The EWAS Classification of Scapholunate Tears: An Anatomical Arthroscopic Study

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Abstract

Treatment of scapho-lunate (SL) injuries is still a challenge for the surgeon, especially in chronic cases. The aim of the study is to experimentally cut, specific portions of scapholunate ligament and extrinsic ligaments and check their corresponding arthroscopic finding in order to understand the pathogenesis and develop a new classification system which is an evolution of the present arthroscopic classifications.

Materials and Methods Thirteen cadaver wrists were studied under arthroscopy. Different portions of the scapho-lunate ligament were subsequently sectioned. In group A the sectioning sequence was: anterior SLIOL, RSC, LRL, SLIOL's proximal and posterior, DIC, DRC ligament and ST ligaments (8 cases). In group B it was: SLIOL's posterior and proximal, DIC, SLIOL's anterior, LRL, RSCL, DRC, ST ligaments (5 cases). The anatomo-pathological findings after each sectioning were correlated to the classification system proposed (Table 1).

Results In group A, stage 3A was obtained when SL ligament's volar and intermediate portion and/ or SC/LRL ligaments were sectioned. A stage 3C was obtained when section of posterior SLIOL was sectioned as well. A stage IV when the DIC was also sectioned. In group B a stage 3B was obtained by cutting intermediate, posterior portion of the SLIOL ligament and DIC. A stage 3C was obtained when the anterior part of the SLIOL was also sectioned. In all cases, sectioning of the SLIOL lead to a stage 3C only if associated with sectioning of at least one of the extrinsic stabilizers (DIC or SC/LRL). Sectioning of DIC and SC ligament, in addition to SLIOL led to an arthroscopic stage IV. When ST, DRC and TH ligaments were also sectioned significant radiological signs appeared (stage V).

Conclusions This study helps us to understand the anatomo-pathological scapho-lunate lesions in their different stages of partial lesions. Commonly called scapho-lunate lesions are complex, involving also extrinsic ligaments.

Scapholunate interosseous ligament (SLIOL) tears, according to the studies of Mayfield, develop in a predictable pattern after a trauma in extension, ulnar deviation, or intercarpal supination. The volar part of the scapholunate ligament is involved first, then the whole SLIOL, then the extrinsic ligaments such as the radioscaphocapitate (RSC) ligament and the radiotriquetral (RT) ligament with a variable degree of ligament damage.¹ They occur mainly in young patients of working age, who may

develop wrist instability, which can eventually lead to degenerative arthritis and a scapholunate advanced collapse (SLAC) wrist.^{2,3} Once arthritis has developed, the treatment of these lesions is not simple and generally requires salvage procedures with a significant loss of wrist function. Treatment of a chronic scapholunate ligament tear is still a challenge for the surgeon, even before wrist arthritis has developed, since it is not always possible to regain complete wrist strength, motion, and

stability.^{4,5} Early identification and treatment of scapholunate tears is thus advisable as well as useful in understanding their anatomopathological development.

The development of wrist arthroscopy has greatly helped in the identification of intracarpal ligament lesions and allowed for their early identification.^{6–8} In 1993, Dautel described a method for identifying occult scapholunate ligament injuries, not visible radiographically, by probing the scapholunate joint arthroscopically through the midcarpal joint. Geissler, in 1995, published a four-stage arthroscopic classification system of scapholunate ligament instability in patients with a distal radius fracture; this is widely used today.⁶ Dreant published a similar classification based on a mid-carpal instability test.⁹ Lindau described measuring the scapholunate gap arthroscopically using the arthroscopic probe.¹⁰

The existing classifications, however, describe the dynamic instability of the scapholunate joint but do not distinguish the site of ligament attenuation or tear per se, particularly in its volar portion. Some authors have identified isolated tears of the volar SLIOL and tears of the extrinsic lesions which have led to the development of open and arthroscopic repair methods.^{11–15} Moreover, many anatomical studies on cadaver specimens to establish the SLIOL's and extrinsic ligament's role in wrist stability have been performed by open approach,^{16–22} but only one has been done by arthroscopy.²³ This prompted us to develop for the European Wrist Arthroscopy Society (EWAS) a more comprehensive classification that includes the site of the scapholunate ligament attenuation or tear.^{24,25}

The purpose of this study was to selectively section the different portions of the SLIOL, followed by the volar and dorsal extrinsic ligaments, and then describe the subsequent arthroscopic findings.^{24,25}

Materials and Methods

Twenty fresh frozen cadaver wrists from ten cadaver specimens, with a mean age 73 (age range 52–85), which included 10 females and 10 males were examined arthroscopically to confirm the absence of associated lesions, such as peripheral triangular fibrocartilage complex tears, lunotriquetral ligament tears, or other ligament lesions. The wrists were subjected to 5 kg of distraction using a shoulder traction device. The SLIOL was observed from the radiocarpal joint through the 3–4 and 6R portals. An instability test was performed using a 3-mm hook probe from the midcarpal radial (MCR) and midcarpal ulnar (MCU) portals. This test is performed by twisting the probe between the scaphoid and the lunate to see whether a dynamic gap is present at the SL joint and where it is located (volar, dorsal, or of the whole joint). Before sectioning the ligaments, an arthroscopic hook test was performed to evaluate the integrity of the radioscapohcapitate (RSC), volar scaphotrapezial ligament (ST), and long radiolunate (LRL) ligaments.²⁶ The dorsal radiocarpal (DRC) and dorsal intercarpal (DIC) ligaments were assessed through arthroscopic portals with a hook extra-articularly.²⁶ The DRC is in fact palpable by sliding the probe along the proximal surface of the triquetrum while hooking the dorsal insertion of the ligament on the triquetrum; it is easier to check it after shaving the dorsal synovium. The DIC

is palpated by sliding the probe from volar to dorsal on the distal surface of the proximal third of the scaphoid. By withdrawing the scope almost extra-articularly, it is possible to visualize the dorsal edge of the scaphoid directly, where the probe can hook the DIC for testing. The DIC is typically the most difficult to be tested by classic midcarpal portals and may sometimes require a specific additional portal MC1–3.²⁶

Specimens that presented with associated SLIOL lesions or extrinsic ligament lesions were excluded from the study. Thirteen wrists were then available for the study. These specimens were imaged using a fluoroscope (Fluoroscanner InSight PXS, Hologic, Bedford, MA) in standard anteroposterior (AP), lateral, and dynamic views in forced radial and ulnar deviation before sectioning, and no radiographic abnormalities or distal radius or carpal bone deformities were found present. The X-ray images were repeated after each ligament sectioning.

The following portals were used: 3–4, 6R, 6U, MCR, MCU, and scaphotrapezotrapezoidal (STT). A 1.9- or 2.7-mm, 30°, small-joint arthroscope was used. A curved 4-mm arthroscopic blade or a no. 11 blade was used for the ligament sectioning. The SLIOL ligament was sectioned under arthroscopic control as follows: in group A, from volar to dorsal (8 cases); in group B, from dorsal to volar (5 cases). In the first two cases, after sectioning of the volar portion of the SLIOL, an open volar dissection of the cadaver wrists was performed to ascertain the complete sectioning of the volar portion (the ligament was observed under magnification with loupes). After verifying this we were able to section the volar SLIOL through the standard dorsal portals as reported by other authors.²³

In group A the sequence of sectioning was performed as follows: volar part of SLIOL, RSC, LRL, membranous and posterior part of the SLIOL, DIC, DRC ligament, ST volar ligament. In fact the DIC and DRC cannot be directly visualized but the DRCL insertion on triquetrum can be hooked and the tension of the ligament can be tested in order to understand if it is tensed or relaxed (damaged). In the same way the DIC can be tested, hooking it from the dorsal surface of proximal scaphoid from MCR.

In group B the sequence of sectioning was performed as follows: posterior part of the SLIOL, membranous part of the SLIOL, DIC, volar part of SLIOL, LRL, RSC, DRC, ST ligament.

After each sectioning the SL lesion/laxity was then classified (► **Table 1**).

After sectioning of each portion of the SLIOL and of the other ligaments, an arthroscopic and fluoroscopic assessment was performed using a fluoroscope as described above. Each radiograph was analyzed by two authors (JM, LVO), and the following measurements were recorded:

1. Congruity of Gilula's lines
2. Maximum SL gap on static and dynamic X-rays
3. SL angle on the lateral view
4. Radiolunate angle

Group A

Due to artifact, the membranous portion of the SL ligament is generally very soft (even in the absence of instability) in cadaver specimens; therefore, we classified this finding as a starting point, stage II in the classification system (► **Fig. 1**). The SLIOL was nevertheless in continuity and stable in its

Table 1 Arthroscopic EWAS (European Wrist Arthroscopy Society) Classification and corresponding anatomic-pathological (AP) findings in cadaver specimens

Arthroscopic stage (EWAS)	Arthroscopic testing of SLIOL from MC joint	AP findings
I	No passage of the probe	Not found in these cadaver specimens
II lesion of membranous SLIOL	Passage of the tip of the probe in the SL space without widening (stable)	Lesion of proximal/membranous part of SLIOL
III A partial lesion involving the volar SLIOL	Volar widening on dynamic testing from MC joint (anterior laxity)	Lesion of anterior and proximal part of SLIOL with or without lesion of RSC- LRL
III B partial lesion involving the dorsal SLIOL	Dorsal SL widening on dynamic testing (posterior laxity)	Lesion of proximal and posterior part of SLIOL with partial lesion of DIC
III C complete SLIOL tear, joint is reducible	Complete widening of SL space on dynamic testing, reducible with removal of probe	Complete lesion of SLIOL (anterior, proximal, posterior), complete lesion of one extrinsic ligament (DIC lesion or RSC/ LRL)
IV complete SLIOL with SL gap	SL gap with passage of the arthroscope from MC to RC joint No radiographic abnormalities	Complete lesion of SLIOL (anterior, proximal, posterior), lesion of extrinsic ligaments (DIC, and RSC/ LRL)
V	Wide SL gap with passage of the arthroscope through SL joint Frequent X Ray abnormalities such as an increased SL gap, DISI deformity	Complete lesion of SLIOL, DIC, LRL, RSC, involvement of one or more other ligaments (TH, ST, DRC)

Abbreviations: SLIOL: scapholunate interosseous ligament. MC: midcarpal. RC: radiocarpal. RSC: radio-scapho-capitate. LRL: long radiolunate. DIC: dorsal intercarpal ligament. SL: scapholunate. TH: triquetro-hamate. ST: scaphotrapezial. DRC: dorso radiocarpal. DISI: dorsal intercalated segmental instability

volar and dorsal portions, so it was possible to include the specimens in the study.

According to the proposed classification (►Table 1), stage II is defined as when the probe's tip can be passed between the scaphoid and the lunate, but joint laxity is not present, as the probe cannot be twisted and no widening of SL space is possible. The cadavers wrists were standardized so they all started from the stage II where no laxity was present of SL joint at the beginning.

In those cases the SL ligament's proximal/membranous portion was found to be damaged or partially damaged (attenuation). From this point the volar portion of the SL ligament was sectioned followed by the RSC and LRL ligaments. The progressive sectioning of the SLIOL's dorsal portion was then performed, followed by a complete sectioning of the DIC ligament. Lastly, additional ligaments such as the triquetrohamate ligament, STT, and DRC ligaments were sectioned. The arthroscopic instability

test was performed after each section, but when the scope can be passed from the midcarpal joint to the radiocarpal joint (stage IV), it cannot be performed anymore.

Group B

In this group, sectioning was initially performed on the dorsal part of the SLIOL followed by the membranous portion and the DIC. Then the volar part of the scapholunate ligament was sectioned, followed by the sectioning/disinsertion of the radioscapocapitate and LRL ligaments. Lastly, the triquetrohamate, ST, and DRC ligaments were sectioned and/or disinserted from MC joint.

The mean values and standard deviation were calculated for the radiological measurements. A statistical analysis was performed using paired *t*-tests applied to the mean of three values.

Results

Before the experiment, the mean value for SL gap in the specimen was 2.1 ± 0.5 mm, the means SL angle was $48.1^\circ \pm 4.3^\circ$, and the radiolunate angle was $1.8^\circ \pm 2.3^\circ$.

Group A: When the volar and membranous part of the SL ligament was sectioned, followed by the RSC and LRL ligaments, a stage IIIA (►Fig. 2) was obtained in all eight cases. The progressive sectioning of the SL ligament's posterior portion led to a stage IIIC in all cases. No radiographic changes were recorded in both static and dynamic X-ray images. The complete sectioning of the DIC led to SL stage IV in all cases. A minimal increase in SL gap was recorded in dynamic views but was not statistically significant.

Group B: Sectioning began with the dorsal SLIOL, and a stage IIIB (►Fig. 3) was obtained as well with DIC ligament

Fig. 1 Arthroscopic stage II. From the midcarpal joint the tip of the probe can pass through the SL joint.

Fig. 2 Arthroscopic stage IIIA. Laxity of the anterior portion of SL joint from the midcarpal joint.

Fig. 3 Arthroscopic stage IIIB. Laxity of the posterior portion of SL joint from midcarpal joint.

sectioning. In all cases, the additional sectioning of the scapholunate ligament's volar portion led to a stage IIIC (►Fig. 4). At this stage, the radiographic appearance was normal in all cases, even in the dynamic X-ray images. Additional sectioning of the radioscapophcapitate and LRL ligaments produced a stage IV. In fact, the ligaments were not only sectioned transversely but detached from their insertion to scaphoid and lunate from MC joint. In addition, when the DIC was sectioned, a stage IV was produced (Elsaidi reported similar data). So it is needed, in addition to complete SLIOL section, at least the section of one volar (LRL/RSC or both) and one dorsal ligament to obtain a stage IV.

Fig. 4 Arthroscopic stage IIIC. Complete widening of SL space at instability test performed with a probe from the midcarpal joint. When the probe is removed, the scapholunate space gets closed again. C, capitate; D, dorsal; L, lunate; S, scaphoid; V, volar.

After sectioning of SLIOL and extrinsic ligaments in both groups the mean SL gap increased to 3.37 ± 0.36 mm, SL angle $55^\circ \pm 5.8^\circ$, RL 2.3 ± 2.5 . This difference was statistically significant ($P < 0.0001$ for SL gap, and for SL angle $P < 0.05$). There were no significant differences compared to pre-sectioning values demonstrated in the RL angles as compared with preoperative values. A disruption of Gilula's lines 1 and 2 was recorded in one case after ST ligament sectioning.

Discussion

From our data, the EWAS classification is useful in improving our capacity to detect different types of partial tears and, particularly, in identifying which part of scapholunate ligament is involved, either volar or dorsal or all. This was not possible with the previous arthroscopic classifications described by Geissler and Dautel, which did not correlate the degree of SL joint laxity to the specific site of the tissue injury. We know from previous studies that the dorsal part of the SLIOL is thicker and biomechanically more important than the volar part,^{1,27} and this is evidenced in the EWAS classification system. In fact, the EWAS stage IIIB is more severe than stage IIIA and less than stage IIIC. The identification of partial SL injuries is important to treat these injuries early, possibly using a tissue-specific procedure before the lesion progresses to a more advanced stage. Theoretically a volar injury (IIIA) might be treated by volar capsulodesis, or pinning,^{14,15} while the dorsal lesion (IIIB) or the complete lesion (IIIC) might be treated by dorsal capsulodesis, open or arthroscopic.^{12,28–32} This has to be demonstrated by further clinical studies.

Several studies on cadaver specimens have been performed, and they have demonstrated that complete sectioning of the SLIOL does not necessarily lead to SL disassociation.^{16–23} In studies conducted by Short, it has been clearly shown that sectioning of the SLIOL by open approach and then submitting the wrist to repetitive cycles of motion led to the progressive development of wrist instability through the attenuation of the secondary stabilizers.

In our study, which was not conducted under articular loading and was conducted without repetitive motion, the scapholunate gap increased and became wider after additional sectioning of at least two secondary stabilizers: volarly the RSC ($\pm$ LRL) and dorsally the DIC. The gap increased significantly with sectioning of additional other extrinsic ligaments. Thus, from our data and from the anatomical studies, the gap seems to be an index of extrinsic ligament involvement (secondary stabilizers) in scapholunate injuries.

The aim of this study was to correlate the arthroscopic findings of SL instability with the anatomic/pathological lesions. This knowledge can guide one as to the best surgical procedure that could be performed in each stage by allowing for a tissue-specific approach to the repair. This, however, is currently an unproven theory. The better definition of stages II and III (pre-dynamic instability) in the new classification is important to clarify the difference between them. In stage II there is absence of instability when performing the midcarpal instability test. This injury is stable and can be treated conservatively or by shrinkage, while in stage III there is a

laxity, either volar, dorsal, or complete, and a potential instability that requires treatment especially in stage IIIB and IIIC that may require treatment.

The stage IV is a SLIOL ligament rupture that is associated with a lesion or incompetence of the volar (SC, LRL) and posterior (DIC) extrinsic ligaments, but other extrinsic ligament injuries can also be associated. With the appearance of SL widening and DISI (Table I), the lesion is considered to be more complex, and we call this a stage IV advanced (or it can be called stage V).

In fact, from our data, not all stage IV cases have radiologic abnormalities, and this is why we have distinguished stage IV (without radiologic abnormalities) from stage V (with radiologic abnormalities). This is relevant for treatment, since stage V, which is a scapholunate injury with a gap and radiologic abnormalities, will require reduction of bone alignment and possibly tendon reconstruction procedures, as reported by Garcia Elias,⁵ while the stage IV without radiologic abnormalities may not and could be treated by capsulodesis.^{5,29–31}

From several studies done in the past, it appears that isolated sectioning of the SLIOL does not give rise to an SL disassociation unless several extrinsic ligaments are also cut; hence, the commonly called scapholunate lesion should be called a “scapholunate ligament complex lesion.” Different extrinsic ligaments are subsequently attenuated according to the chronicity of the lesion^{1–5,12,16–23} and repetitive wrist use. The evolution of this scapholunate classification is helpful in understanding the arthroscopic findings in each patient and, possibly, to compare and improve the results in the different stages.

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Conflict of Interest

None

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