Carpal Instability of the Wrist

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KEYWORDS

• Carpal tunnel • Wrist • Instability • Ligaments

KEY POINTS

- The dorsal aspect of the scapholunate ligament is the strongest of its 3 subregions.
- The common mechanism of injury to the scapholunate and lunotriquetral ligaments is extension, ulnar deviation, and intercarpal supination.
- Although scapholunate widening on a posteroanterior view of the wrist indicates scapholunate ligament injury, this is not a sensitive finding, and continued complaints of pain and/or instability should warrant further work-up.
- Arthroscopic debridement is an appropriate treatment of partial tears.
- Repair should be attempted for acute tears.
- Reconstruction can be attempted for chronic tears that remain reducible.
- Salvage options can be offered for irreducible injuries or in cases with degenerative changes.

INTRODUCTION

Injuries to the scapholunate and lunotriquetral ligaments can have severe deleterious effects. The scaphoid acts as a connecting rod between the proximal and distal rows.[1] The scaphoid is tethered directly by the scapholunate ligament and indirectly by the lunotriquetral ligament. Disruption of these stabilizing ligaments leads to abnormal mechanics of the carpal joints. Both the quality of reduction and the timing of definitive management affect outcomes following dissociative carpal instability. This article explains the anatomy, biomechanics, mechanism of injury, studies, and treatment algorithms involved in caring for patients with dissociative carpal instability.

ANATOMY

The carpal bones are divided into 2 U-shaped rows: the proximal row containing the scaphoid, lunate, triquetrum, and pisiform; and the distal row, which is composed of the trapezium, trapezoid, capitate, and hamate. Both intrinsic and extrinsic ligaments connect the two rows. These ligaments are generally characterized as either palmar or dorsal and are often described as thickenings of the joint capsule.

Of the intrinsic ligaments of the wrist, the most important for stability are the scapholunate and lunotriquetral interosseous ligaments. The scapholunate ligament is a C-shaped ligament composed of dorsal, central, and palmar subregions. These three subregions attach at their respective articular margins of the scaphoid and lunate.

The dorsal subregion of the scapholunate ligament consists of transversely oriented collagen fibers. This dorsal aspect is the strongest and thickest of the three subregions and provides the greatest contribution to the stability of the scapholunate articulation.[2] The central subregion is thinner than the dorsal component and is obliquely oriented, in contrast with the transverse fibers of the dorsal component. The central subregion is not considered a true ligament but more a fibrocartilaginous structure. It merges with the dorsal aspect of the scapholunate ligament, but is separated from the volar subregion by the volar radioscapholunate ligament

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(ligament of Testut).[2] The volar region of the scapholunate ligament is a thin (often less than 1 mm thick)[2] layer composed of obliquely oriented fibers. These fibers are confluent with the radioscapholunate ligament proximally and are sometimes seen to be interconnected with the radioscaphocapitate ligament distally. A sharp division exists palmarly between the volar region and the long radiolunate ligament. The volar region is thought to function as a ligament, but does not confer as much stability to the scapholunate ligament as does the dorsal region.

Additional stabilizers to the scapholunate joint exist on the palmar and dorsal sides of the wrist. The scaphotrapeziotrapezoid and scaphocapitate ligaments lie on the dorsal aspect and provide resistance against the tendency of the scaphoid to palmar flex. The radioscaphocapitate and short and long radiolunate ligaments lend stability on the palmar side of the wrist.[3]

The lunotriquetral ligament is also composed of 3 subregions, 2 true ligaments on the dorsal and palmar aspects and a fibrocartilaginous central segment, similar to the scapholunate ligament. The relative strengths of the three subregions are opposite to those of the scapholunate ligament, with the volar aspect being the thickest and the greatest contributor to lunotriquetral stability.

The proximal carpal row has no tendinous insertion, and is thus often termed the intercalated segment. Three sets of tendons cross the proximal row: the extrinsic flexors and extensors of the fingers; the flexors and extensors of the wrist; and the abductor pollicis longus and the extensor pollicis brevis, which course around the radial styloid. Movement between the carpal bones is negligible. Because there are no muscular attachments onto the proximal carpal row, the movement of the proximal row carpal bones is determined by their ligamentous attachments and the mechanical forces of the tendons that cross the wrist.[4]

BIOMECHANICS

Because the proximal carpal row has no tendinous insertion, the forces that act on its proximal and distal articular surfaces dictate the forces that act on the intercalated segment. The tendons that cross the proximal row exert a compressive force that is resisted by the connecting-rod action of the scaphoid. Instability of the scaphoid leads to an alteration of the articulation between the proximal and distal rows.

During radial deviation of the normal wrist, the trapezoid and trapezium exert a volarly directed force on the distal pole of the scaphoid. This force causes the scaphoid to flex about its waist; this flexion force is then transmitted to the lunate via the scapholunate ligament and to the trapezium via the lunotriquetral ligament. The proximal row radially deviates as 1 unit.[5]

Ulnar deviation of the normal wrist causes the hamate to project a dorsally directed force on the triquetrum. As the triquetrum is rotated dorsally by the hamate, a competent lunotriquetral ligament imparts an extension moment on the lunate, and indirectly on the scaphoid via the scapholunate ligament. It is through this mechanism that ulnar deviation causes extension of the wrist.[5]

The lunate can be thought of as existing in a balanced suspension between the scaphoid and the triquetrum. The scaphoid has a flexion bias, and through the scapholunate ligament exerts a flexion moment on the lunate. However, the triquetrum has an extension bias, and exerts an extension moment on the lunate through the lunotriquetral ligament. In a balanced proximal carpal row, the lunate remains centered on the distal radius without tilting into flexion or extension. The tendons that cross the wrist exert a compressive force across the carpus through the centrally located capitate at the capitolunate articulation.

In the uninjured wrist, the lunate is held in a tightly coupled balance between the scaphoid and the triquetrum. However, injury to either the scapholunate ligament or the lunotriquetral ligament causes respective extension or flexion of the lunate. With disruption of the scapholunate ligament, a gap opens between the scaphoid and the lunate, into which the capitate eventually collapses. The scaphoid, now free of its tether to the lunate, assumes a position of flexion as the capitate comes to occupy the distal space between the lunate and the scaphoid. The lunate, no longer balanced by the flexion moment from the scaphoid, is rotated into extension by the triquetrum. The lunate angles dorsally, producing the pattern known as dorsal intercalated segment instability (DISI).

Unlike injury to the scapholunate ligament, isolated injury of the lunotriquetral ligament is rarely sufficient to allow the flexion moment of the scaphoid to palmar flex the lunate.[6] However, if the dorsal radiocarpal ligament is also injured, the tethering effect on the dorsum of the lunate is lost and the scaphoid and lunate angle into flexion while the capitate begins to migrate between the lunate and the triquetrum.[1] Thus, injury to both the lunotriquetral and dorsal radiocarpal ligaments leads to volar intercalated segment instability (VISI).

MECHANISM OF INJURY AND CLASSIFICATION

Injury to the scapholunate or lunotriquetral ligaments is most commonly caused by a fall on an