Arthroscopic Anatomy and Lesions of the Extrinsic Ligaments

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1 Introduction

The anatomy of the extrinsic ligaments of the wrist is quite complex as is the understanding of their kinematics involved in wrist stabilization [6–8, 15, 23–25].

Arthroscopy has allowed a different approach to these extrinsic ligaments compared to conventional diagnostic methods. The morphological study remains restricted to the intraarticular zones but may be complemented by specific and precise testing of each ligament group.

2 Arthroscopic Anatomy of Extrinsic Ligaments

To facilitate understanding, we have distinguished three groups of extrinsic ligaments:

- Anterior proximal carpal plane: RSC – RLT (LRL, SRL) – RSL – UL – UT
- Anterior midcarpal plane: STq – SC – ST – CTz – TqC
- Dorsal plane: DRC – DIC

Each group is assessed through a certain arthroscopic approach with a possible specific approach that may be needed.

Only the anterior proximal plane of carpal ligaments is accessible to direct arthroscopic vision.

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Even if the arthroscope can only examine the intraarticular portion of these extrinsic ligaments, the data collected can be used to assess the stability of the wrist and orient the choice of technique for potential surgical repair.

3 The Anterior Proximal Carpal Plane

It is composed of two subgroups, the radiocarpal and ulnocarpal, and is explored essentially through dorsal radiocarpal portals.

The classic portals 3–4 and 4–5 allow direct visualization of the scapholunate and lunotriquetral interosseous ligaments. They also give access to the intraarticular portions of the extrinsic ligaments of the anterior radiocarpal and ulnocarpal planes [28–30]. The SRL, UL and UT can also be approached.

3.1 The Anterior Radiocarpal Plane

The radioscaphocapitate ligament (RSC) is a large strong ligament which inserts onto the radial styloid and is directed radially and obliquely towards the capitate. It runs along the proximal half of the scaphoid where it inserts at the level of the waist distal to the tubercle [19] and is fixed distally on the palmar tubercle of the capitate (Fig. 1) [22]. According to Berger, only 10 % of the fibres insert into the capitate [19]. The RSC is intimately related to the distal fibres of the lunocapitate (LC) and the palmar scaphotriquetral (STP) ligaments [19]. The RSC crosses two articular chambers (radiocarpal and midcarpal). Its role is to 'fix' the scaphoid preventing dorsal tilting of its proximal pole. In ulnar deviation, it helps the verticalization of the scaphoid acting as a secondary stabilizer of the scapholunate complex [11], and its injury may be the cause of scaphoid instability with DISI and scapholunate diastasis [12].

On arthroscopic examination of the radiocarpal joint, the RSC is most radial (Fig. 2). Its fibres are obliquely oriented from radial to ulnar, and it is separated from its neighbouring radiolunotriquetral by a hiatus – the interligamentary sulcus which allows testing of both ligaments using the hook palpation (Fig. 3).

The radiolunotriquetral ligament (RLT) is also very strong and usually composed of two bands: the long radiolunate (LRL) radially and the short radiolunate (inconstant) (SRL) separated by the radioscapholunate (Fig. 1). It is almost parallel to the RSC and usually divided into two parts: a proximal purely radiolunate half and the distal palmar lunotriquetral. The SRL fibres cross with those of the ulnotriquetral.

It traces a proximal inverted 'V' with the anterior ulnocarpal where the apex of the V represents the triquetral and lunate insertions.

It forms the palmar part of the triquetral sling [21] and contributes to the stabilization of the lunate, preventing its dorsal flexion and palmar translation. It prevents

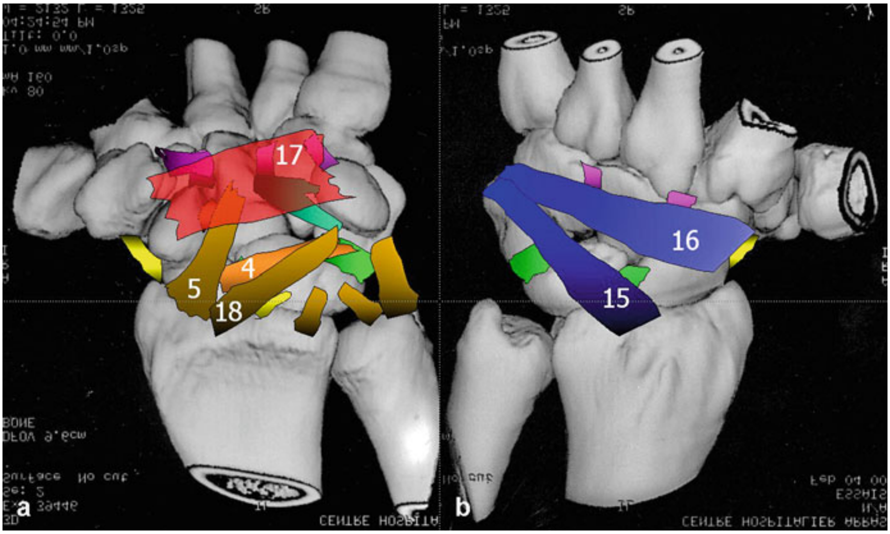

Fig. 1 The plane of extrinsic wrist ligaments, (**a**) palmar and (**b**) dorsal views. *4* Scaphotriquetral ligament, *5* Radioscaphocapitate ligament, *15* dorsal radiocarpal ligament, *16* dorsal intercarpal ligament, *17* annular anterior carpal ligament, *18* long radiolunate ligament

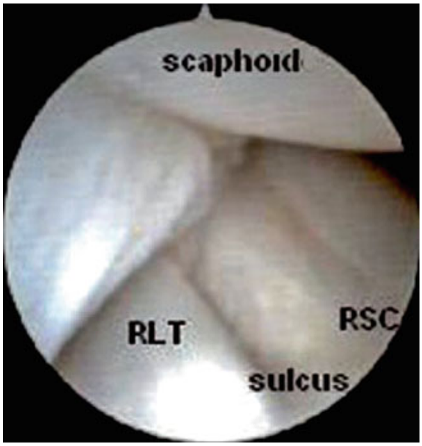

Fig. 2 Arthroscopic view of the radiocarpal interval left wrist. *Right* to *left*: *RSC ligament*, interligamentary sulcus and *RLT* ligament

the ulnar translation of the carpus, and its injury destabilizes the perilunate region. On arthroscopic assessment, the radiolunotriquetral ligament RLT is the ulnar neighbour of the RSC. It links the anterior border of the scaphoid fossa of the radius to the triquetrum, and its fibres are more oblique than those of the RSC (Fig. 2). On its way, it also inserts onto the anterior horn of the lunate.

The radioscapholunate ligament (RSL) or ligament of Testut is quite a lax fibrous structure (Fig. 4). According to Berger, 'the RSL ligament is not a real ligament in the biomechanical or the histological sense of the term'. It can be considered as a

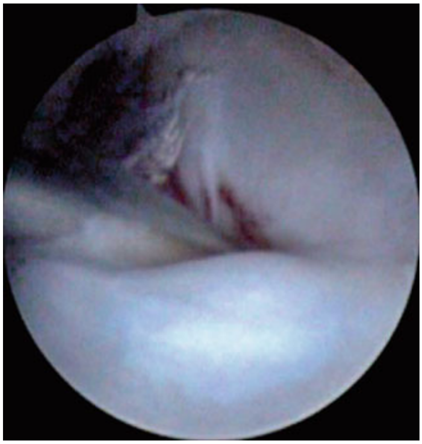

Fig. 3 Arthroscopic view of the left radiocarpal interval. Probing RLT (which is lax stage 2). Probe is in the interligamentary sulcus. Hemorrhagic synovitis in the radial part of the RSC ligament

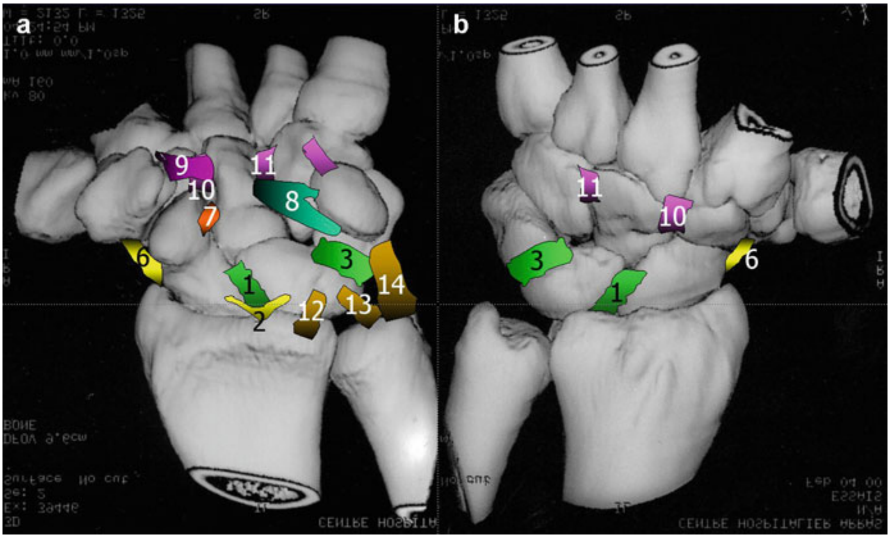

Fig. 4 The plane of extrinsic and intrinsic wrist ligaments, (**a**) palmar and (**b**) dorsal views. *1* Scapholunate, *2* radioscapholunate, *3* lunotriquetral, *6* scaphotrapezial, *7* scaphocapitate, *8* triquetrohamatocapitate, *9* capitotrapezial, *10* capitotrapezoidal, *11* capitohamatal, *12* short radiolunate, *13* ulnolunate, *14* ulnotriquetral

mesocapsule. It contains terminal branches of the anterior interosseous nerve and rami from the radial arcade [19, 20].

It serves as an arthroscopic landmark for the scapholunate ligament which is sometimes difficult to identify without probing which depresses it (Fig. 4). It is characterized by its vertical fibres which extend along the scapholunate crest of the radius. It is the most superficial from the scope and can sometimes obscure the anterior part of the radiocarpal joint like a veil (Fig. 5).

It is more lax than the previous ligaments and feels always more so on probe palpation.

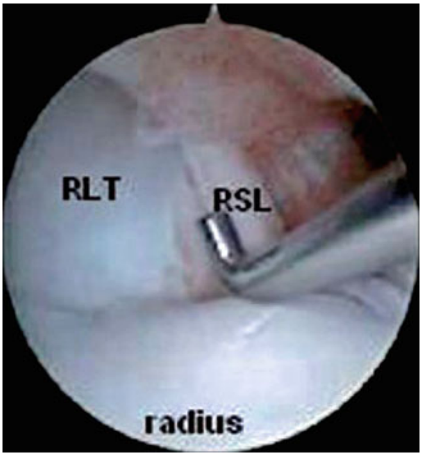

Fig. 5 Arthroscopic view of the right radiocarpal interval. *Left* to *right*: LRTL (long radiotriquetral) and hemorrhagic synovitis on the *RSL* ligament

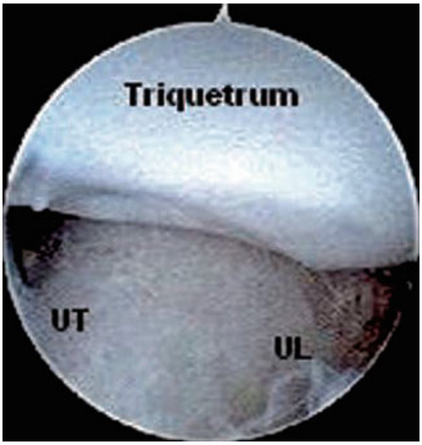

Fig. 6 Arthroscopic view of the left ulnocarpal interval: 3 years after shortening osteotomy described by Milch, 'scarring' chondritis triquetrum. Ulnocarpal ligaments stretched with no clear separation between the *UT* and the *UL*

3.2 The Anterior Ulnocarpal Plane

This is formed by the RLT ligament, the proximal palmar 'V' ligament (Fig. 1), which is formed of the ulnolunate UL and lunotriquetral LT ligaments. It inserts on the proximal part of the anterior portion of the TFCC and the ulnar styloid. It contributes to the stabilization of the lunotriquetral complex and TFCC tension. The ulnolunate ligament may sometimes share fibres with the short RL ligament.

Ulnarly, the anterior floor is composed of less distinctly individualized ligaments (Fig. 6). The difference in obliquity distinguishes between the UL and UT ligaments which appear to be intimately attached to the TFCC and represent an extension of this structure. They are also palpated by the probe.

4 The Anterior Midcarpal Plane and the Scaphotrapeziotrapezoid Complex

The anterior midcarpal plane is formed of a combination of extrinsic and intrinsic ligaments. It includes the distal part of the RSC ligament; the intraarticular midcarpal part of the RSC forming the distal palmar 'V' is visible through the standard arthroscopic portals.

Thus, the RMC and UMC classic midcarpal portals give direct access to the intraarticular part of the RSC and TC ligaments.

The midcarpal part of the radioscaphocapitate ligament is easily identified (Fig. 7) by the same obliquity of fibres as its radiocarpal portion. It is easily accessible to the probe.

The anterior midcarpal plane also includes the triquetrocapitate TC (Fig. 4) and the palmar scaphotriquetral STP (Fig. 1) ligaments.

The TC extends from the distal radial angle of the triquetrum to the ulnar cortex of the capitate [19]. It forms the distal and ulnar part of the palmar midcarpal 'V' and is the palmar ulnar stabilizer of the midcarpal joint. On arthroscopic examination, it is discernible from the RSC by the inverted obliquity of its fibres.

Described in 1994, the STP ligament prevents scaphotriquetral palmar dissociation and thus indirectly scapholunate dissociation. It probably supports the head of the capitate during wrist extension [20]. It is extraarticular and inaccessible to arthroscopic examination.

The anterior midcarpal plane also includes the scaphotrapeziotrapezoid complex. It is strictly palmar and is composed of three distinct exclusively intrinsic structures: the palmar scaphotrapezial ligament (STz) and radially a scaphocapitate ligament (SC) and a capitotrapezoid ligament (CTzo) distal to the scaphoid (Fig. 4). The STz ligament seems to act as a secondary stabilizer to the scapholunate complex along with the RSC and the dorsal intercarpal ligament (DIC) [11–13]. The two ligaments materialize the flexion-extension axis of the scaphoid (Fig. 8). This axis

Fig. 7 Arthroscopic view of the right midcarpal interval: stage 1 laxity of the midcarpal portion of the RSC

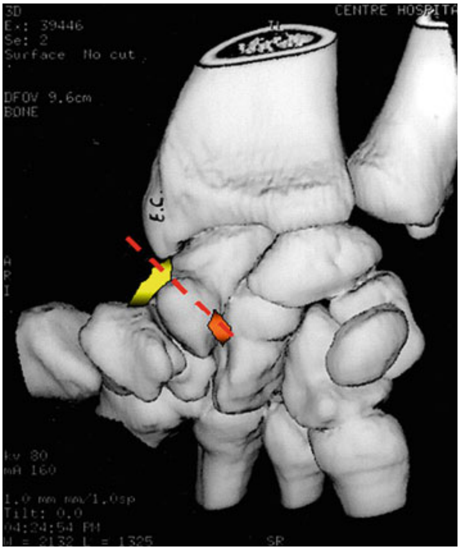

Fig. 8 Plate of extrinsic wrist ligaments: the scaphotrapezial STz and scaphocapitate SC tracethe axis of flexion-extension of the scaphoid

Fig. 9 Arthroscopic view of left midcarpal interval. Scope through RMC, probe through MC 1–3. Enlarged distal scaphocapitate interval allowing palpation of SC ligament

passes through the waist of the capitate [16, 17]. The SC ligament is also an important stabilizer of the scaphoid [19].

The SC ligament is accessible only when the distal scaphocapitate interval is open, i.e., in a pathological situation of instability (Fig. 9).

The CTz ligament is inaccessible to arthroscopic examination, and the STz is not accessible through the dorsal midcarpal ptortals. It is possible to introduce the probe through an MC 1–3 portal in the distal anatomical snuffbox taking care to avoid the dorsal recurrent branch of the radial artery. Recently, we use standard portals (scope through RMC and probe through MC). The probe crosses up the scope into the midcarpal joint and goes to palpate the STz ligament in the STT joint. The scope is slid through the MCR along the scaphoid to visualize the scaphotrapeziotrapezoid junction.

5 The Dorsal Plane

The dorsal plane is formed by two ligaments forming a sloping ‘V’ open radially with the point inserted on the triquetrum. Viegas describes it as a radioscaphoid ligament which relays on the triquetrum [4]. It is distinguished by the constant tension of its branches whatever the opening angle of the ‘V’ and whatever the movement of the wrist (in the sagittal or the frontal plane). Thus, in ulnar inclination, the ‘V’ opens and the dorsal ligament plane participates in the verticalization of the scaphoid, while the triquetrum passes under the hamate (Fig. 10) [26].

The dorsal radiocarpal ligament (DRC) unites the radius and the triquetrum and inserts on the lunate (Fig. 1). It forms the dorsal component of the Khulman’s sling [21] and is a secondary stabilizer of the carpus [12, 13]. A lesion here is as destabilizing to the carpus as a lesion of the palmar bands of the scaphocapitate and scaphotrapezial ligaments [13]. It is ruptured in 50 % of cases of carpal instability usually associated with scapholunate ligament injury but may also be a solo ligament injury [27]. The pain occurs more rapidly with the existence of associated lesions.

The ceiling of the joint space may only be visualized through lateral portals 1–2 and 6U. Care should be taken with approaches through these portals to protect the dorsal sensory branch of the ulnar nerve as well as the radial artery. The dorsal synovium is thick and its folds often obscure the dorsal ligaments. However, careful probing through 3–4 and 4–5 portals – across the synovium – gives a fair appreciation of the tension of the dorsal radiocarpal ligament.

The dorsal intercarpal ligament (DIC) unites the triquetrum and distal scaphoid sometimes extending onto the trapezium and trapezoid [5, 33] (Fig. 1). It is the 3rd secondary stabilizer of the carpus [13, 18].

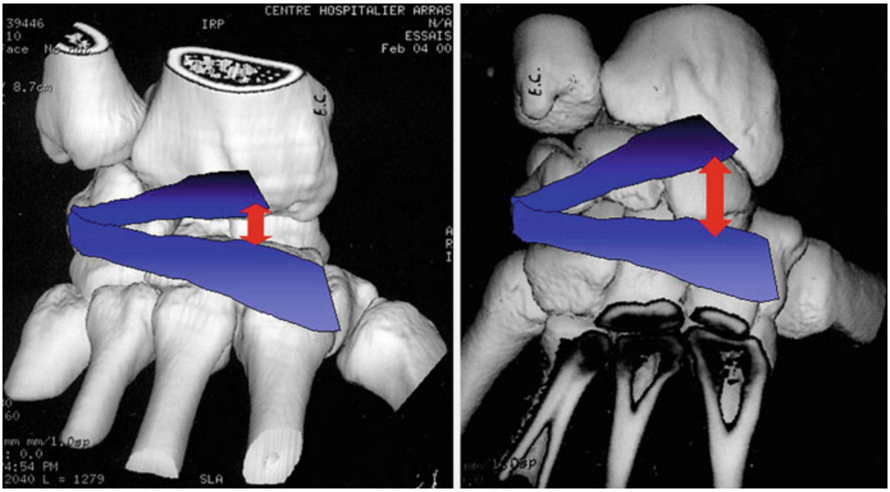

Fig. 10 Plate of extrinsic dorsal wrist ligaments: the ‘V’ opens in ulnar inclination

Fig. 11 Arthroscopic view of left midcarpal interval. Scope through MC 1–3, probe through RMC. After synovial débridement using a shaver, the dorsal intercarpal *DIC* ligament is palpated

The DIC ligament may be seen through MC 1–3 and palpated through UMC; it is likewise possible to estimate the tension of the dorsal intercarpal ligament (Fig. 11).

6 Pathologic Arthroscopy of the Extrinsics

6.1 Genesis of Perilunate Dissociative Instability: Nebulous? Biokinematic and Pathologic Hypothesis

Most authors appear to accept that responsibility for dissociative scapholunate or lunotriquetral is shared by intrinsic and extrinsic ligaments [2, 3, 4, 11, 12, 14, 23–25]. The majority of authors also agree on the primacy of the scapholunate and lunotriquetral ligament lesions as essential for carpal destabilization [1, 11–13].

In the analysis of scapholunate dissociative instability, some consider that in addition to the interosseous ligament, the proximal palmar ligament is essentially involved. Others have incriminated essentially the distal extrinsics or the scaphotrapeziotrapezoid complex [31, 32].

Short et al. consider that the scapholunate ligament is the principal stabilizer of the scapholunate complex, and the extrinsics RSC, DIC and STz are secondary stabilizers [11–13]. For them, the carpus destabilizes progressively under phasic stresses [9, 10].

We propose the following biokinematic theory. The scapholunate complex is stabilized by the scapholunate ligament which is the fundamental intrinsic restrain and also by three extrinsic locks: the distal (STz, CTz, SC), the palmar proximal radial (RSC) and the dorsal (DIC) ligaments. For the stability of the complex to be preserved, the scapholunate ligament as well as two of the three restrains must be intact. If the scapholunate ligament is completely ruptured (Dautel 3; Geissler 4), dissociative instability is clear. We have never witnessed isolated scapholunate ligament rupture without associated extrinsic laxity. If the scapholunate ligament is partially ruptured (Dautel 1 or 2; Geissler 3) and one extrinsic restrain is loosened, the instability process has begun and – without treatment – will inevitably progress to adaptative decompensation.

In the management of an acute sprain (more recent than 6 weeks) we must verify the integrity of these three restrains and systematically repair all partial SL lesions (Dautel 1), when associated with a lesion of at least one extrinsic restrain. It is also necessary in the control of a chronic prearthritic dissociative lesion to assess the state of these three extrinsic locks which will modulate our choice of technique. This will substitute for the broken restrain.

In lunotriquetral dissociative instability, the role of the lunotriquetral interosseous ligament seems fundamental [10], and this interval is systematically tested in our protocol.

As for extrinsics, their responsibility seems even more complex than in scapholunate instability. We test the palmar and dorsal (RLT and DRC) planes of the Khulman's sling and the palmar ulnocarpal (UT) and the DIC ligaments. We have never witnessed frank lunotriquetral instability (combining Dautel 2 with triquetral hypermobility and marginal chondritis of the lunotriquetral interval and the tip of the hamate) without laxity of the components of the triquetral sling. Up to now, we do not modulate the technique of management of instability to any such extrinsic ligament lesion.

7 Approach to Extrinsics

The arthroscopic approach to the extrinsics involves both modalities of assessment: direct vision inspection and testing by probing. Analysis is completed by clinical examination using special tests such as Watson and interosseous ballottement, intraarticular interosseous gaping and hypermobility of the bones.

7.1 Direct Vision Inspection

Radiocarpal through portals 3–4, 4–5, 6U and 1–2 (RSC – LRL – RSL – (SRL inconstant) – UL – UT)
Midcarpal through portals MC 1–3, RMC, UMC, RSC and TC

7.2 Probe Palpation Assessment

For lesions of the extrinsic ligaments in the proximal palmar plane, we propose the following staging:

- Stage 0: Perfect tension: harp string effect.
- Stage 1: Ligament laxity: possible mobility, corresponding to the thickness of the probe 1 mm (Fig. 10).

- Stage 2: Partial ligament degeneration as seen by fibrillary appearance, thinning and blurred edges.
- Stage 3: Complete disappearance of the extrinsic ligament, only remnants may be seen.

This testing may be applied to the distal palmar plane (the scaphotrapezotrapezoidal complex) where only the scaphotrapezial STz ligament can be tested, since – as previously mentioned – the CTz and SC are only accessible in pathological situations.

The palmar plane assessment is completed by probing of the distal scaphocapitate interval. We propose extending the Dautel scapholunate staging [28–30] to the distal scaphocapitate interval (Fig. 11).

We consider stage 2 (easy probe penetration and opening of the interval by torsion) and 3 (spontaneously open interval) to signify a severe lesion of the extrinsic lock, the distal scapholunate.

This testing may be applied to the dorsal plane. It is difficult and needs the use of special portals 1–2, 6U and MC 1–3. It is sometimes necessary to debride the bulky dorsal synovium using the shaver to optimize palpation under visual control. It is also sometimes necessary to use the second probe.

8 Other Arthroscopic Signs of Instability

In recent trauma, hemorrhagic synovitis pigments the stretched extrinsic ligament and is an indicator of the lesion in arthroscopy [34].

Hypermobility of one of the proximal carpal bones, better visualized through the midcarpal, is a better sign especially if the interosseous ligament testing is equivocal.

Chondritis of the borders of the scapholunate or lunotriquetral intervals is a sign of an old instability [34].

Watson's test and interosseous ballottement are of anecdotal importance.

9 Conclusion

The extrinsic ligaments – intimately related to the intrinsics – seem to play a role much more significant than that originally described in the genesis of perilunate dissociative instability.

Arthroscopy allows a descriptive and kinematic study of wrist ligament pathology. It presents an inevitable stage in the assessment of wrist instability.

We systematically assess the extrinsic locks through a lateral approach (portals 1–2, 6U, MC 1–3) to complete the classical examination.

We propose a staging for extrinsic lesions and an application of the Dautel staging to the distal scaphocapitate interval.

We propose the hypothesis that SL dissociative instability is due to SL ligament lesion associated with a lesion of at least one of the three extrinsic locks.

We think that the extrinsic locks' lesion should modulate the choice of technique for treatment of chronic scapholunate instability.

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