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Acute Scapholunate Ligament Injuries: Current Concepts

Ali Izadpanah, MD,* and Sanjeev Kakar, MD†

Scapholunate ligamentous injuries are the most common interosseous carpal injuries within young active individuals, with an incidence up to 54% after distal radius fractures. If left untreated, they can lead to scapholunate ligament advanced collapse. Controversy exists in the management of acute scapholunate ligament injuries. In this article, we review the current concepts in diagnosis, classification, and surgical management of these injuries.
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Types of Carpal Instability

Carpal instability can be classified into 4 major patterns: carpal instability dissociative (CID), carpal instability nondissociative (CIND), carpal instability complex, and carpal instability adaptive.[1] CID occurs when there is injury between the bones of the same carpal row by fracture or ligamentous disruption, such as a scapholunate ligament (SL) injury, in contrast to CIND, which occurs when there is dysfunction between 2 rows such as between the distal radius and proximal carpal row or between carpal rows.[2] When CID and CIND coexist, it is classified as carpal instability complex; an example of which would be a perilunate dislocation.[3] Finally, if the origin of carpal instability lies outside of the carpus (proximal or distal), the pattern of instability is known as carpal instability adaptive, for example, instability secondary to a distal radius malunion.[4]

Tears in the scapholunate interosseous ligament (SLIL) are the most commonly encountered intercarpal ligament injury with an incidence of up to 20% in "sprained" wrists and as high as 21.5%-54% after displaced distal radius fractures. This could lead to a proximal CID collapse pattern. Following the tear, the scaphoid has a tendency to flex around the palmar radioscaphoidcapitate ligament secondary to palmar torque from the scaphotrapezio-trapezoid (STT) articulation. Conversely, the lunate has a tendency to extend secondary to the extension moment transmitted by the triquetrum via the lunotriquetral ligament. As the secondary stabilizers of the scapholunate joint become attenuated, that is, the volar radioscaphocapitate (RSC) ligament, the short radiolunate and long radiolunate (LRL) ligaments, the dorsal intercarpal (DIC), the STT, and the dorsal radiotriquetral ligaments, dorsal intercalated segment instability (DISI) deformity ensues.[5]

Scapholunate instabilities can also be classified as predynamic, dynamic, or static. If the injury causes only partial SLIL tear, it would appear as predynamic instability with normal radiographs, (including stress views) but may have some magnetic resonance imaging (MRI) and arthroscopic evidence of SLIL tear. On the contrary, as the tear progresses, a dynamic (seen on stress views) and eventual static instability (visible on standard unstressed radiographs) can ensue.[1]

Despite being the most common interosseous ligamentous wrist injury, the natural history of SL tears is not clearly understood. Many of these injuries go undetected. Watson studied 4000 wrist radiographs and identified 210 cases of wrist arthritis. The evolution of arthritis in the scapholunate advanced collapse (SLAC) pattern was then proposed by his findings.[6] Arthritis starts at the radial styloid and progresses to include the radioscaphoid articular surface. As the SL interval widens, the head of the capitate migrates proximally into the widened interval, resulting in arthritic changes at the lunocapitate joint[6] (Fig. 1).

O'Meeghan et al[7] evaluated 11 patients with arthroscopic-proven SLIL injuries without any radiographic evidence of SL gapping or secondary osteoarthritis, and noted that in the absence of complete dissociation of the scapholunate, there would not be an eventual widening of the SL interval or DISI deformity within a 7-year follow-up period. Only 1 out of the

*Department of Surgery, University of Montreal, Montréal, Québec, Canada.
†Department of Orthopedic Surgery, Mayo Clinic, Rochester, MN.
Address reprint requests to Sanjeev Kakar, MD, Department of Orthopedic Surgery, Mayo Clinic, 200 First St SW, Rochester, MN 55905. E-mail: Kakar.sanjeev@mayo.edu

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Figure 1 Scapholunate advanced collapse (SLAC) wrist arthritis. There is evidence of scapholunate diastasis with radioscaphoid and midcarpal arthritis, and proximal migration of the capitate.

11 patients developed radiographic arthritis, but all patients developed chronic wrist pain affecting their activities of daily living.[7]

Relevant Anatomy and Biomechanics of Injury

The SLIL is a true intra-articular ligament bathed in synovial fluid with poor intrinsic healing potential.[8] It comprises a dorsal, membranous, and a palmar segment. The dorsal segment is the strongest of the 3 with a yield strength of 260 N and fibers that are transverse and parallel. The fibers of the palmar segment are obliquely oriented with a yield strength of 120 N. The membranous portion has a yield strength of 65 N and is largely made of anisotropic fibrocartilage, blending in with the articular cartilages of the scaphoid and lunate.[9,10] (Fig. 2).

The SL ligament is highly innervated with proprioceptive receptors including Pacini (perceiving acceleration and deceleration) and Ruffini (perceiving joint positioning) receptors that contribute to dynamic joint positioning.[11] The palmar subregion of SLIL contains the greatest amount of neural structures and mechanoreceptors compared to the dorsal subregion, which is predominantly comprised of densely packed collagen fibers with limited innervation.[11]

The motion of the carpus is complex. The proximal row acts as the intercalated segment within the wrist and is devoid of any musculotendinous insertions. Its movement is determined by the complex interactions of the forearm and the distal carpal row. Many of the adjacent carpal ligaments act as critical components in SL stability, in particular, the STT and the RSC ligaments.[12]

Selective sectioning studies by Werner et al[13] have established that the SLIL is the primary stabilizer of this complex, and the secondary stabilizers are responsible for stabilizing the SL at the extremes of motion. In a cadaveric model, increasing rotatory subluxation of the scaphoid led to a progressive decrease of the articular contact surface area (20° scaphoid subluxation caused a 77% reduction in the articular contact).[14]

The most common mechanism of SL injury as originally described by Mayfield et al[15] is a fall on an extended, ulnarly deviated, and supinated wrist. Given the relative strength of the dorsal SL ligament, these tears tend to start palmar and propagate dorsal. This is the basis for progressive SL instability from predynamic to eventual static deformity with a fixed flexed scaphoid and an extended lunate.

History and Physical Examination

Patients may complain of weakness and dorsal radial wrist pain during loading of the extended wrist after a wrist injury. Associated pain may limit their range of motion (ROM) and grip strength affecting different activities of daily living, that is, lifting heavy objects, grocery shopping, or using a screwdriver. Given this, many patients may have to adapt to their lifestyles.[7]

On examination, in an acute injury, there may be swelling, ecchymosis, and pain over the dorsoradial aspect of the wrist. This area can be found just distal to Lister tubercle with the wrist in a partially flexed position. A positive Watson scaphoid shift test (pain over the dorsal scaphoid with radial deviation of the wrist and a dorsally directed force on the scaphoid tuberosity) could indicate a complete or near-complete disruption of the dorsal portion of SLIL. The palpable click during this maneuver test is secondary to the scaphoid shifting in relation to the remaining carpal bones. Frequently, a clunk can be felt when releasing the force as the scaphoid relocates from the dorsal rim of distal radius into the radioscaphoid fossa. This should be compared with the contralateral side. A unilateral Watson shift test is associated with an increased risk of SLIL injury, with positive and negative likelihood ratios of 2.9 and 0.28, respectively.[16,17]

Imaging, Diagnosis, and Classifications

After a detailed history and examination, initial investigation should commence with posteroanterior and lateral plain wrist radiographs. This should be examined for any carpal fracture and increased SL diastasis and angle. Plain radiographs are often normal with dynamic instability. Given this, stress views are advocated as they may demonstrate abnormal widening of this interval. In a cadaveric study by Lee et al investigating different stress views (the "clenched pencil" view, clenched fist views in varying positions, and traction views) (Fig. 3), the "clenched pencil" view was considered the best stress view to demonstrate dynamic SL instability[18] (Fig. 4). It is important to obtain radiographs of the contralateral wrist, as bilateral SL