IFSSH Scientific Committee on Carpal Instability

Part 1: Definition and Investigations

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Introduction

The wrist is a load bearing articulation able to resist both compressive and torsional loads without yielding. For this to happen, there is a need for: 1) a coordinated action of the muscles crossing the joint, 2) smooth and normally tilted joint articular surfaces, and 3) a system of interdependent ligaments. In the presence of muscle imbalance, ligament insufficiency and/or bone deformity several patterns of wrist instability may appear. From this point of view, carpal instability may be described as the inability of the wrist to maintain a normal balance between the articulating surfaces under physiologic loads (dyskinetics) and/or movements (dyskinematics). When the wrist is not able to keep normal articular alignment when subjected to physiologic deforming forces, the wrist is said to be unstable.

Not long ago, carpal instabilities were only identified if the patient was referred to a knowledgeable wrist specialist. Nowadays, the diagnosis is often established in the emergency rooms of our hospitals. Certainly, the general understanding of these complex injuries has improved. Such an increased awareness, however, has not been followed by an increase in the quality of the results obtained. Indeed, the literature concerning the management of carpal instabilities still is rich in misconception justifying surgical techniques that have not yet proved the test of time. We are certainly improving, but we are not definitively there yet.

The natural history of carpal instabilities is still unclear. It is not unusual to find authors defending the notion that all ligament injuries will sooner or later evolve hopelessly into a symptomatic osteoarthritis. Now we know that ligament ruptures do not always generate instability, nor is all wrist osteoarthritis derived from an unstable joint. Furthermore, some malaligned, theoretically unstable wrists are well tolerated, if not completely asymptomatic. E.g. those produced by malunited fractures of the lower end of the radius or the dynamic midcarpal instability in patients with hyperlaxity of their joints. Others, such as scapho-lunate dissociation, may rapidly lead to degenerative arthritis and require early detection and treatment.

Classification

Carpal instability is difficult to classify. Many diverse clinical conditions may result in an unstable wrist for which different classifications have been suggested. Carpal instability has been classified based on seven parameters:

1) **Aetiology** (congenital, developmental, post-traumatic),

2) **Location of the initial injury** (extrinsic, intrinsic ligament, bone),

3) **Characteristics of the original injury** (partial vs. total; repairable vs non-repairable, reducible vs. non-reducible),

4) **Constancy of the radiological findings** (pre-dynamic, dynamic, static),

5) **Location of the predominant dysfunction** (dissociative scapholunate, dissociative luno-triquetral, non-dissociative radiocarpal, non-dissociative midcarpal),

6) **Chronicity of the dysfunction** (acute, sub-acute, chronic),

7) **Direction of the resultant malalignment** (DISI, VISI, ulnar translocation).

Unfortunately, none of these provide a comprehensive enough classification which is able to be used to decide a treatment. Algorithms of treatment based on a combination of the seven parameters have also been proposed. The ideal algorithm must include all possible forms of carpal instability, and be simple enough as to be easily remembered. Although imperfect, the analytical scheme proposed by Larsen and Associates in 1995 (Table 1) and the recently revised algorithm of treatment originally proposed by Garcia-Elias, Lluch and Stanley (2006) fulfil these criteria. Needless to say, there is a need for further refinement in this regards.

Table 1: A summary of classification types for carpal instability is presented below in a tabular form[5]

Category I Chronicity	**Category II Constancy**	**Category III Etiology**	**Category IV Location**	**Category V Direction**	**Category VI Pattern**
Acute < 1 week (Maximum primary healing potential)	Predynamic Dynamic Static reducible	Congenital Traumatic Inflammatory	Radiocarpal Proximal Intercarpal Midcarpal	VISI rotation DISI rotation Ulnar translation	Carpal instability dissociative (CID)
Subacute 1-6 wks (some healing potential)	Static irreducible	Neoplastic Iatrogenic Miscellaneous	Distal intercarpal Carpometacarpal Specific bones	Carpal instability Dorsal translation Other	Carpal instability non-dissociative (CIND)
Chronic >6 wks (little healing potential)					Carpal instability complex (CIC)
					Carpal instability adaptive (CIA)

Scapholunate Dissociation

Introduction

Injuries to the scapholunate ligament and the secondary restraints may lead to different degrees of scapholunate instability. Dependently this may lead to a considerable degree of wrist dysfunction, inability to work and interference with manual activities. If left untreated, it can lead to wrist osteoarthritis. Impairment of the scapholunate interosseous ligament (SLIL) in association with injury to the extrinsic ligaments is known to lead to rotatory subluxation of the scaphoid, dorsal intercalated segment instability (DISI) and finally scapholunate advanced collapse (SLAC).[7]

Anatomy

The SL ligament consists of three distinct structures: the two SL ligaments (palmar and dorsal) and the proximal fibrocartilaginous membrane.[8]

The **dorsal** SL ligament is located in the depth of the dorsal capsule and connects the dorsal aspects of the scaphoid and lunate bones. It is formed by thick and stout collection of fibers, slightly obliquely oriented, with a key role in SL stability. 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 is histologically a fibrocartilaginous structure, and in isolation, contributes little to the restraint of the normal motion of the SL joint[9]. However, recent publications have also highlighted the major role of the secondary restraints, the dorsal intercarpal and radiocarpal ligaments in maintaining scapholunate stability.

In a study by Elsaidi et al[10]; the authors found that after sequential sectioning of volar ligaments and the scapholunate interosseous ligament, no scapholunate diastasis or excessive scaphoid flexion occurred. After dividing the dorsal intercarpal ligament, scapholunate instability occurred without carpal collapse. With detaching the dorsal radiocarpal ligament from the lunate, a dorsal intercalated scapholunate instability deformity ensued.

More recently, van Overstraeten et al[11] described an attachment between the dorsal wrist capsule, the dorsal part of the scapholunate interosseous ligament (SLIOL) and the dorsal intercarpal ligament (DIC) which they termed the Dorsal Capsulo-ligamentous Scapholunate Septum (DCSS). (Figure 1)

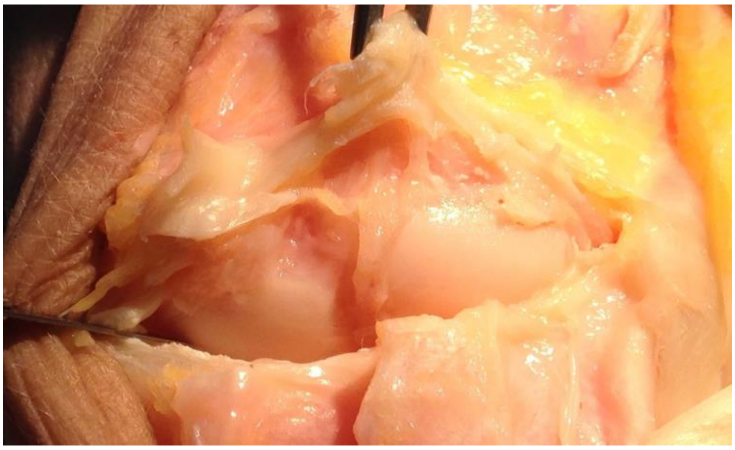

Figure 1 *The Dorsal Capsulo-ligamentous Scapholunate Septum (DCSS) is thought to be an important stabilizer of the SL joint, which may have therapeutic and prognostic implications.*

There are other factors that also determine carpal kinematics. For example ligamentous laxity and carpal morphology affect carpal kinematics.[12] The lunate morphology determines the kinematics of the normal scaphoid, and the abnormal scaphoid.[13-15] Viegas et al[41] classified lunate morphology as either type 1 or 2, according to the number of facets (one or two, respectively) present on the midcarpal surface of the bone. Lunate type is associated with carpal pathology. Type1 lunate wrists have a higher incidence of Dorsal Intercalated Segment Instability deformity in the setting of scaphoid non union[14], and type 2 lunate wrists are associated with proximal hamate [41] and scapho-trapezial-trapezoidal joint[42] degeneration. Lunate morphology is associated with differences in the ligamentous anatomy[43] and the kinematics of the carpus, particularly in the central carpal column (radius-lunate-capitate) [13, 15] (Figure 2) [47].

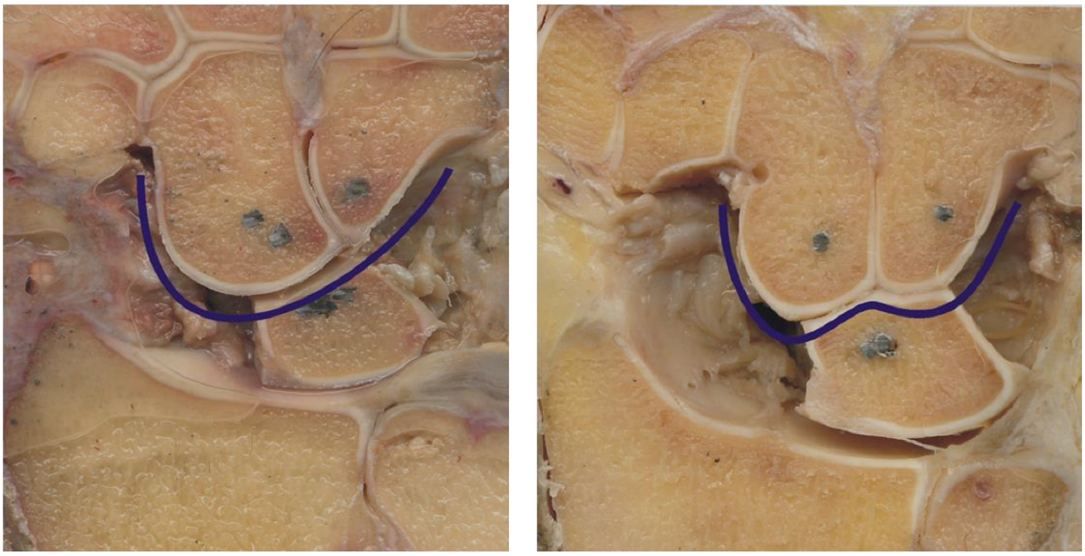

Figure 2 *Type 1 and type 2 lunate shown in these cadaveric wrists. The type 1 has a single distal facet to articulate with the capitate. The type 2 lunate has 2 distal facets that tend to lock the midcarpal joint. (Used with permission from Fogg)* [47]

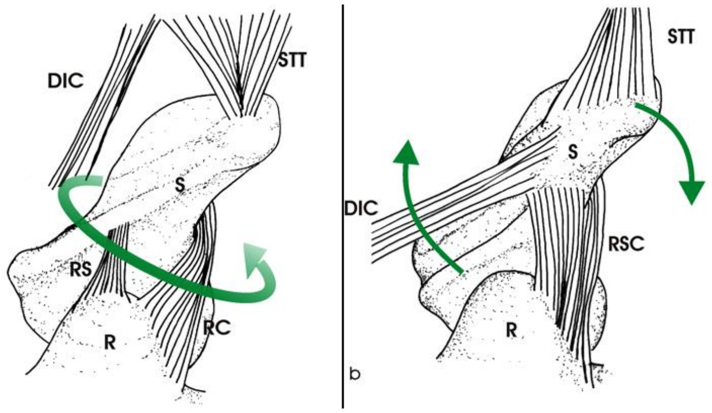

Figure 3
Scaphoid rotation and flexion

There are anatomic differences in the ligament attachments of the scaphoid. The ligament attachments may predispose to rotation or flexion of the scaphoid. (Figure 3 - used with permission from Quentin Fogg) [47]

The majority of wrist flexion and extension motion occurs at the three radio-carpal articulations of a type 2 lunate wrist, with the midcarpal articulations being comparatively restricted. In contrast, type 1 lunate wrists have greater motion at the luno-capitate joint and less at the radio-lunate joint during the same wrist movement [15] (Figure 4).

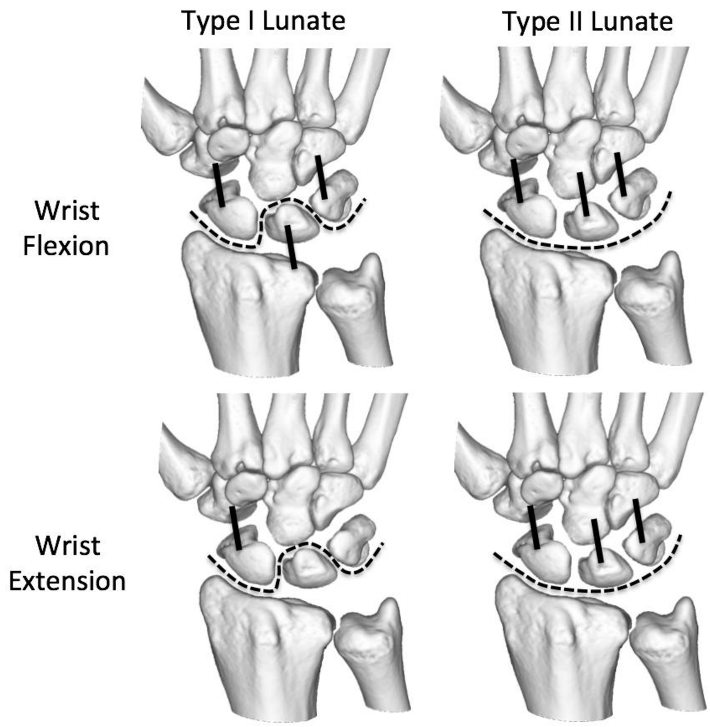

Figure 4 *The wrist type determines the dominant and restricted articulations. In the type 1 wrists, the dominant articulation alternates between the radiocarpal and midcarpal joints. In type 2 wrists, all the midcarpal articulations are restricted and all the radiocarpal articulations are dominant. (In plane motion with wrist flexion (15°) and extension (15°). Dashed line = Dominant articulation (≥50%). Solid bar = restricted articulation (<4°). (Copyright G.I. Bain. Used with permission).*

Pathoanatomy

The mechanism of injury is usually a fall onto an outstretched hand. With the wrist in extension there is a risk of sustaining an injury to the scapholunate ligament, or alternatively a fracture of the scaphoid or distal radius can occur. The scapholunate ligament injury can be part of a perilunate injury [58], or part of a carpal dislocation (Figure 5).

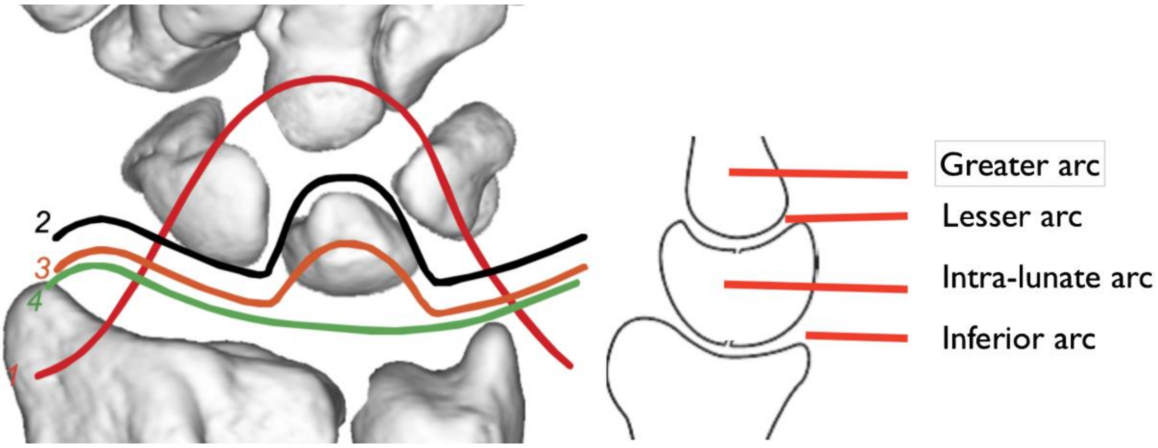

Figure 5 *Dislocation classification, the spectrum of radiocarpal dislocations that can occur. These include the greater arc (1), lesser arc (2), intra-lunate arc (3) and the inferior arc (4).* [57]

History and Physical Examination

The history reported by the patient with scapholunate dissociation usually includes weakness and pain with strenuous activities.[7] Physical findings usually include swelling in the radial snuffbox or tenderness over the scapholunate interval just distal to Lister's tubercle, pain at the extremes of wrist extension and especially radial deviation, and a positive ballottement test (dorsal volar stress manipulation of the scapholunate interval). Subluxation of the proximal pole of the scaphoid associated with a clunk during dynamic wrist loading (the Watson scaphoid shift test) frequently is present on dynamic testing.[16] 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 manoeuvre, but in scaphoid instability the manoeuvre 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." Patients with an appropriate history and a positive scaphoid shift test should be considered as having a suspected SLIL disruption and should be evaluated further with appropriate imaging or arthroscopy.

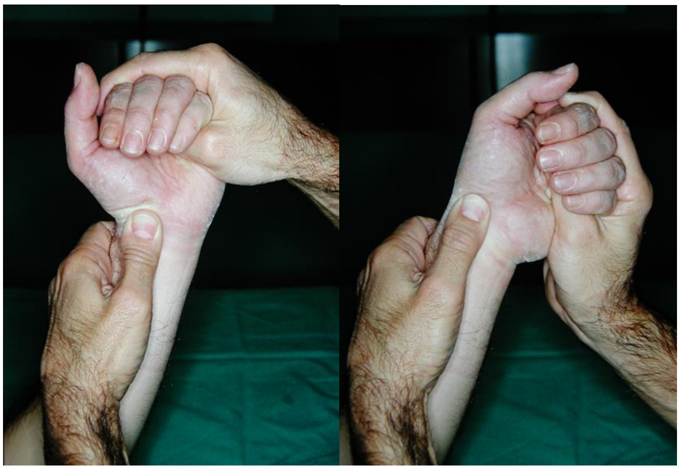

Figure 6 *Watsons test: The examiner's thumb applies pressure to the scaphoid tubercle as the patient's wrist is brought from a position of ulnar deviation and slight extension to radial deviation and slight flexion. Assess for pain and click or clunk, due to reduction of dorsal scaphoid subluxation.*

Imaging

Assessment of the unstable wrist includes plain radiology in all cases, and advanced imaging is often required to determine staging and as part of pre-operative planning.

Plain Radiographs

A complete radiographic assessment with six views of the wrist (postero-anterior, lateral, radial deviation, ulnar deviation, flexion, and extension) is performed. In a patient with scapholunate dissociation, standard PA view (neutral radioulnar deviation) shows an increased scapholunate gap (≥ 3 mm compared with the opposite wrist), and the cortical ring sign of the flexed scaphoid. Lateral radiographs best show scaphoid flexion and lunate extension relative to the radius. SL dissociation should be suspected if the scapholunate angle is greater than the normal 45^{o} to 60^{o} (DISI pattern) (Figure 7). Plain radiographs can be used to identify associated injuries, including the degeneration, which usually begins at the radial styloid, and later can involve the midcarpal joint (Figure 8).

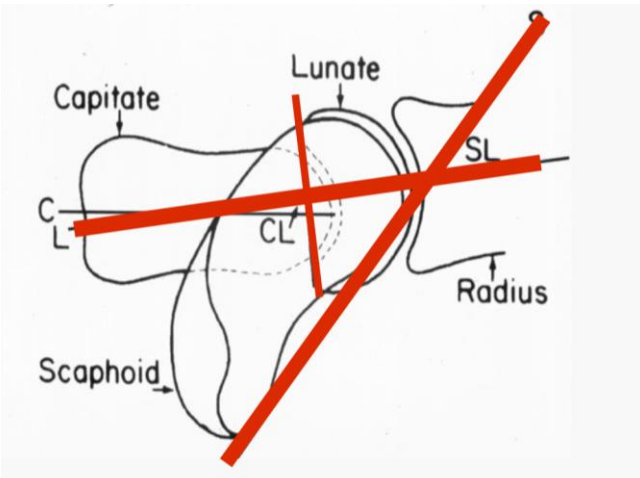

Figure 7 *SLA The scapholunate angle: Identify the volar and dorsal distal cusps of the lunate. Draw a line joining these 2 points, which is the alignment of the lunate. The scapholunate angle is the angle between a line drawn perpendicular to the alignment of the lunate and the line along the volar aspect of the scaphoid. Normal is* 30^{o} *–* 60^{0}*. Mean is* 47^{o}*.*

Figure 8 *The plain radiographs demonstrate the natural progression of SLAC wrist with degeneration at the radial styloid, then the midcarpal joint.*

Cineradiography

Even in static SLD, in which the diagnosis can be made on standard radiographs, obtaining further information using cineradiography is useful. Cineradiography shows not only abnormal movement between the scaphoid and lunate, but also substantial changes in the movement of the midcarpal joint. The hamate-triquetrum relationship normally changes from full engagement in ulnar deviation to complete disengagement in radial deviation; in SLD patients with DISI, this joint remains permanently engaged.

Arthrogram

Contrast is sequentially injected in the midcarpal and radiocarpal joints and scans obtained after each injection. These may be useful in further defining partial tears of the scapholunate ligaments, and in discovering other local problems, such as osteochondral defects or capsular ligament ruptures.[17] When interpreting these scans, care must be taken not to confuse degenerative perforations, or anatomic variants of the scapholunate membrane with true ligament ruptures (Figure 9) [41, 54]. However, there are several limitations to arthrography, and its use has diminished substantially in favor of arthroscopy.

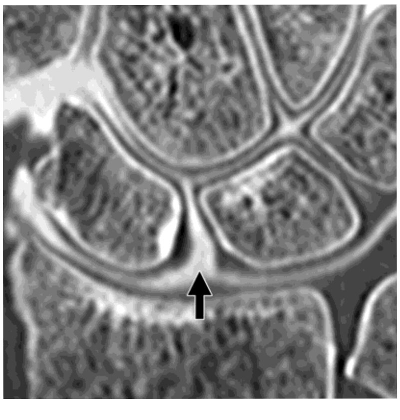

Figure 9 *CT arthrogram of wrist with contrast within the SL interval.*

MRI

MRI provides an assessment of the scapholunate ligament integrity, identification of diastasis and chondral changes. The resolution of the scan can make assessment of partial or complete tears unreliable, but improved resolution is certainly much better than previously.[18, 19] With the MRI the ligament can assessed, and also the degeneration over the radial styloid (Figure 10).

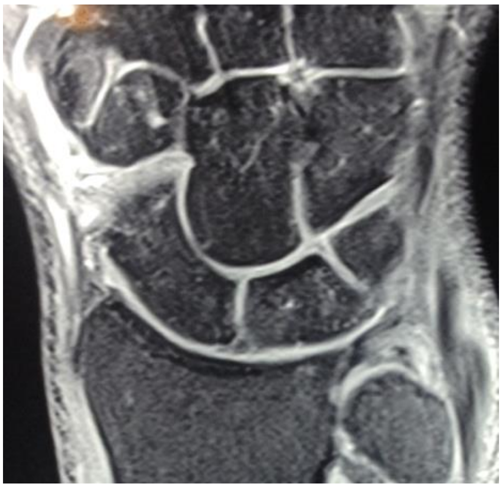

Figure10 *MRI of the wrist, demonstrating the SL ligament, and adjacent carpus.*

Arthroscopy

Wrist arthroscopy is regarded by many authors as the gold standard technique in the diagnosis of intracarpal derangements.[18-23] Three-compartment arthrography will identify perforations of the intercarpal ligaments, but it does not provide accurate localization of the tears or the extent of instability. Arthroscopy has the advantage of direct visualization of the ligaments (Figure 11), and is the most accurate technique for describing the degree of injury of the interosseous ligament, the cartilage, to distinguish fresh from chronic lesions and to analyse concomitant injuries to other structures.[24]

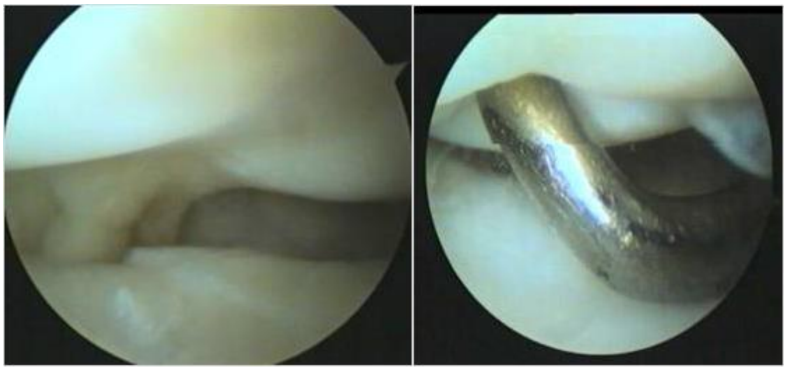

Figure 11 *Normal scapholunate ligament scope (a) Normal scapholunate ligament in the radiocarpal joint, with the ligament of Testut in the background. (b) The probe can be used to palpate the ligament and ensure a concealed tear is not missed.*

The state of the ligament, the extent of the ligament injury, and whether it is a repairable ligament stump can be assessed directly. Associated haemorrhage, synovitis, chondral damage, and degenerative changes (e.g. radial styloid degenerative osteoarthritis) can also be visualized.

When infiltration into the midcarpal joint is being performed, a leakage of saline solution through the radiocarpal portals indicates that there must be a tear of the lunotriquetral ligament or scapholunate ligament. This is the same concept as that seen with an arthrogram where the midcarpal joint is injected and a leakage of contrast is seen in the radiocarpal joint on follow-up radiographs.[24]

From the midcarpal joint, the degree of laxity between the scapholunate interval can be assessed. Geissler et al. described a classification for assessment of scapholunate instability. The functional significance of the ligament injury can be assessed as well – that is, the presence of a tear with or without associated significant instability (as identified in the midcarpal joint). Under the same anaesthetic, a fluoroscopic assessment of the wrist can be performed. If this is performed before draping, then the opposite wrist can be used for comparison. This examination should include placing the wrist in a neutral position, moving to full ulnar deviation, applying an axial load, and also applying traction across the wrist to determine whether there is abnormal distal translation of the scaphoid.[24]

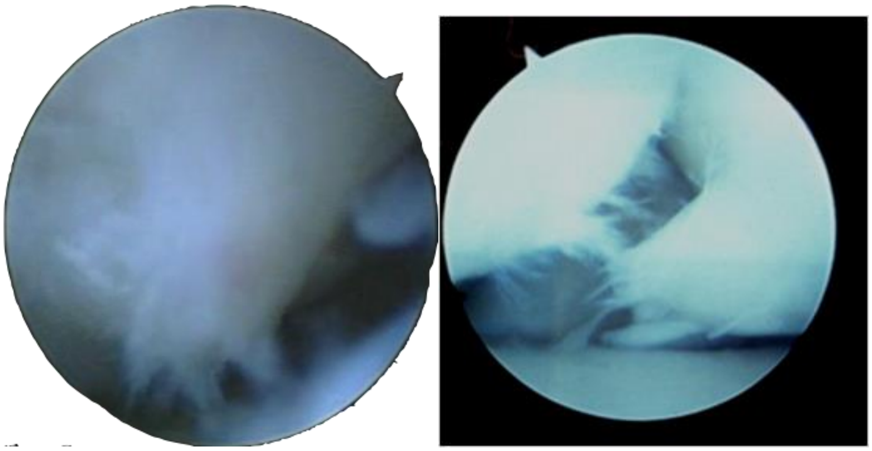

Figure 12 *Scapholunate ligament tear (a) Tear of the ligament seen from the radiocarpal joint. (b) Diastasis of the scapholunate interval interval, when the Watson's test is performed under arthroscopic vision[24].*

The scapholunate instability test of Watson et al. can be performed under fluoroscopy or arthroscopic vision (or both) (Figure 12) [24]. Abnormal widening of the scapholunate interval and subluxation or dislocation of the scaphoid over the dorsal rim of the distal radius can be identified.

Lunotriquetral instability can also be assessed by use of the same arthroscopic assessment techniques and specific provocation tests. Pressure is placed directly onto the pisiform and on the dorsal aspect of the lunate. By squeezing the lunate volarly and the triquetrum dorsally, lunotriquetral instability is identified.[24] The wrist is taken through radial and ulnar deviation with direct visualization of the lunotriquetral articulation.

Arthroscopic Classification

Because arthroscopy of the wrist is one of the most accurate means of evaluation of scapholunate instability, the classifications deduced from these findings are widely used. Geissler has proposed a method of quantifying the degree of interosseous ligament injury (Table 2), by probe placement into the scapholunate interval from the radiocarpal and midcarpal joint on wrist arthroscopy. (Figure 13). If the scope can be advanced from the radiocarpal to the midcarpal joint, it is classified as a grade 4 injury (Figure 14).

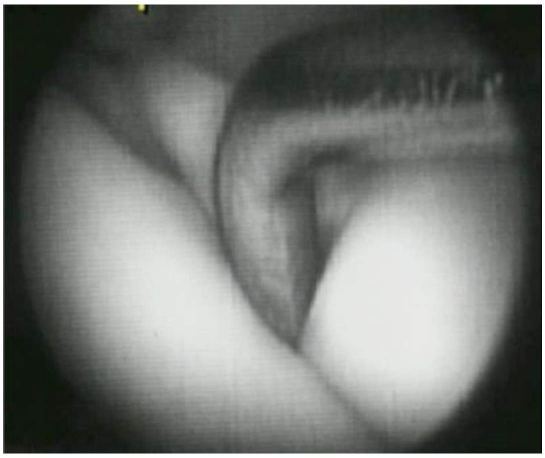

Figure 13 *Probe in the scapholunate interval in the midcaral joint. It is normal for the probe to not be able to be admitted into the interval.*

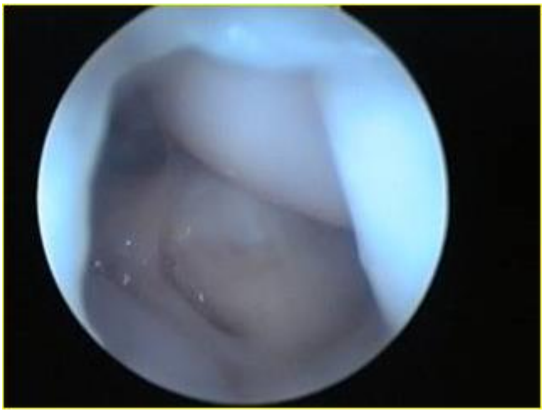

Figure 14 *Grade 4 tear, with the capitate seen in the interval between the scaphoid (left) and lunate (right).*

Table 2: Geissler Arthroscopic Grading System [25]

Grade	Description
I	Attenuation/haemorrhage of SLIL (viewed from radiocarpal space). No midcarpal malalignment
II	Attenuation/haemorrhage of SLIL (viewed from radiocarpal space) AND step off / incongruency of carpal alignment. Slight gap between carpals (less than width of probe)
III	Step off / incongruency of carpal alignment (viewed from both radiocarpal and midcarpal space) AND SL gap large enough to pass probe between carpals
IV	Step off / incongruency of carpal alignment (viewed from both radiocarpal and midcarpal space), gross instability, AND 2.7- mm arthroscope can pass through the gap between the scaphoid and lunate (positive “drive-through sign”)

Recently, the European Wrist Arthroscopy Society (EWAS) classification for SL dissociation was introduced. This is a more comprehensive classification that includes the site of the scapholunate ligament attenuation or tear.[26]

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