U P T O D A T E

Pathogenesis and evolution of carpal instability: imaging and topography

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Abstract. Carpal instability is a biomechanical alteration with a multiple pathogenesis which, if not identified and treated in time, leads to gradual articular collapse. Traumatism is known to be one of the main causes of carpal instability, while deposits of microcrystals caused by metabolic (chondrocalcinosis and gout) and congenital (ulna minus variance) diseases are less frequently involved in the pathogenesis. In forms secondary to traumatism, the trauma causes ligamentous injuries that lead to misalignments of the joint surfaces, or badly healed fractures with consequent articular incongruency. In both situations, an alteration of carpal kinematics is generated and, if normal carpal biomechanics are not restored, this alteration leads, over the course of time, to degenerative alterations of the cartilage, followed by chondral erosions and to the exposure of the bone. We present the etiology, topography and consequences of carpal instability, discussing the diagnostic procedure, which always begins with a conventional X-ray examination, followed by a CT and/or an MRI with an intra-articular injection of contrast medium as the gold standard for a correct evaluation. Our aim is to present and compare the different patterns of carpal instability observed in our Radiology Institute with those found in literature. (www.actabiomedica.it)

Key words: Carpal instability, X-Ray, CT, œMRI

Introduction

The clinical-radiological interest in the wrist is due to its extreme anatomical and biomechanical complexity. It is, in fact, remarkable to think that as many as ten skeletal segments together with numerous ligamentous and tendinous structures interact and move so harmoniously in such a small space. Each of these structures has a specific role in the biomechanics, stability and motility of the wrist and hand, enabling ulnar deviation, radial deviation and flexion/extension movements (Table 1).

The biomechanical complexity can be demonstrated by means of a simple lateral view X-ray in ulnar and radial deviation; these movements are, in fact, accompanied by carpal flexion and extension, respectively (Fig. 1 a-b).

Numerous definitions attempting to explain the meaning of carpal instability have been formulated, but none of these has been able to describe and clarify it in an exhaustive manner. Paraphrasing some of these definitions, we can affirm that:

Table 1

	Total	Radiocarpal	Mediocarpal
Flexion	80°	32°	48°
Extension	70°	47°	23°
r/u dev	50°	20°	30°

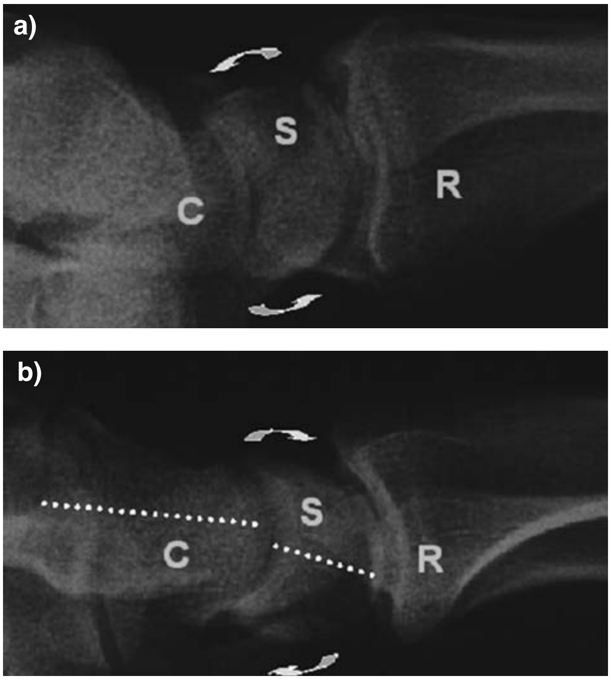

Figure 1. X-ray lateral view: radius (R), lunate (S), capitate (C). Ulnar and radial deviation movements are accompanied by carpal flexion (a) and carpal extension (b), respectively

- all untreated dislocations and displaced fractures are examples of carpal instability (1);
- carpal instability often depends on capsular integrity and, above all, on the interosseous ligaments (2);
- carpal instability cannot be attributed to congenital ligamentous laxity (3);
- not all types of carpal instability are painful in the initial stages (3).

A complex structure such as the wrist may be considered stable when the modifications brought about by the various forces acting on it are restored when the said forces stop to act; in contrast, the alteration of one or more of the structures that are responsible for stability leads to an altered response of the said structures to the forces acting on them, precluding the possibility of restoring the pre-existing condition of equilibrium and generating a clear clinical picture of instability.

This takes place when the structures comprising the wrist are damaged by traumas, chronic inflammation processes (rheumatoid arthritis), congenital anatomical alterations (as it may be observed in negative ulnar variance) and neoplastic diseases (3, 4).

Instability of the wrist is undoubtedly a pathological condition in which the carpal bones become misaligned, leading to a deficit in biomechanical performance, pain and a progressive tendency towards carpal collapse, if a precocious treatment is not provided.

Etiopathogenesis topography and imaging of carpal instability

Numerous classifications of carpal instability have been suggested in recent times since knowledge of the biomechanical mechanisms of the carpus progressively increases.

The first classification, which is still partially applied today, was formulated by Dobyns in 1972, in which the following clinical-radiological presentations were identified (5):

- Dorsal Intercalary Segment Instability (DISI)
- Volar Intercalary Segment Instability (VISI)
- carpal instability due to a fracture with dorsal displacement of the radial epiphysis.

The interposed segment indicates the proximal carpal row, which must be considered as a single structure in which the various bone elements are strongly stabilized by the interosseous ligaments.

DISI, the most common alteration, is caused by injury to the scaphotrapezoidal ligament, by a badly healed trans-scaphoid fracture (pseudoarthrosis) or, even more frequently, by injury to the scapholunate ligament; the instability is detected by means of a lateral view X-ray where a dorsal tilt of the lunate can be observed, together with a variation in the capitolunate and scapholunate angles; the first angle, normally between 0° and 30° is greater than 30° and the second angle, normally between 30° and 60°, is greater than 60° (6) (Fig. 2 a-b).

In cases of DISI, during posterior-anterior (PA) view X-rays, scapholunate dissociation, progressive proximal migration of the capitate between the scaphoid and the lunate and ulnar shift of the lunate may be observed.

VISI is a condition of carpal instability relative to lunotriquetral, radiotriquetral and scaphotriquetral

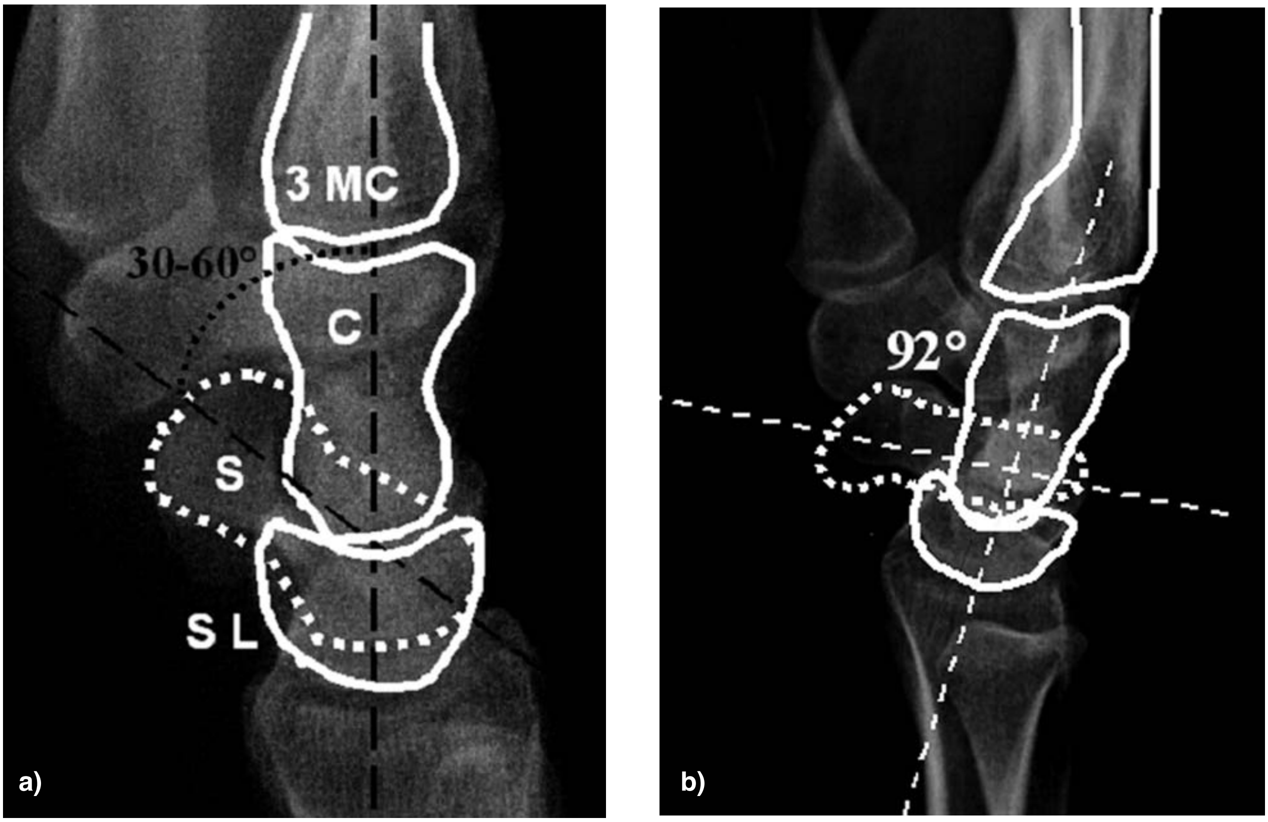

Figure 2. X-ray lateral view; lateral view: radius (R), lunate (SL), capitate (C). a) The normal size of the scapholunate angle is between 30°-60°. This angle is determined by the intersection of two lines drawn along the major axis of the scaphoid and lunate, respectively. b) An increase in the scapholunate angle to > 60° is consistent with DISI

dissociation or to badly healed displaced fractures of these skeletal segments. From a lateral view X-ray, it is possible to observe a dorsal tilt of the lunate, an increase in the capitolunate angle to >30°, and a reduction in the scapholunate angle to < 30°(6) (Fig. 3).

In 1984, Taleisnik made a further classification of instability, dividing it into (1):

- STATIC: relative to the total rupture of the interosseous ligaments, generally due to the collapse of the scapholunate interosseous ligament; in this condition there is a stiff *flexion of the scaphoid* and a stiff *extension of the lunate,* and the skeletal dissociation can be readily observed in the PA view X-ray in the neutral position, identifying the DISI presentation already described

- DYNAMIC due to the partial scapholunate or lunotriquetral ligamentous injury, not visible from the PA view X-ray, but easily recognizable from additional views (PA view X-ray in ulnar deviation) and from fluoroscopies as inter-bone dissociation (Fig. 4).

PA view X-rays in both neutral position and ulnar deviation are useful and, in many cases, sufficient to ensure a correct diagnosis of scapholunate dissociation; in this condition, the *Terry-Thomas sign* appears (7), i.e. the widening of the space between the scaphoid and the lunate, which in normal conditions does not measure more than 2 mm, more readily visible in the view with the wrist in ulnar deviation; another finding associated with scapholunate dissociation is the *signet ring sign*, the name of which derives from a cortical shadow, not normally present at scaphoid level, due to a rotatory partial dislocation of the bone, leading to overlapping of the distal pole and the body, visible in PA view X-rays in neutral position and in ulnar deviation (beware of X-rays in radial deviation because the normal volar tilt of the scaphoid

Figura 3. X-ray lateral view. VISI: reduction of the scapholunate angle to < 30°

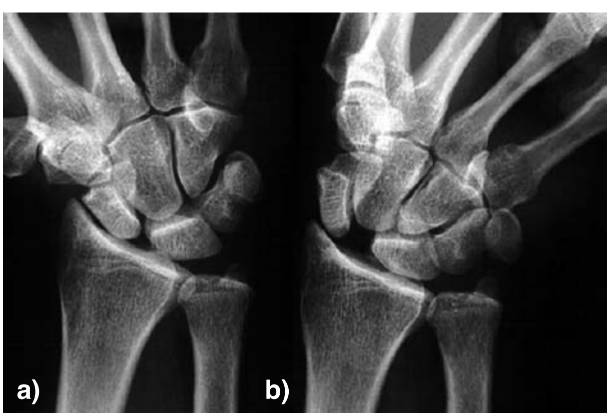

Figura 4. (X-ray PA view in neutral position and ulnar deviation of the carpus. a) normal scapholunate articulation maintained; b) scapholunate dissociation

produces a similar radiographic image) (Fig. 5). However, failure to detect these signs does not necessarily mean that the scapholunate ligament is not damaged. A fluoroscopic observation of the wrist with the aid of a video recording could reveal a situation of dynamic carpal instability (8, 9).

Figure 5. The rupture of the scapholunate ligament generates two signs, visible under X-ray PA view. *Terry-Thomas sign:* widening of the gap between scaphoid and lunate which, under normal conditions, does not exceed 2 mm, best seen with the wrist in ulnar deviation. *Signet ring sign*: this name derives from a cortical shadow not usually present at scaphoid level generated by the rotatory dislocation of the bone, leading to the overlapping of the distal pole and the body. Failure to observe these signs does not, however, guarantee that the scapholunate ligament is intact (see text)

Under MRI examination, the scapholunate ligament is displayed as a hypointense band which runs from the scaphoid to the lunate, blending almost imperceptibly with their articular cartilage; the injuries to this ligamentous structure are displayed as delimited or widespread areas of hyperintensity within the ligament (10). A more precisely detailed diagnosis, in terms of increased sensitivity and specificity in the detection of injuries to the scapholunate ligament, can be obtained by injecting a suitably diluted paramagnetic contrast medium (0.3 ml gadolinium/100ml hydrosaline solution) into the articular groove by means of a fine needle; in the event of complete or partial lesions of the scapholunate ligament, this method shows a pathological communication between the radiocarpal and mediocarpal joints (11-13). In 1994, more than 20 years after the first classification, Dobyns identifies other groups of carpal instability (14):

- Dissociative Carpal Instability or CID
- Non-Dissociative Carpal Instability or CIND
- Complex Carpal Instability or CIC in which CID and CIND coexist
- Adaptive Carpal Instability or CIA

In *Dissociative Carpal Instability (CID),* it is possible to observe the loss of the connections between carpal segments of the same row due to the rupture of interosseous ligaments (small ligaments), as a result of well-healed displaced carpal skeletal fractures or badly healed fractures (pseudoarthrosis) (14, 15). CID comprises both DISI and VISI instabilities (14, 15).

Scapholunate dissociation, and the less frequent lunotriquetral dissociation, are examples of dissociative instabilities of the proximal carpal row (14).

Injuries of the distal row are rarer and usually develop longitudinally with dislocations that are often associated with fractures of the skeletal elements.

Non-dissociative Carpal Instability (CIND) is distinguished by an alteration in the articular relationship between the two carpal rows, while the joint connections between the skeletal elements of each row are maintained. The main non-dissociative carpal instabilities affect the radiocarpal and mediocarpal joints, the most frequent causes being the collapse of the capsule and that of the intercarpal ligaments (long ligaments), as it may often be observed in chronic inflammatory processes (rheumatoid arthritis) and in cases of overuse (14).

Complex Carpal Instability or CIC refers to pathological situations in which there is an association of dissociative and non-dissociative instability; a typical example of a CIC is lunate dislocation (14, 15) (Fig. 6).

PA and lateral view X-rays of the wrist in neutral position can provide a diagnosis in the event of a suspected dislocation of the lunate or perilunate. Moreover, the lateral view, which normally shows an alignment between the distal surfaces of the radius, lunate, capitate and third metacarpal, shows, in these particular circumstances, an alteration of this alignment (16).

Figure 6. X-ray lateral view. Lunate dislocation

In this case, the PA view X-ray will show an interruption in the second Gilula's arc, consequent to the altered lunate tilt. In the case of perilunate dislocation, the capitate becomes dislocated, losing its normal alignment with the lunate and distal surface of the radius, migrating dorsally. This type of dislocation is detected in lateral view X-rays due to the loss of the normal alignment of the capitate and in PA view X-rays due to the overlapping of the capitate with the proximal carpal row, leading to an interruption of the first and second Gilula's arc (3, 4, 17).

In *Adaptive Carpal Instability (CIA)*, the causes of the instability do not reside in the carpus itself, but are due to residual findings of radial fractures with dorsal displacement in the epiphyseal region (Fig. 7).

In 1995, Amadio classified carpal instabilities according to four characteristics (4): I) Severity distin-

Figure 7. X-ray lateral view. Instability derived from adaptation due to residual findings of dislocated radial epiphyseal fracture

guished according to (from the least to the most serious): dynamic, static with partial dislocation, static with dislocation; II) Direction of the dislocation (dorsal or volar); III) Site of the injury; IV) Type of injury.

The most frequent types of wrist dislocation are scapholunate (8), perilunate, mediocarpal and lunate dislocation (10, 11).

Johnson places the emphasis on the importance of the so-called vulnerable area. According to this interpretation, the main injuries are the two types affecting the lesser and greater arc (12).

An injury to the lesser arc can therefore produce, in the following sequence: a scapholunate dissociation with a rotatory partial dislocation of the scaphoid, perilunate dislocation, mediocarpal dislocation and, finally and most serious, lunate dislocation (12).

In the event of an injury to the greater arc, all of bone segments adjacent to the lunate are subject to fracturing in association with dislocations (13).

Mayfield (18), and in a successive work, Yeager and Dalinka (19) described a model comprising 4 successive phases of lesser arc injuries. Stage I involves scapholunate dissociation with rotatory partial dislocation of the scaphoid. Stage II is produced by capitolunate damage generating either a capitate or a perilunate dislocation. Stage III is characterized by lunotriquetral damage with loss of the articulation between the triquetral and the lunate, leading to mediocarpal dislocation. Finally, Stage IV refers to the most serious injury of all, i.e. lunate dislocation, in which the bone segment is found to be dislocated and totally devoid of ligamentous insertions (3, 4, 6, 14, 15).

The rupture of the scapholunate ligament causes a disjunction between the scaphoid and the lunate which, over the course of time, triggers secondary arthrosis with progressive collapse of the carpus (gradual invasion of the capitate in the scapholunate space) (20).

Most secondary forms of wrist arthrosis are localized in the area of radiocarpal and mediocarpal joints (20).

Among the main causes of its pathogenesis traumas and metabolic diseases resulting from the deposition of microcrystals (20) are shown.

The forms secondary to traumas are the most frequent; the trauma provokes a ligamentous injury which leads to chronic instability or fractures which heal badly, causing articular incongruency. In both situations an alteration of carpal kinematics is generated which, if normal carpal biomechanics are not restored, leads, over the course of time, to degenerative alterations of the cartilage followed by chondral erosions, and to exposure of the bone.

Knowledge of radiocarpal kinematics is of fundamental importance in the understanding of instability (21).

The scaphoid with the widest arc of rotation (76° when flexed; 35° when extended) and the scapholunate joint whose movement is three times greater than that of the lunotriquetral one, are the mainstay for ensuring carpal stability.

During wrist extension, the scaphoid extends, assumes a supine position and deviates radially, while, during wrist flexion, it bends, assumes a prone position and deviates ulnarly (22).

When the wrist is extended, the lunate extends, assumes a prone position and deviates radially while, during flexion, it bends and deviates ulnarly.

The flexion/extension of the wrist generates, therefore, a continuous spatial change in the relationship between the elements of the carpus.

The loss of this mechanism can lead to articular incongruency, progressive rupture of the radiocarpal and intercarpal ligaments and cartilage degeneration.

It has been experimentally demonstrated that the cutting of the scapholunate ligament initially produces a collapse in flexion and pronation of the scaphoid due to rotatory partial dislocation; the lunate only changes position in extension by 4.9° (23), perilunate instability is generated only later (15), and the scaphoid and lunate space is progressively occupied by the capitate. This proximal migration of the capitate creates shearing forces between the proximal pole of the same and the distal part of the lunate and, at the same time, forces the lunate dorsally and ulnarly in DISI position, leading to progressive carpal collapse.

Injury to the lunotriquetral ligament – a much rarer phenomenon – does not, on its own, produce static instability (24).

Only injuries of the radiotriquetral or dorsal scaphotriquetral ligaments bring about a significant alteration in carpal kinematics with the lunate in volar

VISI position and the triquetral in supination and extension.

The first diagnostic approach in the study of carpal instability is the conventional X-ray; although standard PA and lateral view X-rays provide an excellent panoramic view of the carpus and the radiocarpal joint, it is often necessary to resort to additional X-ray views. A PA view X-ray with the wrist in ulnar deviation is necessary for a complete evaluation of the scaphoid; in this position, the scaphoid is not subject to the overlapping of perspectives caused by its natural volar tilt and its shape, which are observable in the standard PA view X-ray, making it possible to assess scapholunate dissociations (25).

The proximal carpal row moves as though it were a single unit, firmly stabilized by interosseous ligaments; examining the wrist in neutral position in a PA view X-ray, Gilula identified three regular arcs that circumscribe the proximal (first arc) and distal (second arc) joint surface of the first carpal row (scaphoid, lunate and triquetral) and the counterposed joint surface formed by the convexity of the great bone and the unciform bone (third arc) (26) (Fig. 8).

Figure 8. X-ray PA view. Gilula's arcs: in normal conditions, three parallel arcs may be observed, delineating the radiocarpal and proximal intercarpal joint surfaces

The lateral view, obtained with the wrist in neutral position, shows the alignment of the radius, lunate, capitate and third metacarpal along their longitudinal axes (25).

If the ligamentous formations have collapsed, this is shown in the PA view X-ray by the interruption of the arcs due to the interposition of the edges of the carpus skeletal elements, which rotate due to the action of forces that are no longer well-balanced, and by a misalignment of the bone segments detectable in the lateral view X-ray (17, 26) (Fig. 9 a-b).

The study of carpal kinematics by fluoroscopy is of fundamental importance for the assessment of the motility of carpal structures and for the identification of dynamic instability situations. This assessment must be performed with equipment that has the capacity to store the images, or alternatively, with the aid of a video recorder, in order to reduce the patient's exposure and facilitate the diagnosis.

Other views can be useful in recognizing anomalies linked to carpal instability, in particular, the supine-oblique view, the prone-oblique view and, finally, the view for the study of the carpal tunnel syndrome (25).

If the diagnosis remains doubtful, it is advisable to resort to CT scanning and MR imaging procedures, since these are indispensable for the detection of hidden fractures; the MRI, in particular, is recommended for the in-depth study of the fibrocartilaginous and ligamentous structures (10, 27-31).

Examination with an intra-articular injection of contrast medium is currently the best method for directly detecting injuries of the interosseous ligaments and of the triangular fibrocartilaginous complex (11, 31). An arthrographic study may be carried out using a non-ionic iodine-based positive contrast medium suitable for arthrographies or arthro-CT scans (11-13, 31-34), the latter being executed by means of the spiral technique and millimetric or sub-millimetric collimation of the radiating beam, enabling subsequent reprocessing of the acquired data.

Magnetic resonance imaging is, today, a second level investigation in the study of carpal instability and it is performed only after a conventional X-ray; out of all the instrumental investigative methods, it possesses the best contrast resolution between tissue types, together with good spatial resolution, multiplanarity of scanning and has the advantage of not using ionizing radiation. Additionally, when a suitably diluted, paramagnetic contrast medium is injected into the joint, the MRI guarantees increased diagnostic accuracy (31, 34).

In all cases (conventional arthroscopy, arthro-CT, arthro-MRI) an intra-articular injection technique is applied in order to circumscribe the margins of the endoarticular anatomical structures, hence delimiting the possible spreading of the contrast medium into the various carpal compartments where there is a presence of ruptured interosseous ligaments (radiocarpal, mediocarpal and distal radio-ulnar) (12, 33) (Fig. 10).

It is of great interest to be able to assemble the images acquired in the MRI on dedicated reels that enable wrist movement in guided mode, in order to assess the wrist in animated motion during the various phases of ulno-radial deviation. The advantage of cine magnetic resonance compared to fluoroscopy is that it provides a synthetic diagnosis obtained from the analysis of the dynamic tomography of the carpus associated with the morphological findings and signal data of the resonance (13).

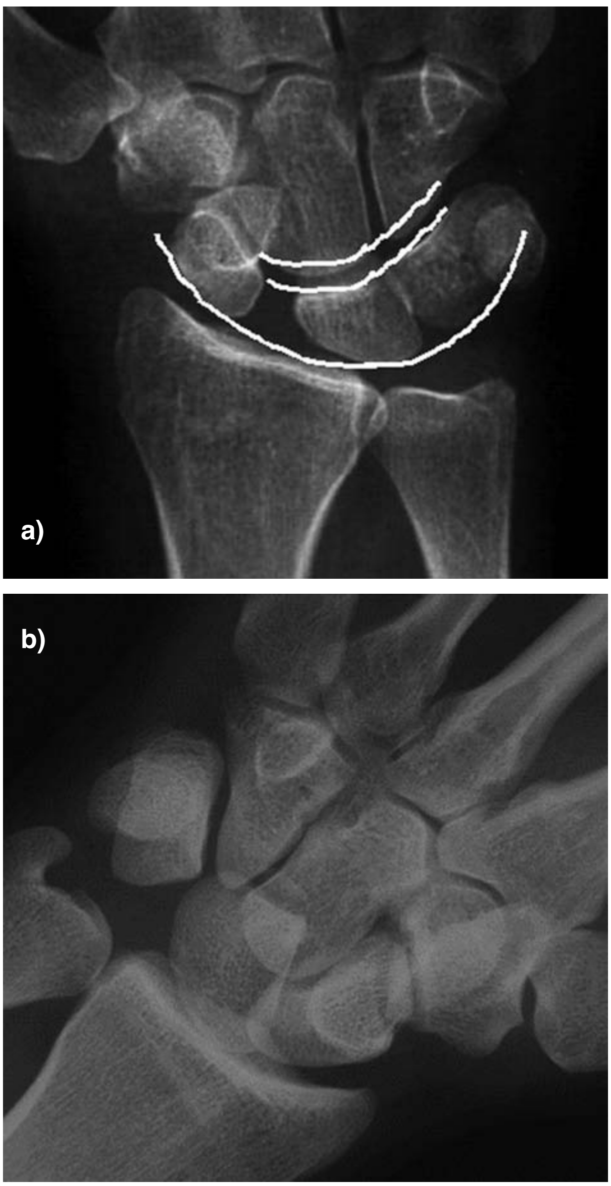

Figure 9. X-ray PA view; interruption of Gilula's arcs due to: a) rupture of scapholunate interosseous ligament; b) lunate dislocation

Arthrosis and carpal collapse: the natural evolution of the instability

The radiographic presentation following injury to the scapholunate ligament, known as SLAC (Scapho Lunate Advanced Collapse), simultaneously defines both the pathogenesis of the carpal instability and the progressive collapse of the carpus (20, 23).

Figure 10. Arthro-MRI, GE FA 90° coronal view. Direct demonstration of scapholunate ligament rupture

The progression involves a number of subsequent stages of increasing severity (20, 23, 35).

- SLAC 1: distinguished by the reduction of the space between the radial styloid and the scaphoid. There are signs of degenerative alterations of the apex of the radial styloid and of the radial edge of the scaphoid, often characterized by minute osteophytosis (Fig. 11). This condition is present in dynamic scapholunate dissociation.
- SLAC 2: onset of cartilage degeneration, chondritis of the articular facet of the radius and the scaphoid. Further reduction of the joint space and formation of osteophytes. Static scapholunate dissociation (SLAC 2A). Secondary arthrosis of the scaphoid-trapezium-trapezoid joint may also be present (SLAC 2B) (Fig. 12).
- SLAC 3: further progression of the cartilage degeneration affecting not only the radioscaphoid but also the capito-lunate and the capito-scaphoid joints (Fig. 13).

In the advanced stages of SLAC 1, there is a decrease in the height of the carpus which, if associated with the progressive ulnar shift of the lunate, explains the presence of ulnocarpal impingement in a certain

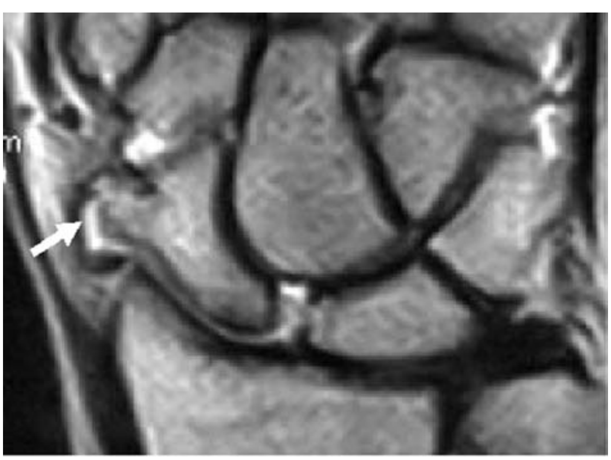

Figure 11. Arthro-MRI, SE T1 SLAC 1: osteophytosis of the distal pole of the scaphoid (arrow). This condition is typical of dynamic scapholunate dissociation. It may be observed that the scapholunate ligament is intact and that the contrast medium spreads into the intercarpal joint compartment (the cm has been injected into the radiocarpal joint compartment): this condition is consistent with a partial injury of the interosseous ligament

Figure 12. Coronal MIP CT. SLAC 2. Marked reduction in the thickness of the radioscaphoid articular cartilage with subchondral sclerosis

Figure 13. Sagittal MIP CT. SLAC 3. Arthrosis with capito-lunate partial dislocation

percentage of patients with arthrosis of the wrist (20, 23, 35).

Arthrosis resulting from traumas involving fractures affects both the radial and ulnar columns of the radiocarpal joint.

In the radial column area, pseudoarthrosis of the scaphoid generates a significant alteration in carpal kinematics, giving rise to a clinical and radiographic presentation known as SNAC (Scaphoid Nonunion Advanced Collapse) (20,36,37).

The proximal fragment of the fractured scaphoid during extension movements of the wrist increases its arc of movement from 29° to 49°, while the rotation of the lunate increases from 7° to 30° (20, 36, 37). In this way, a dorsal and radial deformity of the scaphoid, characteristic of pseudoarthrosis, is created.

Depending on the progression of the arthrosic process between the proximal fragment of the scaphoid and the radius, three different stages may be distinguished (20):

- SNAC 1: arthrosis localized in the distal part of the radial styloid and the scaphoid.
- SNAC 2: same as the previous stage but with the addition of scaphocapitate arthrosis.
- SNAC 3: periscaphoideal arthrosis affecting the radial styloid, distal scaphoid and scaphocapitate with progression to the lunocapitate. The maintenance of the proximal pole of the scaphoid and the lunate depends on the degree of pseudoarthrosis severity.

As already mentioned, the pathogenesis of arthrosis secondary to wrist instability, in addition to trauma, also arises from metabolic diseases caused by microdeposits.

Chondrocalcinosis (or pseudogout) and gout are the main causes of degenerative arthropathies due to metabolic diseases; localized at wrist level, these can cause scapholunate dissociation which leads, slowly and gradually, to carpal collapse (11, 38, 39). For this reason, these conditions have been named SCAC (Scaphoid Chondrocalcinosis Advanced Collapse) by some Authors, a title which clearly refers to the dissociative pathogenesis of the scapholunate and to carpal collapse (20).

While for SLAC, the initial pathological event is the injury to the scapholunate ligament, in this case it is secondary to calcium pyrophosphate microcrystal deposition disease. The evolution of the degenerative alterations following the ligamentous instability and the presence of calcifications manifest themselves in a number of different stages:

- SCAC 1: gap between the scaphoid and lunate with possible calcifications between the bones or around the carpus. The scaphoid tends towards a rotatory partial dislocation of the scaphoid, taking up a vertical position, thereby reducing the scaphoid-trapezium-trapezoid joint space.
- SCAC 2: in addition to scapholunate dissociation, there is a radio-scaphoid subchondral thickening, with reduction of the joint space. Presence of lunocapitate arthrosis.
- SCAC 3: progressive penetration of the proximal pole of the scaphoid in the radial groove for the lunate: characteristic finding of the disease.
- SCAC 4: total destruction of the wrist cartilage also affecting the radiolunate joint; all the carpal bones are affected by the calcification process.

General considerations and conclusions

Carpal instability is a biomechanical alteration with a multiple pathogenesis that is responsible for a gradual carpal collapse if not identified and precociously treated (Table 2).

The forms secondary to traumas are the most frequent; the trauma causes ligamentous injuries that lead to misalignments of the joint surfaces or fractures that heal badly causing articular incongruency. Carpal instability due to the deposition of microcrystals caused by metabolic diseases (chondrocalcinosis and

Table 2. Clinical-radiological presentation

• Scapholunate dissociation
• Lunotriquetral dissociation
• Scaphoid pseudoarthrosis
• Displaced fractures of the carpus: residual findings
• Extrinsic radiocarpal ligament insufficiency (inflammation/trauma)
• Distal radial fracture: residual findings
• Complex carpal instability (at least two of the abovementioned conditions)

gout) and congenital diseases (ulnar minus variance) are less frequent (Fig. 14).

In both situations, an alteration of carpal kinematics is generated and, if the normal carpal biomechanics are not restored, this alteration leads, over the course of time, to degenerative alterations of the cartilage, followed by chondral erosions, and to the exposure of the bone.

The rapid technological progress of modern diagnostic equipment has not, in any way, displaced the important role of conventional radiography when carpal instability is suspected; in such cases, PA and LL view X-rays of the wrist must be performed in association with additional views, the first of these being the PA view in ulnar deviation.

Negative radiographic findings do not necessarily exclude the presence of instability, especially dynamic instability; in such cases a fluoroscopic examination with video recording may be extremely useful for the radiologist in making a diagnosis, highlighting alterations in the relationships between the bones during the various phases of carpal movement.

Recourse to the so-called "heavy" methods, i.e. CT and MRI is justified – especially the second – when diagnosis remains doubtful or when a more panoramic, in-depth study of the bone, ligamentous and cartilaginous structures is called for.

Figure 14. MRI SE T1 w, coronal view. Ulnar minus variance

Figure 15. MIP CT, coronal view. Carpal collapse. Complete resorption of triquetral, lunate and partial resorption of scaphoid may be observed

The use of an intra-articular contrast medium becomes necessary when doubts regarding the diagnosis persist; the spreading of the contrast medium into the various compartments of the carpal joint – normally non-communicating – provides indirect proof of ligamentous injury. In our opinion, an arthro-MRI is preferable to an arthro-CT since it provides more information and does not involve the use of ionizing radiation.

In conclusion, the instability of the wrist is frequent, and just as frequently neglected, and only the rational integration of imaging and an exchange of opinions between the orthopedist and the radiologist can lead to a correct diagnosis and identification of the stage of the disease.

This allows the timely therapeutic intervention required to avoid progressive carpal collapse (Fig. 15), responsible for a serious functional deficit of the wrist and the hand, with a view to improving the patient's quality of life.

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