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Educational Corner

Scapholunate Ligament Injury: Reviewing the Concept and the Challenges Ahead

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Background

Regarding carpal instability, the most frequent etiology is scapholunate interosseous ligament (SLIL) (1, 2). It happens mostly when the wrist is in extension, supination, and ulnar deviation (3). Due to the difficulty in diagnosing the entity, the exact epidemiology of the injury is not known (4). Also, the injury is commonly misinterpreted as a wrist sprain by patients (2). Forty-three percent of intraarticular (IA) distal radius fractures (5) and 5% of wrist sprains are accompanied with scapholunate (SL) dissociation (2, 6). Therefore, it should be considered as a possible diagnosis in the presence of wrist trauma (1).

If SLIL tear is identified early, it may be repairable (7). However, in chronic SLIL injury, the prognosis is poor (8). There is a wide spectrum of proposed options for chronic SLIL injury aiming at improving the pain and wrist's function and slowing the degenerative process (8). However, none are perfect (2, 8).

In the following, we discuss the concepts and delineate the management of the SLIL injury.

Anatomy and Biomechanics of SL Ligament (SLL)

The C-shaped SLIL is the most important stabilizer of the SL joint. It has dorsal, interosseous, and palmar portions. The dorsal part has the most important role in resisting against distractive, torsional, and translational forces. The palmar portion, apart from its role in stability against rotational forces, has the highest number of mechanoreceptors and sends proprioceptive feedbacks (1, 9).

The SLIL is attached to the dorsal intercarpal ligament (DICL). This junction, which is also called the dorsal capsulo-SL septum (DCSS), has a role in SL stability (10).

The forces applied to the wrist tend to flex the scaphoid and at the same time, they tend to extend the triquetrum. However, due to the SL and lunotriquetral (LT) ligaments, these two opposing forces, neutralize each other.

After SLIL injury, the scaphoid will be forced to flex and the lunate will be forced to extend due to unopposed force applied through the LT ligament (11). However, secondary stabilizers of the scaphoid and lunate like the flexor carpi radialis (FCR), scaphotrapeziotrapezoid (STT), and radioscaphocapitate (RSC) ligaments resist against these deforming forces (1).

When time passes, if the injury is not corrected, the secondary stabilizers may weaken. This leads to an abnormal lunate extension and scaphoid flexion called dorsal intercalated segment instability (DISI). The DISI finally results in wrist degenerative changes named SL advanced collapse (SLAC) (1).

Diagnosis

History and Physical Exam

Symptoms of SLIL injury include low to moderate pain in the dorsoradial side of the patient's wrist and decrease in carpal range of motion (ROM) or grip strength. Grasping an unyielding object may induce pain or an audible clunk or click (3, 11). The patient started to worry and came to clinic after several weeks or months when he realized that his symptoms did not go away.

On examination, tenderness may be found on the wrist (dorsal side), distal to the Lister's tubercle (1), anatomical snuff box, or the scaphoid tubercle (12). The wrist pain may exacerbate with extension of 2nd and 3rd fingers against resistance, while the wrist is partially flexed (resisted finger extension sign) (1). Another important test is scaphoid shift. In this test, also known as Watson shift test, while pressuring the scaphoid tubercle dorsally, the wrist is passively moved from ulnar deviation to radial deviation (Figure 1).

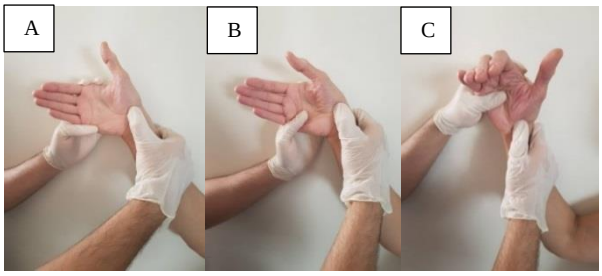

Figure 1. Scaphoid shift test. In this test, while pressing on the scaphoid tubercle, the examiner moves the wrist from ulnar deviation and slight extension (A) to radial deviation and slight flexion (C). Painful clunk during the maneuver makes the scaphoid shift test positive.

Painful clunk during the mentioned maneuver makes the scaphoid shift test positive (2). However, resisted finger extension sign and scaphoid shift test are not specific and they may be positive in other clini cal entities such as dorsal ganglion cyst (1).

Imaging Studies

When history and physical examinations are suggestive of SLIL injury, 5 classic wrist x-ray views [anteroposterior (AP), lateral, pronated oblique, supinated oblique, and scaphoid] should be obtained. The SL gap > 5 mm is diagnostic and SL gap > 3 mm is compatible with SLIL injury (Figures 2 and 3) (3).

Figure 2. Increased scapholunate (SL) gap. SL diastasis known as the Terry-Thomas sign (after the famous English comedian who had a gap between his front teeth) is suggestive of SL interosseous ligament (SLIL) injury. [Adapted with permission from Konopka and Chim Copyright 2018. Orthopedic Research and Reviews (12). (Adapted with permission from Dove Medical Press)]

Radiographic findings suggestive of DISI include the SL angle > 60, abnormal flexion of the scaphoid producing ring appearance in AP view known as "signet ring sign", and triangular shape of lunate (3, 12).

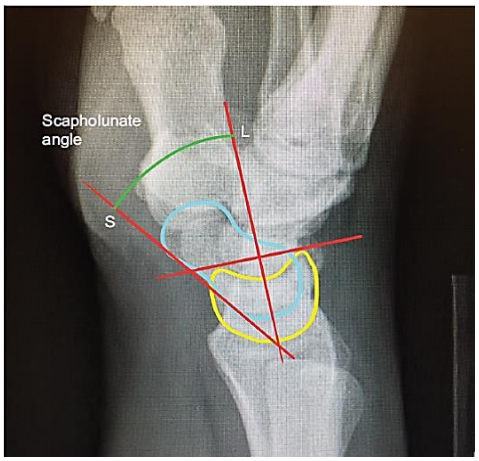

Figure 3. Increased scapholunate (SL) angle in the lateral wrist x-ray. The angle is created between the long axis of the scaphoid and the mid axis of the lunate. SL angle > 60 is suggestive of dorsal intercalated segment instability (DISI). [Adapted with permission from Konopka and Chim Copyright 2018. Orthopedic Research and Reviews (12). (Adapted with permission from Dove Medical Press)]

If the radiographs are negative but there is suspicion of SLIL injury, stress x-ray (e.g., clenched pencil view, clenched fist view, or ulnar deviated stress view) can be taken (13). Recently, a new stress view known as twist stress view was proposed that may have better ability than conventional views in diagnosing dynamic SL instability (14).

Magnetic resonance imaging (MRI) may be helpful in evaluating the extent of SLIL injury. Localized increased signal of SLIL in T2 MRI may suggest SLL injury. However, MRI is reported to have false positive and false negative results (15).

The gold standard diagnostic tool for SLIL injury is arthroscopy (2). When there is a high suspicion of SLIL injury with no related radiologic findings, the patient may be managed conservatively with immobilization for 3 weeks. If the patient's symptoms are not subsided after 3 weeks, in the next step, proceeding with diagnostic arthroscopy may be appropriate (7).

Classification

Based on the findings from imaging and operative findings, Garcia-Elias classified SLIL injury into 6 stages. In stage 1 (predynamic), there is a partial SLIL injury. Plain x-ray is intact. However, in wrist arthroscopy, ligament hemorrhage, inflammation, or partial tear can be detected (16). This group corresponds to the Geissler classification grade 1 to 3 (12).

In stage 2 (dynamic), the SLIL is completely torn but the secondary stabilizers are intact. In this stage, increase in the SL gap (> 3 mm) in the stress wrist x-ray can be recognized. On the other hand, routine wrist x-rays are normal (1).

In the stage 3 (static), the SLIL and some secondary stabilizers of the SL joint are injured and SL diastasis can be noticed even in the plain wrist x-rays (2). Worsening of injury in the SLIL and secondary stabilizers of the SL joint eventually leads to the reducible (stage 4) and irreducible DISI (stage 5). Finally, the carpal degeneration may result in SLAC (stage 6).

Treatment

Treatment is based on Garcia-Elias stage of the SLIL injury (Table 1).

Table 1. Therapeutic options for scapholunate (SL) instability within different stages based on the Garcia-Elias classification

Treatment	Garcia-Elias stage of SL instability					
	1	2	3	4	5	6
Immobilization						
Arthroscopy. Partial debridement/curretage						
Arthroscopy. Pinning ± capsulodesis						
SLIL repair and internal fixation						
Capsulodesis						
SLAF method						
Bone-ligament-bone graft						
Tenodesis						
SLAM						
Local arthrodesis						
PRC						
4CF						
Total carpal arthrodesis						

SL: Scapholunate; SLIL: Scapholunate interosseous ligament injury; SLAF: Scapholunate suture anchor fixation; SLAM: Scapholunate axis method; PRC: Proximal row carpectomy; 4CF: 4-corner fusion

Predynamic (Partial SLIL Injury)

Predynamic acute (less than 3 weeks since injury) cases may be managed with cast immobilization (7) or with arthroscopic pinning for more unstable cases (1, 17). In the chronic cases (≥12 weeks), the injury may be managed arthroscopically with partial debridement or curettage (7) or with open fixation plus capsulodesis (1).

A survey of the members of the American and Canadian societies for surgery of the hand demonstrated that the most commonly used cast for immobilizing patients with SLIL injury was below-elbow cast both in acute and chronic cases (8).

Dynamic (Complete SLIL Tear with Normal Secondary Stabilizers and Normal SL Alignment)

In dynamic cases, the management depends on how the SLIL is injured. In most cases (60%), the ligament is avulsed from either the scaphoid (40%) or lunate (20%). In these cases, the avulsion may be managed with open repair and internal fixation in acute cases (6). In 40% of scenarios, the ligament is teared in the mid-substance and can be repaired and pinned arthroscopically in acute cases (6).

Mathoulin suggested to repair not only the SLL but also the DCSS with arthroscopic sutures. During a mean follow-up of 39.4 months, he demonstrated that the procedure improved the patients' pain, grip strength, and their ROM in all directions significantly (10).

In chronic cases (time since injury ≥3 months) (16), the SLIL injury is mostly unrepairable. Seradge et al. performed their technique of tendon reconstruction in 102 patients with symptomatic dynamic SLIL instability and followed them for an average of 24.4 months. They reported that pain improved by 94% of patients, grip strength increased by 65%, and wrist extension-flexion increased by 9%. However, radial deviation was reported to decline after the surgery by 9% (18).

Kamrani et al. proposed to use anchor sutures between the scaphoid and lunate in order to decrease the SL gap and keep them reduced. This method known as SL suture anchor fixation (SLAF) was demonstrated to improve passive flexion-extension arc from 56 to 136 degrees. It also improved the disabilities of the arm, shoulder and hand (DASH) quick score from 60 to 25. During the mean follow-up duration of 36.6 months, they showed that using the SLAF method, the SL gap and SL angle of participants improved from 5.4 to 3.4 and from 81 to 65 at the end of the follow-up, respectively (19).

Static Injury (Complete SLIL Tear, with Injury in Secondary Stabilizers but Normal SL Alignment)

In this stage, soft tissue reconstruction methods have developed to decrease the SL diastasis and improve symptoms (20). Soft tissue reconstruction involves a spectrum of methods from bone-ligament-bone graft (21) to capsulodesis (12, 22) and tenodesis (12, 23).

In Blatt's technique for capsulodesis, a proximally-based flap is created from dorsal radiocarpal capsule and is inserted to the scaphoid to correct its flexion and decrease the SL gap. However, connecting the scaphoid to the radius results in less than 20-degree decrease in wrist flexion (13). As a modification to Blatt's technique, in Mayo method, insertion of the proximal part of the DICL is split from triquetrum to create a distally-based flap and the flap is then inserted to the lunate in order to augment the SLIL. It is reported that Mayo capsulodesis improves patients' pain and grip strength without significantly decreasing their carpal ROM (22).

As time passes, the SL gap in patients with SLIL injury managed with capsulodesis increases postoperatively and the SL angle also increases (24). Thus, capsulodesis is recommended not to be used alone in SL instability (25). It rather is used as an adjunct to augment the outcome of other management options.

Tenodesis techniques can be performed open or arthroscopically.

Brunelli and Brunelli used a distal-based flap from FCR and passed it through an interosseous tunnel made in the scaphoid to insert the flap on the distal radius (dorsal side). They used this technique to augment both SLIL and scaphotrapezial ligament. However, fixing the scaphoid to the distal radius by the flap decreased the patient's ROM significantly (16).

As a modification to the Brunelli and Brunelli method, Garcia-Elias weaved the FCR flap after passing it through the interosseous tunnel of the scaphoid from the dorsal scaphoid to the dorsal triquetrum and turned it back from the triquetrum to the lunate through a split in the radiotriquetral ligament. Finally, he sutured the flap to itself on the lunate. This technique, known as three-ligament tenodesis augments the scaphotrapezial, SL, and radiotriquetral ligaments simultaneously (26).

Corella et al. proposed a method to use a graft from FCR arthroscopically to augment dorsal part of SLIL (27). More recently, Ho et al. introduced a method to augment both dorsal and palmar SLIL with a free graft arthroscopically (28).

Ligament to tendon grafts are exposed to delayed elongation proportional to the length of tendon used between the fixation points (19, 25).

Pauchard et al. managed 20 patients with SLIL injury with three-ligament tenodesis. Despite improvement in patients' pain and function, they noticed no final improvement in radiologic angular anomalies and showed 6-23 percent of midcarpal or radiocarpal osteoarthritis (OA) after a 25-month follow-up. They suggested that ligamentous loosening might have a role in the occurrence of degenerative changes and recurrence of radiologic abnormalities that they had observed (26).

It is proposed to use short free tendon graft fixed near the SL joint to eliminate further creeping or delayed elongation of the graft. In this method known as SL axis method (SLAM) (26), the tendon graft is placed within the scaphoid and lunate along the SL axis of rotation.

This technique is reminiscent to the reduction and association of the scaphoid and lunate (RASL) method in which a Herbert nail is used to maintain the SL reduction (29). Since the SL axis of rotation is inconsistent during the wrist motion, the screw used in RASL method spins eccentrically and may result in bone erosion around the screw and screw loosening. However, developers of the SLAM procedure claim that using a graft as a tether between the scaphoid and lunate is a biological repair and the graft has a theoretical advantage of not being as rigid as a screw (25).

The SLAM method has been shown to improve radiographic variables more properly than the more classic methods (Garcia-Elias tenodesis and Blatt's capsulodesis) (30). However, the clinical implication of this benefit has yet to be evaluated.

Static Injury with Reducible SL Malalignment

In the presence of malalignment, the SL is tried to be reduced during the surgery using k-wires as a joy stick. If the malalignment can be corrected without bending the k-wires, the malalignment is assumed to be reducible (11, 19).

In cases having reducible DISI malalignment, without ulnar deviation of lunate, three-ligament tenodesis can be used (12). In more advanced reducible DISI with lunate extension and ulnar deviation, the secondary stabilizers are more severely damaged and the spiral anti-pronation tenodesis may be needed (11).

Static Injury with Irreducible SL Malalignment

In the presence of irreducible malalignment, the patient may be managed with local arthrodesis, like radio-SL (RSL) arthrodesis. RSL arthrodesis spares the midcarpal joints. Therefore, dart-throwing movement, that is moving the wrist from radial deviation-extension to ulnar deviation-flexion which is needed in performing many

routine tasks during everyday life (1), can still be performed by the patient postoperatively (6, 12). Many other local arthrodesis techniques either have low rate of union (like SL arthrodesis) (12) or involve midcarpal joints (e.g., STT arthrodesis) (12).

SL advanced collapse (SLAC)

If the SLAC is asymptomatic, no treatment is required. In the presence of symptoms (e.g., pain, decreased ROM or grip strength), nonoperative management including wrist splinting, oral analgesics, and IA steroid injection can be started. Whenever the symptoms persist or worsen despite nonoperative treatment, surgery may be considered (31).

Patient may be managed only with radial styloidectomy if the degeneration is limited to the most radial aspect of the radioscaphoid joint (SLAC, stage 1) (31).

In SLAC stage 2, as the degeneration involves the entire radioscaphoid joint (31), either scaphoidectomy with midcarpal fusion known as 4-corner fusion (4CF) is performed or proximal row carpectomy (PRC) may be planned (12).

Both PRC or 4CF method have similar effect in improving subjective symptoms like pain or grip strength. It is shown that the PRC improves the wrist's ROM, slightly more than the 4CF. Also, nonunion and impingement is only seen in 4CF. On the other hand, OA is more commonly seen after PRC (32).

When the degeneration involves the capitolunate joint (SLAC, stage 3), only 4CF or perhaps PRC plus proximal capitate resurfacing may be used (6). In most severe SLAC cases (stage 4) with degeneration involving radiolunate joint, the only therapeutic option may be total wrist joint fusion (6, 12).

Conclusion

Carpal instability occurs most commonly due to SLL injury. In order not to miss the diagnosis of SLIL injury, the possibility of this diagnosis should always be considered. Future well-designed controlled clinical trials may pave the way to a better management of SLIL injury.

Conflict of Interest

The authors declare no conflict of interest in this study.

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