was 48.5°, which was 62.5% of the unaffected side. The mean wrist extension was 67° and 88.2% of the contralateral side. The mean radial deviation was 18° and 63.2% of the unaffected side. The mean ulnar deviation was 31.5° and 91.3% of the opposite side.

The average grip strength was 24.5 kg, compared with mean grip strength of 44.5 kg (range, 25 to 60 kg) on the opposite side. The Watson test was negative in all cases. The ballottement test was painful without excessive mobility of the scaphoid. The mean initial *QuickDASH* score was 32.5, and the VAS pain score was 6.1.

Preoperative Radiological Findings

None of the cases showed evidence of scapholunate diastasis or a ring sign (consistent with rotatory instability of the scaphoid) on the PA view. On the lateral view, 5 of the 10 patients showed an increased scapholunate angle, which ranged from 65 to 85°. The radiolunate angle was always greater than 5° (5 to 25°). No abnormality was seen on any of the seven CT-arthrograms. A T2-weighted MRI revealed an increased signal intensity, compatible with fluid on the dorsal capsule at its insertion on the dorsal aspect of the lunate, in three cases (►Fig. 2).

Arthroscopic Findings

A tear between the dorsal capsular reflection and the dorsal part of the SLIL was found in all cases² (see ►Fig. 3). A variable amount of synovitis was visible in all cases in the radiocarpal joint. The dorsal and membranous portions of the SLIL were

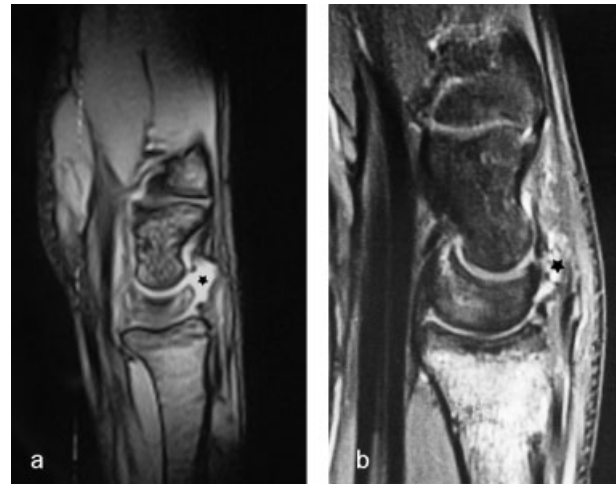


Fig. 2 T2-weighted magnetic resonance images of two patients (a, b) with an isolated tear of the dorsal capsular reflection with an increased fluid intensity dorsal to the lunate.

intact: its aspect, its texture, and response to probing were considered as normal. The palmar aspect of the SLIL was not directly visualized. The dorsal and proximal portions of the lunotriquetral ligament were also intact. Five patients had a scapholunate instability of stage II according to the Messina-EWAS classification, and a 1-mm arthroscopic probe could be inserted between the scaphoid and lunate. This would correspond to a Geissler grade III lesion. Five patients had a Messina-EWAS stage IIIB instability, in which there was

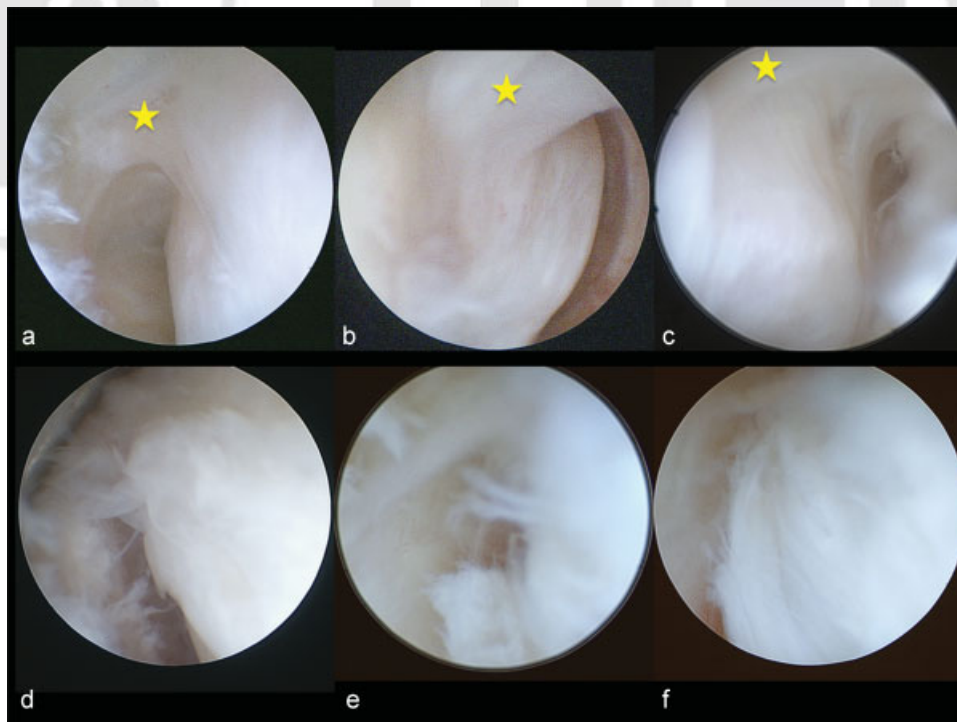


Fig. 3a-f Arthroscopic views from the radiocarpal joint of the dorsal capsule in six different patients. The arthroscope is inserted in the 6R portal. (a-c) Normal "bow"-aspect with a synovial fold of the dorsal capsule at the level of the SLIL in three patients without lesion of the dorsal capsuloscapholunate septum. (d-f) Arthroscopic views of a tear of the DCSS in three patients: when a probe is inserted in the 3-4 portal and applied to the dorsal capsule, no resistance is felt and the probe can pass through the capsule at the dorsal aspect of the SLIL toward the midcarpal joint, which suggests a tear of the attachment of the dorsal intercarpal ligament on the dorsal part of the scapholunate interosseous ligament.

posterior widening of the scapholunate space when the arthroscopic probe was rotated through 90°. These five patients had a DISI pattern on plain X-ray views. In 7 of the 10 patients a class 1 lesion of the TFCC according to the Atzei-EWAS classification (which corresponds to a class 1B of the Palmer classification) was seen: a distal, dorsal avulsion. No osteoarthritis was seen in the radiocarpal and midcarpal compartments. No lesion of the volar radiocarpal ligaments was observed.

Postoperative Clinical Results

The mean follow-up was 16.3 months (range, 12 to 24 months). The clinical and radiographic results are summarized in ►Table 2. The mean postoperative pain on the VAS was 1.5. The postoperative QuickDASH score was 4.3 with a decrease of 86.8% compared with the preoperative value.

The postoperative ROM improved in all planes as compared with the preoperative measurements, reaching an average of 94.7% of the unaffected wrist (from 84% for flexion to 98.6% for ulnar deviation). The average of grip strength was 44 kg, reaching 96.6% of the contralateral side. The wrist ROM (except the ulnar deviation), the QuickDASH score, and the VAS improved significantly over preoperative values ($P < 0.01$). Six patients were very satisfied with their results. Three were satisfied, and one considered the result as poor, because of some residual pain (postoperative VAS graded as 4).

Radiographic Results

No scapholunate angle was greater than 65° on the lateral X-ray view at the final follow-up (►Fig. 4). The radiolunar angle was less than 10° for all the patients. PA views remained normal.

Complications

One patient developed Sudeck atrophy. There was no deterioration of wrist ROM.

Discussion

In this study we observed that a tear of the dorsal capsule at its insertion onto the dorsoproximal aspects of the scaphoid

and lunate appeared to be a cause of chronic dorsal wrist pain and was associated with scapholunate instability without an actual tear of the SLIL itself. We demonstrated that arthroscopy-assisted capsuloplasty had encouraging short-term results in improving pain, wrist mobility, strength, and decrease of the scapholunate angle.

Currently there is no specific clinical sign or test to diagnose a tear of the dorsal wrist capsule. The Watson test was negative in all cases, but the ballottement test was positive, which suggests that the scapholunate laxity could participate to the generation of the pain. Patients usually complained of a nonspecific, diffuse, throbbing chronic wrist pain on the dorsal aspect of the wrist that was aggravated by strenuous work or by activities requiring radial deviation. In this study we found that wrist extension and ulnar deviation of the injured side were well preserved, but flexion and radial deviation were decreased (62.2 and 63.2% of the uninjured side, respectively), but our numbers were too small to demonstrate statistical significance.

A DISI pattern was found on the lateral X-ray view only for patients with Messina-EWAS stage IIIB scapholunate instability. Although an increased fluid signal intensity was seen dorsal to the lunate in several cases (30%), the sensitivity of MRI in detecting this lesion was low in the current study. Slutsky reported a case of increased signal intensity due to a tear of the dorsoradial carpal ligament that was misinterpreted as a dorsal wrist ganglion.¹² Adler et al¹³ used MRI to examine the extrinsic radiocarpal ligaments in eight wrists with scapholunate dissociation and found frequent abnormalities of the palmar ligaments but few involving the dorsal extracapsular ligaments.

An avulsion of the dorsal capsular reflection as a cause of chronic dorsal wrist pain has not been previously reported. This can be attributed to the difficulty in visualizing it through a conventional dorsal approach of the wrist or through the standard dorsal wrist arthroscopy portals, especially when the wrist is in traction, during which the capsule is compressed against the ruptured ligaments.⁶ The dorsal capsular attachment cannot be seen through a palmar portal. The dorsal capsule is best seen with clockwise rotation of a 30° scope in the 6R portal. Although the dorsal part and the membranous portion of the SLIL appeared normal when

Table 2 Clinical and radiographic results of the case series of arthroscopy-assisted dorsal capsuloplasty in the treatment of isolated dorsal capsular tears

Parameters	Preoperative mean (range)	Postoperative mean (range)	t test (P)
DASH	32.5 (15.9–55.6)	4.3 (0–13.6)	0.00000059
VAS	6.7 (5–8)	1.5 (0–4)	0.00000002
Flexion (°)	48.5 (20–70)	65.5 (45–85)	0.00024373
Extension (°)	67 (60–80)	74.5 (70–80)	0.00668929
Ulnar deviation (°)	31.5 (25–40)	34 (30–45)	0.05217724
Radial deviation (°)	18 (0–30)	28 (15–35)	0.00105387
Grip strength (kg)	24.5 (10–45)	44 (20–55)	0.00012558
DISI (number of cases with scapholunate angle superior to 65°)	5	0	



Fig. 4 (a) Posteroanterior and (b) lateral views of the left wrist of a 52-year-old right-handed plumber who did not remember any wrist trauma. He suffered from chronic dorsal wrist pain. Arthroscopy revealed a scapholunate instability stage IIIB. (c) PA and (d) lateral views of his wrist 18 months after an arthroscopy-assisted capsuloplasty. The scapholunate angle passed from 80 to 65°. The radiolunate angle passed from 20 to 10°.

viewed from the radiocarpal joint, slight attenuation of the dorsal SLIL could not be completely ruled out, especially when there was an increased scapholunate angle.

Berger described a normal transverse recess between the dorsal joint capsule and the dorsoproximal surfaces of the scaphoid and lunate.² He noted that the dorsal capsular attachment just distal to the dorsal SLIL may be obscured by a curtain of dorsal joint capsule, seemingly hanging into the radiocarpal joint. He believes this tissue most likely represents a vestige of the radiocarpal joint septum that forms transiently during fetal development and separates the radiocarpal joint into radioscapoid and radiolunate joint clefts.

The DICL arises from the triquetrum, has a transverse route above the lunate, and inserts onto the scaphoid, trapezium, and trapezoid.¹⁴ The proximal part of the DICL binds the triquetrum to the scaphoid¹⁵ and sends a thin band of fibers

to the dorsal aspect of the lunate in 90% of cases^{16,17} and onto the dorsal part of the SLIL (see ►Figs. 5 and 6). We suggest calling this latter attachment the dorsal capsuloscapolunate septum (DCSS). We observed this ligament consistently in a

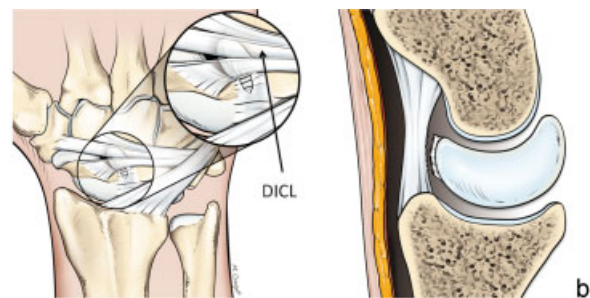


Fig. 5 Artist drawing. (a) Frontal view and (b) lateral view of the attachment of the proximal part of the dorsal capsular reflection to the dorsoproximal aspect of the scaphoid and lunate.

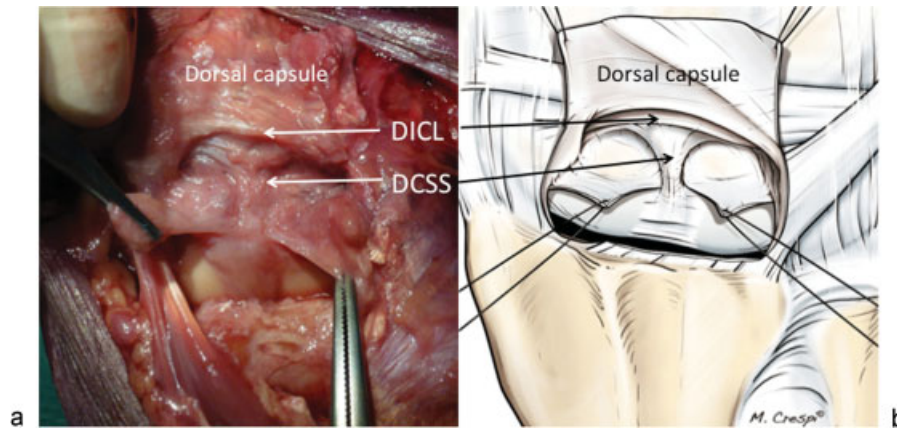


Fig. 6 View from the radiocarpal joint of the attachment of the DICL to the dorsal part of the SLIL, called the dorsal capsuloscapholunate septum (DCSS), in a normal fresh cadaver. The left bone is the scaphoid, the right one the lunate. The dorsal capsule is opened and retracted toward the bottom of the picture. (a) Dissection photograph. (b) Explanatory drawing.

separate anatomical study on 15 fresh cadaver wrists (unpublished data) (→Fig. 6). In a cadaver study of 90 wrists, Viegas observed communicating fibers between the DICL and the SLIL in 100% of the specimens.¹⁷ In 10 cases, he noted an avulsion of the DICL from the scaphoid, the lunate, or both. During arthroscopy, the DICL cannot be seen directly from the radiocarpal compartment. One can, however, consistently observe the synovial fold at the junction between the dorsal part of the SLIL and the dorsal capsule. The sagittal communicating fibers from the DICL to the dorsal capsular reflection can be palpated using a hook probe. In cases where these fibers are torn, the probe can be passed into the midcarpal space without resistance.

These dorsal structures were not easily explored until recently, since prior anatomical studies inadvertently divided these fibers when using a dorsal transligament approach. The use of wrist arthroscopy has improved our understanding of the biomechanical importance of the DICL by enabling us to study the wrist joint after sequential sectioning of individual ligaments while keeping the dorsal capsule and dorsal ligaments intact.

Several cadaver studies demonstrated that an isolated division of the entire SLIL was not sufficient to cause a scapholunate dissociation as long as the dorsal extrinsic ligaments were intact.^{4,5} Elsaidi and Ruch⁴ sequentially divided the radioscapulocapitate (RSC) ligament, the long and short radiolunate ligaments, the SLIL, and finally the dorsal capsule insertion on the scaphoid. There was no appreciable change in the scapholunate and the capitulunate angles. Rotatory instability of the scaphoid with increase of the scapholunate angle occurred when the DICL insertion on the scaphoid was divided in addition to the aforementioned ligaments. When the dorsal radiocarpal ligament (DRCL) was then divided, a DISI deformity occurred. Mitsuyasu⁵ observed that the lunate moved into extension and the scapholunate gap increased significantly when he detached both the DICL from the scaphoid and the triquetrum and the SLIL.

It seemed logical to us to use an arthroscopic, noninvasive procedure for the repair of isolated DCSS tears. The technique previously described by the senior author for chronic scapholunate ligament tears⁶ allows the reattachment of the dorsal capsule and the DICL on the scapholunate ligament without impairment of the wrist ROM. Viegas had previously suggested the reattachment of the DICL over the lunate and over the scaphoid with the dorsal SLIL, using anchors, to treat scapholunate dissociations.¹⁷

The main limitations of the current study are the retrospective nature and the small number of cases. There is no control group; hence, the incidence of preexisting asymptomatic dorsal capsular tears cannot be determined. Further studies are necessary to analyze the incidence of dorsal capsule tears and to determine their role in scapholunate instability. The natural history of an isolated DICL tear is unknown. Based on our experience, we believe that recognition and treatment of these lesions is warranted, as the clinical status of patients can be improved. A longer follow-up study is necessary to determine whether the repair of the DCSS tear is perennial and can prevent scapholunate advanced collapse.

Conflict of Interest

None

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