SCAPHOLUNATE INSTABILITY: CURRENT CONCEPTS IN DIAGNOSIS AND MANAGEMENT

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Injuries to the scapholunate joint [SLJ] are the most frequent cause of carpal instability and account for a considerable degree of wrist dysfunction. It is insufficient to cause abnormal carpal posture or collapse on static radiographs, an isolated injury to the scapholunate interosseous ligament may cause progression to abnormal joint mechanics, cartilage wear, and degenerative changes. Intervention for scapholunate instability is aimed at arresting the degenerative process by restoring ligament continuity and normalizing carpal kinematics.

ANATOMY

Dual linkage system composed of proximal and distal carpal rows.

Ligamentous or bony injuries to the wrist have the potential to irreversibly disrupt the balance, and to set the stage for an inexorable progression to abnormal motion, joint loading, and degenerative change.

The scaphoid, lunate, and triquetrum can be described as an intercalated segment, because no tendons insert upon them.

Their motion entirely depends on mechanical signals from their surrounding articulations, checked by an intricate system of intrinsic, or interosseous, and extrinsic carpal ligaments.

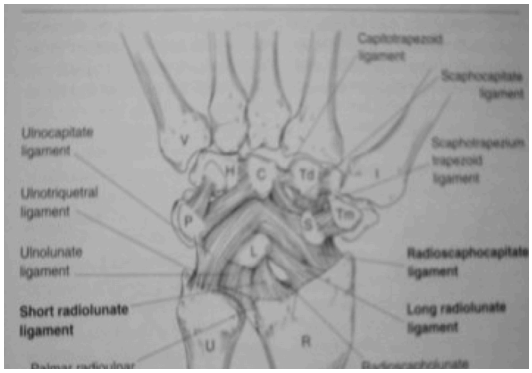
LRL, long radiolunate ligament; SRL, short radiolunate ligament; RSC, radioscaphocapitate ligament; RSL, radioscapholunate ligament; UT, ulnotriquetral ligament; UL, ulnolunate ligament.

On the volar-radial side are the stout extrinsic ligaments: the radioscaphocapitate ligament, the long and short radiolunate ligaments, and the radioscapholunate ligament (of Testut)

Intrinsic Scapholunate SLL; LunotriquetrumLTL

SL: dorsally strong ; LT Volarly strong

Other: Scaphocapitate and Scaphotrapezoid



Extrinsic: Palmar: RSC, Long RL, Short RL

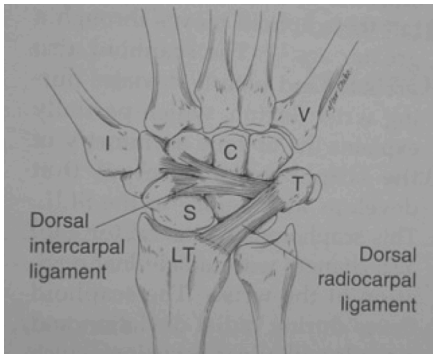
Ulnolunate, palmar radiolulnar ligament,

Ulnotriquetral ligament, Ulno-capitate ligament

Poirier space: Between RSC &LRL

Dorsal: Dorsal radio carpal,

Dorsal intercarpal



Radioscapolunate liga(Testut): between LRL &SRL; is not a ligament as previously thought; NV pedicles.

The most frequently injured of these intercarpal relationships is the SL joint. **The SLIL** [scapholunate interosseous ligament] is C-shaped and attaches exclusively along the dorsal, proximal, and volar margins of the articulating surfaces, leaving a crevice between the bones distally. The 3 subregions of the ligament have different material and anatomic properties, and the dorsal component is the thickest, strongest, and most critical of the SL stabilizers. The dorsal component is a true ligament with transversely oriented collagen fibers, and is a primary restraint not only to distraction, but also to torsional and translational moments. The palmar SL ligament, although considerably thinner, has important contributions to rotational stability of the SL joint. The proximal membranous portion of the SLIL appears histologically as a fibrocartilaginous structure, and in isolation, contributes little to no restraint to abnormal motion of the SL joint.

WRIST MECHANICS

Load Transmission

Scaphoid- 60% and Lunate 40%

S-T/T: 23%, S-Capitate: 28%, L-C: 29%; Triquetrum-hammate 20%

As the anterior cruciate ligament is considered the primary stabilizer of the knee, so, too, can the SLIL be considered the primary stabilizer of the SL joint, if not the entire carpus. It is surrounded in turn by several secondary stabilizers, each insufficient to cause instability after isolated disruption, but each important in the maintenance of normal SL kinematics.

The unique helicoidal surface of the triquetrohamate joint converts ulnar deviation of the hamate into a conjoined rotation of the triquetrum into palmar displacement and dorsiflexion.

Thus, normal kinematics of the SL joint

1. By a tough SLIL
2. Surrounding extrinsic ligaments
3. The scaphoid, lunate, and triquetrum rotate collectively in flexion or extension depending on

As the hand flexes or radially deviates, mechanical forces from the distal carpal row drive the distal scaphoid into flexion, and the lunate follows passively into flexion through the strong SLIL.

As the hand ulnarly deviates, the unique helicoidal articular surface of the hamate engages the concordant surface of the triquetrum and, via a screw like engagement, directs it into a dorsally tilted and palmarly translated position.

During a 120° arc of flexion and extension, for example, scaphoid flexion-extension exceeds lunate flexion-extension by approximately 35°. Scaphoid pronation is approximately 3 times that of lunate pronation during wrist flexion, and lunate ulnar deviation exceeds scaphoid deviation considerably

Recent studies focused attention on coupled motion of the wrist—that is, combination motions of flexion-extension and radioulnar deviation, such as the dart thrower's motion (DTM) of radial-extension to ulnar-flexion. This oblique path of motion has been postulated to be uniquely human and is widely used in occupational activities such as hammering or pouring.

SCAPHOLUNATE INSTABILITY:

Definition : Scapholunate instability is defined as a wrist that is symptomatic during mechanical and load-bearing activities, demonstrating abnormal kinematics during motion.

The concept of dynamic SL instability was proposed to describe abnormal carpal positioning that required special stress radiographs to be manifested.

It is now recognized that SL instability is a spectrum of injury rather than an all-or-none condition.

CLINICAL SIGNS

1. A history of a fall with impact: to the hypothenar region of the hand.
   Mechanical studies demonstrate that this ligament fails as the wrist is forcibly extended while in a position of ulnar deviation and supination.

2. Tenderness is usually poorly localized about the periscaphoid area
   Diffuse swelling may obscure the characteristic wrist effusion.
   Arthrocentesis is helpful when the history is suggestive and radiographs are normal.

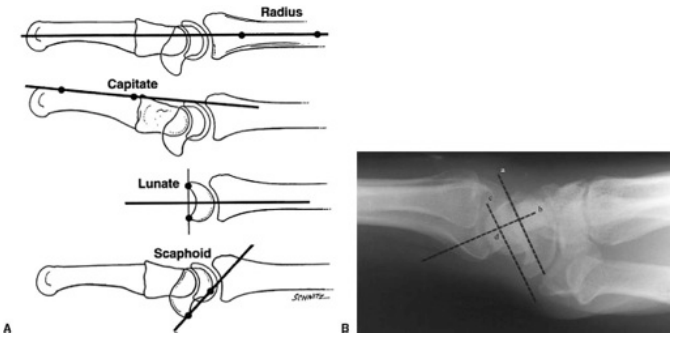
3. Patients with subacute injuries (1–6 wk) often present with a history of painful popping or

and dorsal SL interval.

4. **Kirk Watson test**: described a provocative maneuver known as the scaphoid shift test that can detect subtle degrees of scaphoid instability. The examiner's thumb applies pressure to the scaphoid tubercle as the patient's wrist is brought from a position of ulnar deviation and slight extension to radial deviation and slight flexion. The scaphoid will normally flex and pronate during this maneuver, but in scaphoid instability the maneuver will be painful, and thumb pressure will force the proximal scaphoid from the scaphoid fossa onto the dorsal articular lip of the radius. Relief of thumb pressure allows the scaphoid proximal pole to spontaneously reduce, often with an audible or palpable "clunk." The test may be falsely positive in up to one-third of individuals, and is thought to result from ligamentous hyperlaxity that permits capitolunate translation with similar findings.

RADIOGRAPHS

1. **Collinear arrangement** **2. Scapho-lunate angle**



X ray: PA [Neutral, Ulnar deviation and Radial deviation
Lateral [Flexion and extension, Neutral],
AP grip radiographs

1. **Collinear arrangement** The radius, capitate, and long finger metacarpal are not roughly collinear in the sagittal plane.

Capitate posture can be approximated by a tangent to the dorsal cortex of the long finger metacarpal, and a flexed capitolunate joint in excess of 15° signifies collapse of the midcarpal joint and confirms a DISI deformity.

2. **Measurement of Scapholunate angle** Normal 30 to 60 degrees
DISI>70 degrees
VISI<30 degrees

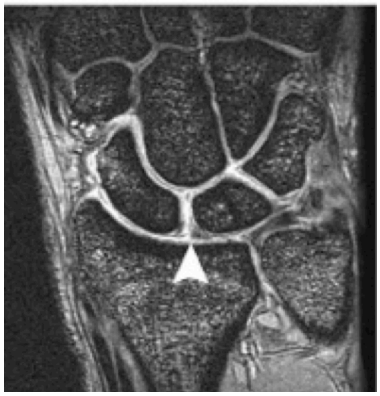
3. **Cortical ring sign**: PA radiograph when the scaphoid is abnormally flexed, creating the so-called “ring sign”.

4. **Terry Thomas sign:** Scapholunate diastasis more than 3 mm [Ulnar deviation view shows abnormal widening of the SL interval]

5. A full-flexion stress view shows abnormal scaphoid subluxation dorsally with minimal conjoined flexion of the lunate. A fleck of avulsed bone from the SLIL dorsal insertion site on the scaphoid can be identified

Arthrography had been described as more sensitive if the radiocarpal, midcarpal, and radioulnar compartments were injected separately (3-compartment arthrography). Arthrography as been all but supplanted by magnetic resonance imaging.

Computed tomography arthrography has been reported as having 95% sensitivity and 86% specificity for detecting SLIL tears compared with arthroscopy, but is also rarely performed today.



MRI Magee reported a sensitivity of 89% and a specificity of 100% for detecting SL ligament tears using 3-T MRI

Wrist arthroscopy: [Giessler's classification]

Grade I: Attenuation of interosseous ligament;

no midcarpal step off

II: Mid carpal step off

III: Complete separation demonstrated from RC and MC and 1 mm probe can be passed between scaphoid and lunate

IV: Same as III and 2.7 scope can be passed. Open repair and capsulodesis

PRINCIPLES OF MANAGEMENT

Garcia-Elias: 5 factors:

1 Is the dorsal SL ligament intact?

2 Does the dorsal SL ligament have sufficient tissue to be repaired?

3 Is the scaphoid posture normal?

4 Is any carpal malalignment reducible?

5 Is the cartilage on the radiocarpal and midcarpal surfaces normal?

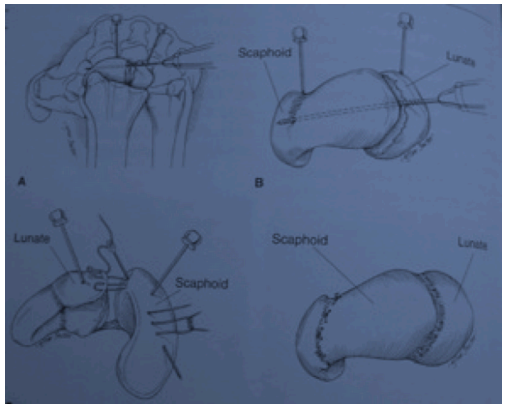
Stage 1: occult instability

Partial SL ligament incompetency

X ray normal

Fluoroscopy may be abnormal

Capsulodesis/Pinning



1. May benefit from conservative treatment such as casting
2. ? Arthroscopic debridement has been reported with success. Temporary percutaneous K-wire stabilization of the SL and scaphocapitate joints protects the heated ligamer for 2 to 4 weeks.

Arthroscopic debridement of partial SL ligament tears: satisfactory improvement in 85%.

Stage II: dynamic instability with a repairable SLIL

Complete SL incompetency

X ray may be normal

Fluoroscopy always abnormal

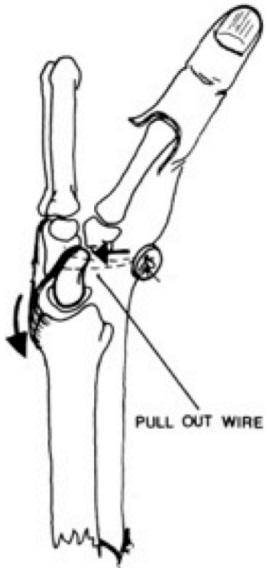
1. Open reduction of the displaced carpals, SL repair, and a dorsal capsulodesis.
2. Regarding the second requirement, the SLIL degenerates fairly quickly after it is torn, which makes repairs difficult in subacute or chronic cases.

Technique

a. Dorsal incision

b. Use joysticks to rotate the scaphoid and lunate [1.6-mm (0.062-in) K-wires]

c. Suture anchors are planned for the SL ligament repair

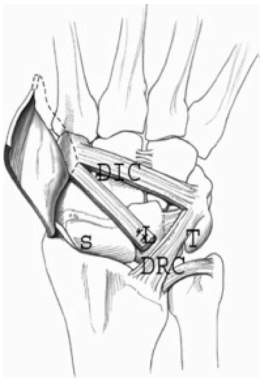


In acute injuries, the SL ligament is typically avulsed from the scaphoid and remains attached to the lunate. When sufficient tissue remains, open repairs are performed with suture anchors or transosseous suture channels.

Dorsal capsulodesis is a critical part of the surgery.
It addresses the sagittal plane deformity by limiting abnormal scaphoid flexion. With this procedure, the dorsal capsule is imbricated to stabilize the rotatory subluxation of the scaphoid. There are 2 techniques for dorsal capsulodesis: the traditional Blatt technique, which resists scaphoid rotation in the sagittal plane by creating a tether from the distal scaphoid to the radius, and the modified dorsal intercarpal (DIC) ligament technique, which instead tethers the scaphoid to the lunate and triquetrum

In the Blatt technique, a strip of the dorsal wrist capsule is left attached to the distal radius and inserted into the scaphoid distal to its axis of rotation to prevent abnormal scaphoid flexion.

Bickert reported excellent or good results in 8 of 12 patients after acute SLIL repairs using Mitek Mini G2 bone anchors. Regarding dorsal capsulodesis outcomes, there is no current evidence to support the use of 1 method over another to augment a direct repair of the SL ligament.



Because SL instability represents a biplanar deformity, long-term results after combined ligament repairs with capsulodesis procedures should be superior to results after using either technique in isolation.

In more challenging subacute and chronic cases of SL diastasis, we have moved to temporarily augmenting the SLIL repair and capsulodesis with an SL screw.

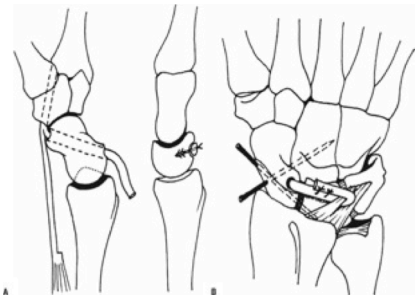
Stage III: reducible SL dissociation without a repairable SLIL

Complete SL + volar or dorsal extrinsic ligament

Classical radiological signs [> 3 mm]

Fluroscopy: grossly +ve

Repair SL ligament + Pinning + capsulodesis + Tri-ligament reconstruction



Brunelli proposed a reconstructive procedure that used a flexor carpi radialis (FCR) tendon graft.

A portion of the FCR is passed through the scaphoid tuberosity and sutured to the remnants of the SLIL on the dorsal aspect of the scaphoid. Next, the remaining portion of the FCR slip is anchored to the dorsal ulnar corner of the distal radius.

This technique was subsequently modified to eliminate the tether to the radius and to reconstruct not only the scaphotrapezial and SL ligaments, but also the dorsal radiotriquetral ligament.

This triligament tenodesis thereby addresses both the intrinsic and extrinsic ligament pathology.

Salva-Coll performed a cadaveric study to assess the role of the FCR as a dynamic scaphoid stabilizer, and determined that FCR contraction provides stability by inducing scaphoid supination and triquetrum pronation. An alternative technique that uses the extensor carpi radialis longus tendon as a graft has recently been described for SL dissociation.

Finally, SL arthrodesis has been attempted in the past, but this procedure has been largely abandoned because of low fusion rates.

The senior author prefers to use triligament tenodesis in this group of prearthritic patients, because it effectively controls abnormal rotation in both planes, increases scaphoid stability to minimize painful clunks, and provides medium-term effective outcomes.

Stage IV: dorsal intercalated segment instability [unreduced], prearthritic

Complete SL + volar or dorsal extrinsic ligament with secondary changes in RL and STT joints

X ray: secondary changes

SL >70; RL >15; CL >15 and SL distance >3 mm

1. Scaphotrapezial trapezoid arthrodesis [Watson]

   Concerns linger over abnormal load transmission to the distal radius and a high rate of complications in some series

2. Scaphocapitate arthrodesis has also been advocated to stabilize the scaphoid, but by spanning the midcarpal joint, this procedure leads to an obligate 50% reduction in wrist motion. 30% Non-union has been reported

3. To prevent degenerative changes between the less mobile scaphoid and the remaining radial styloid after any of the intercarpal arthrodesis.

Stage V: scapholunate advanced collapse wrist

Progressive degenerative changes known as SL advanced collapse (SLAC).

SLAC I Arthritis first develops along the scaphoid facet of the distal radius

SLAC II Along the proximal radioscaphoid joint

SLAC III Within the radial midcarpal joint

SLAC IV Although it was not described in the original report, in this stage may ensue, involving the radiolunate joint.

SLAC I Radial styloidectomy will not alter the progression of the degenerative process, but it may be an acceptable short-to midterm treatment for active SLAC I patients who wish to avoid intercarpal arthrodesis.

SLAC II With preservation of the midcarpal joint, radioscapholunate arthrodesis. This procedure is typically combined with distal scaphoid excision to enhance wrist flexion-extension motion, and anterior and posterior interosseous nerve neurectomies to enhance pain relief.

Proximal row carpectomy (PRC) is an option for patients with a relatively well-preserved midcarpal joint. It is often combined with a limited radial styloidectomy. Osteoarthritis progression is a known complication because of the noncongruent articular surfaces of the capitate and distal radius.

SLAC III 4 corner fusion/ PRC

Extensive degenerative changes at the midcarpal joint, with preservation of the radiolunate joint, are best treated with capitate–lunate–hamate–triquetral (4-corner) arthrodesis. Four-corner arthrodesis can be performed for SLAC I, II, and III disease. Circular plate fixation should be avoided with this technique

SLAC IV

Wrist arthroplasty is a motion-preserving option that is generally reserved for lower-demand patients with advanced disease.

Patients with diffuse degenerative changes with higher activity demands a complete wrist arthrodesis provides predictable pain relief.

Proximal row carpectomy compares favorably with 4-corner fusion in several studies in terms of range of motion and grip strength. A recent systematic review of 52 articles on outcomes for SLAC and scaphoid nonunion advanced collapse patients undergoing PRC or 4-corner fusion confirmed that both procedures lead to similar postoperative improvements in pain, subjective outcome measures, and grip strength. Proximal row carpectomy may result in better range of movement and fewer complications specific to 4-corner fusion, such as nonunion, impingement, and hardware failure. However, PRC is associated with a higher risk of subsequent osteoarthritis, because the articulating surfaces are not congruent, generating abnormal sheer forces during wrist motion.

Current designs for **total wrist arthroplasty** are associated with high failure rates, most often resulting from distal component loosening. Ward and colleagues reported a 50% revision rate in a series of 20 rheumatoid patients treated with the Universal wrist prosthesis after a mean follow-up period of 7.3 years.

We reserve the **PRC** for older, lower-demand patients with stage I to II SLAC disease and intact volar extrinsic ligaments. **Scaphoid excision and 4-corner arthrodesis** or lunocapitate arthrodesis with excision of both the scaphoid and triquetrum may be promising choices for younger, higher-demand patients.

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