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Scapholunate Instability

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Abstract: Scapholunate instability is the most common carpal instability. The evaluation and treatment of scapholunate instability is controversial and the outcome unpredictable. This article will review the pertinent ligamentous anatomy of the wrist and carpal kinematics. There will be a discussion of the clinical presentation, examination, and diagnostic testing of the patient suspected of having scapholunate instability. The treatment options and indications, including repair and reconstructive and salvage procedures, will be reviewed.

Introduction

The most common carpal instability occurs between the scaphoid and lunate. Scapholunate instability may occur after a traumatic injury or from repetitive use. Patients often complain of weakness and pain of the wrist. The treatment options are multiple and controversial. This article will briefly review the pertinent wrist ligamentous anatomy, carpal kinematics, exam, and diagnostic evaluation for scapholunate instability. Treatment options and their indications will also be discussed.

Anatomy

The ligaments of the wrist can be classified as either intrinsic or extrinsic, depending on their location. The extrinsic ligaments are capsular ligaments that cross the radiocarpal joint, midcarpal joint, or both. The intrinsic ligaments, in contrast, are intracapsular with their origins and insertions on carpal bones [2,4,24].

The dorsal extrinsic ligaments can be seen after incising the extensor retinaculum and retracting the extensor tendons. The dorsal radiocarpal ligament (DRC) originates from the distal radius at Lister's tubercle. Its deep fibers attach to the dorsal horn of the lunate and its superficial component courses to attach to the dorsum of the triquetrum. The dorsal intercarpal ligament (DIC) originates on the triquetrum and courses radially as it fans out to insert on the dorsal ridge of the scaphoid, the trapezium, and the trapezoid. The deep portion of the DIC also augments the scapholunate and lunotriquetral interosseous ligaments. The area radial to the DRC ligament and proximal to the DIC ligament consists of loose capsular tissue. A dorsal approach to the radiocarpal joint is performed with a radial-based flap through this interval, splitting the fibers of the DRC ligament and incising along the proximal aspect of the DIC ligament [2,4] (Fig. 1).

The volar extrinsic ligaments are best viewed from within the radiocarpal joint from dorsal to volar as occurs when performing a wrist arthroscopy. The radioscaphocapitate ligament (RSC) arises from the volar lip of the radius and has several regions of attachment. It inserts on the waist of the lateral scaphoid, the waist of the capitate, and coalesces ulnarly with the ulnocapitate ligament to form the arcuate or deltoid ligament. The long radiolunate (LRL) ligament lies ulnar to the RSC ligament. It arises from the volar lip of the radius and courses across the proximal pole of the scaphoid to attach to the volar lip of the lunate. The sulcus between the RSC and LRL ligaments makes up a portion of the space of Poirier. The radioscapholunate (RSL) ligament, or ligament of Testut, lies in the region of the interfossa ridge of the distal radius. This structure plays less of a role in stabilizing the wrist, but its importance may be related to the vascular and neural structures that lie within the ligament. The short radiolunate (SRL) ligament arises from the radius adjacent to the lunate fossa. It inserts on the volar lip of the lunate, coalescing with the LRL, ulnolunate, and palmar lunotriquetral ligaments. The SRL ligament is believed to

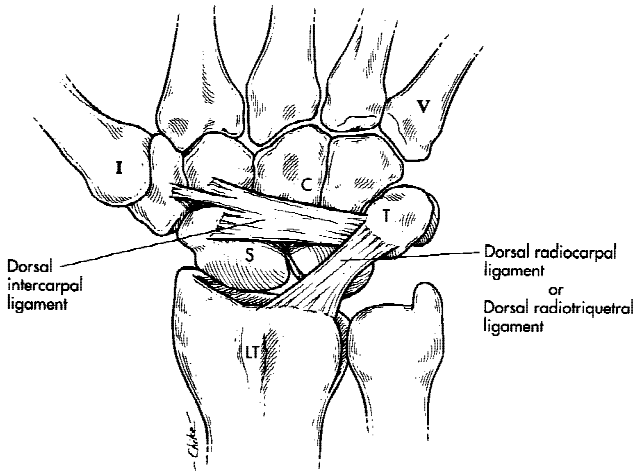

Fig. 1. Diagramatic representation of the ligamentous anatomy of the dorsal wrist. LT, Lister's Tubercle; C, capitate; S, scaphoid; I, first metacarpal; V, fifth metacarpal. (From Berger [4] by permission—Mosby.)

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be one of the more important stabilizers of the lunate as it is the ligament that maintains the position of the lunate adjacent to the radius after a perilunate dislocation [2,4] (Fig. 2).

The interosseous ligament of the scapholunate joint is C-shaped, attaching proximally from volar to dorsal. The portion of the scapholunate joint at the midcarpal space is devoid of an interosseous ligament. The scapholunate (SL) ligament is composed of thick bundles dorsally. It is looser on the volar aspect to accommodate the varying radii of curvature of the two bones. The central portion of the interosseous ligament is relatively thin and termed the intramembranous portion [6,13].

Carpal Kinematics

In general, there are no tendons that attach directly to the carpal bones. Motion of the carpal bones depends on the sum of the forces that cross the carpus. Therefore, the proximal carpal row behaves as an intercalated segment in a three-joint system [24]. The tendons that primarily move the wrist insert on the base of the metacarpals. Muscular contraction of these tendons will cause wrist motion that is initiated at the distal carpal row. Motion of the proximal carpal row is dependent on the tautness of the ligamentous attachments and the compressive forces of the distal carpal row [16,24].

Although there is some motion between the bones of the proximal row, it normally moves synergistically. When the wrist is flexed, the proximal carpal row flexes and radially deviates. With the wrist in extension, the proximal carpal row extends and ulnarly deviates. The proximal carpal row flexes with radial deviation of the wrist and extends with ulnar deviation of the wrist [24].

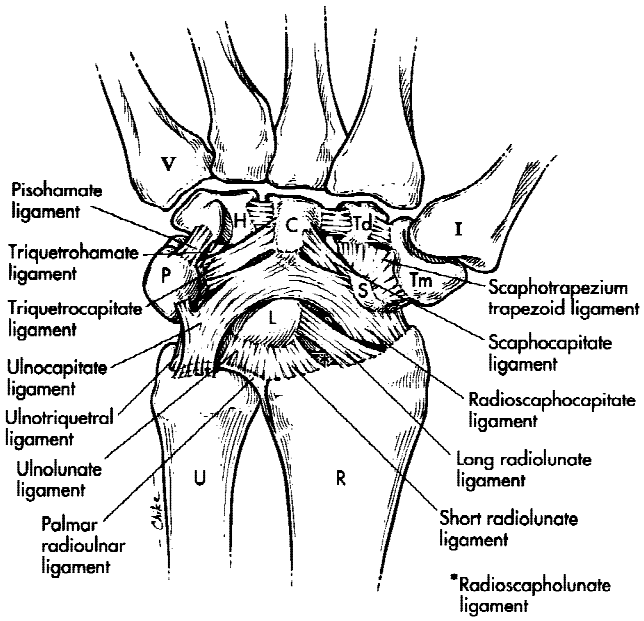

Fig. 2. Diagramatic representation of the ligamentous anatomy of the volar wrist. C, capitate; H, hamate; L, lunate; P, pisiform; R, radius; S, distal pole scaphoid; Td, trapezoid; Tm, trapezium; U, ulna; I, first metacarpal; V, fifth metacarpal. (From Berger [4] by permission—Mosby.)

Scapholunate dissociation is considered carpal instability dissociative (CID) since the instability pattern occurs between carpal bones within the same row. The instability is considered static if the radiographic abnormalities are noted on static x-rays of the wrist. A patient with dynamic instability will have normal static x-rays, but the instability will become apparent on dynamic radiographic evaluation. Dynamic studies include a clenched fist posteroanterior (PA) view or cineradiography [2].

Scapholunate dissociation results from an injury to the scapholunate interosseous ligament as well as to the palmar radiocarpal ligaments. Progressive instability will lead to a dorsal intercalated segment instability (DISI) pattern of the wrist and, ultimately, degenerative arthritis [15,25].

Watson and Ballet [27] have described progressive degenerative changes of the wrist related to chronic scapholunate dissociation. Scapholunate advanced collapse (SLAC) of the wrist initially will present with sharpening of the radial styloid. Later, progressive degenerative changes occur at the radioscaphoid and capitolunate joints. Typically, in a SLAC wrist, the articulation between the lunate and radius is preserved [27].

Examination

Evaluation of the patient with suspected scapholunate instability begins with an accurate history and physical exam. Patients often give a history of an extension injury to the wrist, although repetitive trauma may be associated such as in chronic crutch walking [25]. Weakness and pain about the dorsal radial aspect of the wrist are noted. Tenderness is often elicited in the region of the SL ligament that lies just distal to Lister's tubercle. The scaphoid shift test, described by Watson et al. [26], is a provocative maneuver to elicit scapholunate instability. In this maneuver, the wrist is brought from ulnar to radial deviation while the scaphoid tuberosity is stabilized with the examiner's thumb. A click with associated pain is considered a positive test. The associated click is due to subluxation of the proximal pole of the scaphoid over the dorsal rim of the radius.

Imaging

Further evaluation of scapholunate instability includes routine PA and lateral x-rays of the wrist. Scapholunate instability is associated with a widening of the scapholunate interval of more than 3 mm on the PA view. This has been termed the Terry Thomas sign. A cortical ring sign may also be noted in which the scaphoid tuberosity is seen in profile due to the flexed position of the scaphoid (Fig. 3A). Normally, the proximal carpal row will form a smooth arc on the neutral PA view [2,24,25]. A step-off in the contour of the scapholunate interval may indicate an instability pattern, although Peh and Gilula [21] have reported step-offs occurring in normal wrists with radial or ulnar deviation. In the evaluation of dynamic instability, a PA clenched fist view is

obtained that axially loads the wrist while evaluating for a widening of the scapholunate gap. On the lateral view, the normal scapholunate angle is between 30 and 60 degrees. A scapholunate angle of more than 70 degrees is consistent with a scapholunate dissociation. While the scaphoid is flexed in scapholunate instability, the lunate and triquetrum will lie extended in a DISI pattern [2,15,24,25] (Fig. 3B).

A triple-phase bone scan is helpful in evaluating the patient with nonspecific chronic wrist pain. Abnormalities on bone scan may suggest that further diagnostic evaluation is warranted. The three components of the study include a phase immediately after the injection, which allows assessment of the vascular system; a static or blood pool phase, which shows uptake within the soft tissues; and a delayed

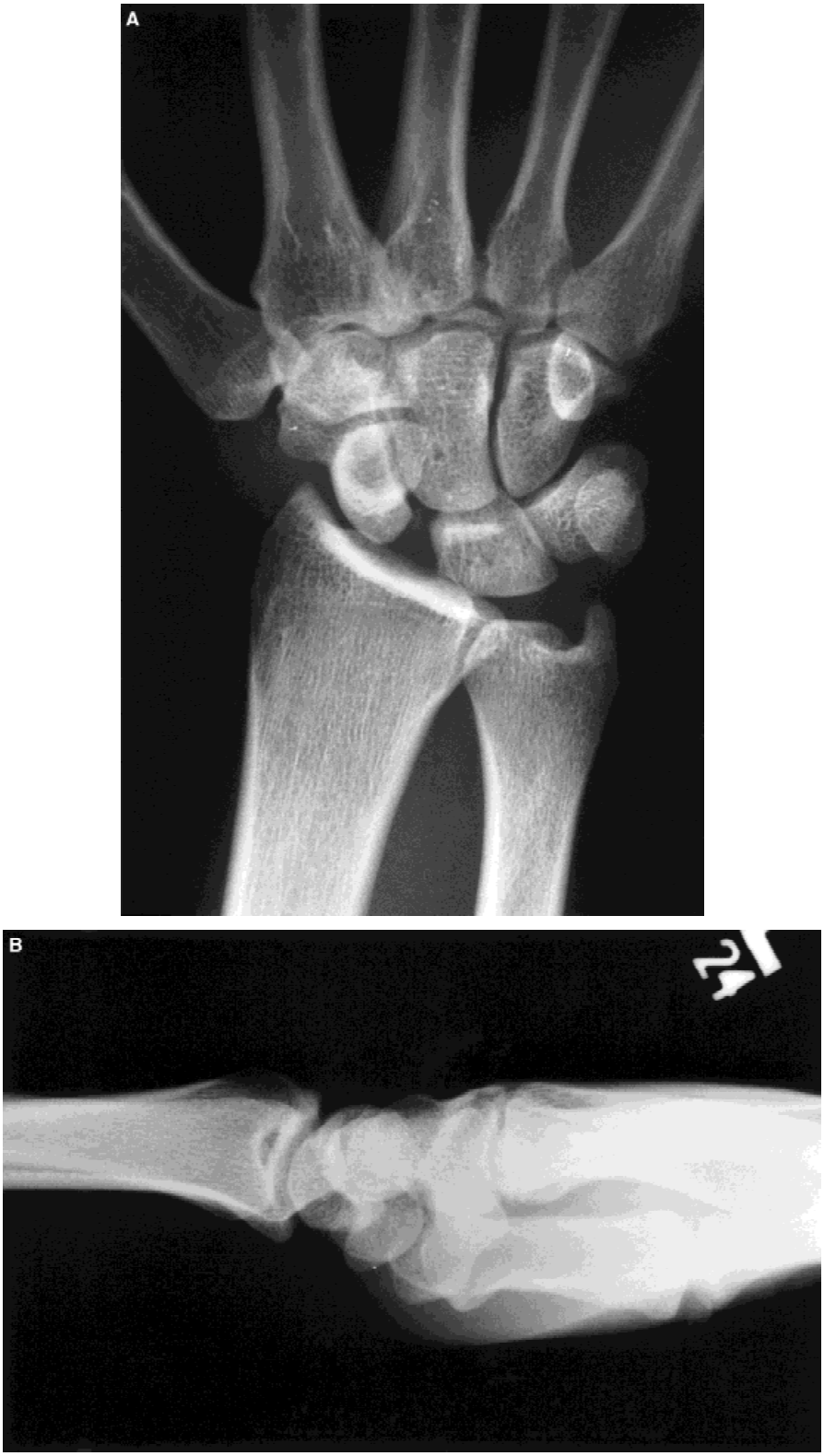

Fig. 3. A: PA radiograph of wrist with scapholunate dissociation. Note the wide scapholunate interval (Terry Thomas sign) and cortical ring sign. **B:** Lateral radiograph of the wrist. Note the DISI collapse pattern.

phase taken two to three hours after injection, which shows accumulation of the radiotracer within bone. Intense focal uptake will occur with occult fractures. Mildly increased focal activity suggests a ligamentous injury although bone scans correlate poorly with partial intrinsic ligament injuries [20].

A wrist arthrogram is used to evaluate the integrity of the SL ligament, LT ligament, and triangular fibrocartilage complex (TFCC). In the normal wrist, there should be no communication between the midcarpal, radiocarpal, and distal radioulnar joints. The SL ligament is found along the proximal aspect of the midcarpal joint, which has no interosseous ligament within it. If the SL ligament is intact, an injection into the midcarpal joint will allow dye to flow to the proximal portion the scapholunate interval but not into the radiocarpal joint [31]. Magnetic resonance imaging (MRI) is also used to evaluate the integrity of the SL ligament. An SL ligament tear is identified as a discontinuous area with increased signal intensity on T2-weighted images [7]. MRI has more recently been used in the evaluation of the extrinsic radiocarpal ligaments [1,3]. A wrist arthrogram and an MRI can determine whether the SL ligament is torn, but these studies cannot differentiate small insignificant perforations from larger tears. Care must be taken in correlating the significance of SL ligament perforations since ligamentous interruptions may often be seen in the unaffected wrist as well. The optimal treatment will depend on correlating the diagnostic studies with the patient's history and physical evaluation, as well as sound judgement [8,10]. Wrist arthroscopy is an invaluable diagnostic tool in the further assessment of the SL ligament. Arthroscopic evaluation allows a determination of the location, size, and extent of the ligamentous injury as well as arthritic change within the wrist [11,12].

Treatment

Treating a patient with symptomatic scapholunate instability depends on multiple factors including chronicity, integrity of the SL ligament, reducibility of the carpus, the presence or absence of wrist arthritis, and other patient-related factors. In general, the surgical procedures in treating scapholunate instability are classified as repair, reconstruction, or salvage procedures. Repair or reconstructive procedures are considered if the carpus is reducible and there are no significant arthritic changes about the wrist. Salvage procedures are considered after a failed ligamentous repair, if the carpus is not reducible, or if arthritic changes have developed [2,15,19,24,25].

Partial SL ligament tears that occur in the intramembranous portion of the ligament typically do not cause progressive instability, but patients may note a painful crepitance of the wrist due to the process. Reasonable results have been reported with arthroscopic debridement of these injuries if care is taken not to injure the important dorsal or volar aspects of the ligament [22]. Arthroscopic pinning of the scapholunate joint has been performed with reasonable results. This procedure is performed by placing multiple Kirshner wires across the scapholunate joint with the reduction confirmed by arthroscopic visualization of the midcarpal joint. The goal is the development of a fibrous union at the scapholunate joint [29].

If the ligament is of adequate integrity, a direct repair of the SL ligament may be considered. The ligament typically tears from the scaphoid and remains attached to the lunate. A trough is made just below the articular surface of the lunate facet of the scaphoid. Drill holes are placed from this trough to the dorsal ridge of the scaphoid. Sutures are passed from the ligament through the bone holes and tied after pinning the joint in a reduced position. This procedure is often combined with a dorsal capsulodesis. If the ligament injury is associated with an osteochondral fragment, the fragment is pinned to the scaphoid [17,25].

If ligament repair is not feasible, reconstructive procedures may be required. Tendon weaves through bone for reconstruction of the SL ligament have been performed in the past and are unreliable [19,24,25]. Recently, bone-ligament-bone autografts have been used, which is similar in concept to procedures performed for anterior cruciate ligament reconstruction. The graft may be obtained from the distal radius using a portion of the extensor retinaculum for the ligament. The foot is an alternative donor site using the dorsal medial portion of the navicular-first cuneiform ligament [13,23].

Indirect soft tissue reconstructive procedures to prevent abnormal flexion of the scaphoid have been shown to improve carpal kinematics [14]. The dorsal capsulodesis described by Blatt [5] uses a proximally based flap of the DRC ligament as a checkrein for the distal pole of the scaphoid. The DRC ligament is incised from the triquetrum and transferred to the distal scaphoid pole. The carpus is pinned in a reduced position and the ligament is sutured to the scaphoid using a button volarly or a bone suture anchor [5,25] (Fig. 4). As an alternative, the DIC ligament may be taken as a flap off the triquetrum and sutured to the distal radius through the dorsal capsule or using a bone suture anchor. A distally based split extensor carpi radialis longus tendon or flexor carpi radialis tendon has also been used for this purpose [9,14]. Satisfactory results have been reported for these procedures, although some loss of wrist flexion should be expected.

Triscaphe arthrodesis is considered if the carpus is not reducible, the ligament is not repairable, and there are no associated degenerative changes about the radiocarpal joint. The scaphoid is fused to the trapezium and trapezoid in 45 degrees of flexion relative to the radius. The more extended the scaphoid is fixed, the greater the loss of radial deviation. Local bone graft from the distal radius may be used and a radial styloidectomy may be combined with the procedure [18,28].

The salvage procedures are classified as motion preserving or motion sacrificing. Two of the most commonly performed motion-preserving procedures are proximal row carpectomy and scaphoid excision with "four-corner" fusion of the lunate, capitate, hamate, and triquetrum. Proximal row carpectomy involves excising the scaphoid, lunate, and tri-

quetrum, thereby allowing the capitate to articulate with the lunate facet of the distal radius. If there are no degenerative changes in the capitolunate interval, proximal row carpectomy tends to be the preferred primary procedure [30]. If degenerative changes are noted at the capitolunate interval, scaphoid excision and four-corner arthrodesis (also called the SLAC procedure) is performed [27].

Full wrist fusion is a motion-sacrificing procedure that is considered the ultimate salvage. This procedure provides a stable wrist with limited discomfort. Plate and screw fixation provides rigid internal fixation that allows limited postoperative immobilization. Wrist fusion may be performed with a local bone graft from the distal radius rather than from the iliac crest graft. Plates specifically designed for wrist arthrodesis decrease the time required for contouring and allow appropriate screw sizing for the radius and metacarpal.

Summary

Scapholunate instability is a significant clinical problem. Care for these injuries requires the consideration of findings on history and physical exam and correlation with the diagnostic studies. The therapeutic options are varied and the optimal treatment depends on chronicity, integrity of the SL ligament, reducibility of the carpus, the presence or absence of wrist arthritis, and other patient-related factors. As our understanding of the altered kinematics improves, so will our treatment modalities.

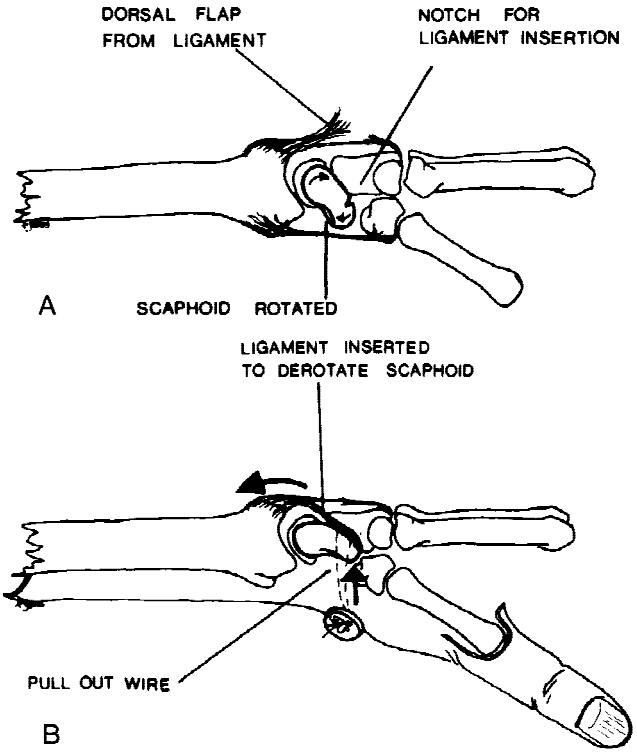

Fig. 4. A: Blatt dorsal capsulodesis with elevation of a flap of dorsal wrist capsule, leaving it attached proximally. **B:** After reduction and pinning of the scapholunate joint, the dorsal capsular flap is sutured to the distal pole of the scaphoid. (Reprinted with permission from Green DP. Carpal dislocation and instabilities. In: Green DP ed. *Operative Hand Surgery.* New York: Churchill-Livingstone, p 889, l995.)

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