# Carpal instability in athletes

Educational article - English edition

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Source article: Grégory Mesplié. Instabilités du carpe chez le sportif. Promanu, 2017.

## 1. General introduction

Athletic wrist injuries are important in hand therapy and sports medicine. Falls onto the hand expose the carpus to compression, shear and torsion that may damage intrinsic and extrinsic ligaments.

The article integrates joint biomechanics, ligament and muscle stabilisation, proprioception, neuromuscular control and sensorimotor rehabilitation. Its central contribution is to replace a purely passive view with a dynamic system in which muscles and sensorimotor control are essential.

## 2. Fundamental biomechanics

The carpus is stable when it maintains cohesion under physiological loading. Stability depends on congruence, intrinsic and extrinsic ligaments, stabilising muscles, joint compression and proprioception.

The distal row behaves as a single block. Under axial loading it moves proximally and compresses the proximal row. The scaphoid tends to flex and pronate, while the triquetrum tends to extend. The lunate balances these opposing influences. Intact scapholunate and lunotriquetral ligaments provide biomechanical locking.

## 3. Garcia-Elias's oval-ring concept

The system combines ligaments transmitting forces between rows and ligaments maintaining proximal-row cohesion. Principal structures are scapholunate, lunotriquetral, scaphotrapeziotrapezoid (STT) and triquetrohamatocapitate ligaments. This explains compensation, intracarpal imbalance and radiographic instability patterns.

## 4. Anti-pronation and anti-supination ligaments

Distal-row pronation tensions anti-pronation structures: scaphocapitate ligament, posterior scapholunate bundle, lunotriquetral bundles and long radiolunate ligament.

During supination, anti-supination stabilisers include dorsal radiocarpal, triquetrohamatocapitate, ulnolunate and STT ligaments. This helps explain why some muscle contractions protect structures while others increase harmful loading.

# 5. Proprioception

Wrist ligaments are richly innervated rather than merely mechanical. Described receptors include Ruffini and Pacinian corpuscles, Golgi organs and free nerve endings, detecting movement and loading and contributing to reflex control and motor adaptation.

Afferent information follows a rapid monosynaptic reflex pathway and a slower, more precise polysynaptic corticocerebellar pathway. This dual organisation supports dynamic stability under substantial loading.

# 6. Extrinsic muscles

Forearm muscles have intracarpal pronation or supination components. APL, radial wrist extensors and flexor carpi ulnaris (FCU) protect anti-pronation ligaments. Flexor carpi radialis (FCR) and extensor carpi ulnaris (ECU) protect anti-supination ligaments.

FCR has a distinctive dual effect: its metacarpal insertion pronates the midcarpal joint while its tendon simultaneously exerts a supinating force on the scaphoid. ECU opposes proximal-row flexion. FCU supinates the midcarpal joint and stabilises the proximal row through the pisiform.

The article stresses that active muscular compression and passive compression have opposite biomechanical effects.

# 7. Intrinsic muscles

Their role is less studied. Through connections with the pisiform and FCU, abductor digiti minimi might help control proximal-row flexion and stabilise the midcarpal joint. Thenar muscles might contribute to STT stability according to functional thumb position.

# 8. Instability classification

Instability is classified by chronicity, location, direction and dynamic behaviour.

Dissociative instability is loss of cohesion within the proximal row. VISI follows lunotriquetral injury: the lunate flexes under the dominant scaphoid influence. DISI follows scapholunate injury: the lunate extends under the triquetrum’s influence.

Non-dissociative instability is loss of cohesion between rows without intrinsic instability. Palmar midcarpal instability is the most frequent in athletes.

# 9. Rehabilitation’s role

Treatment must match the injured ligament and instability type. Dynamic or predynamic instability may be managed conservatively. Static instability with persistent radiographic changes generally requires surgery followed by specific rehabilitation.

In some palmar midcarpal instability cases, conservative outcomes may be comparable to surgery.

# 10. Orthoses and immobilisation

Selection depends on injured ligament, instability type and healing stage. Although dart-throwing motion (DTM) is physiological with intact ligaments, after scapholunate rupture the scaphoid may behave like a distal-row bone, increasing ligament loading. The article therefore advises against routine DTM orthosis use for ligament injuries.

Scapholunate injuries: neutral orthosis with slight ulnar deviation. Lunotriquetral injuries: sometimes control of forearm rotation or slight radial deviation, according to the injury. Palmar midcarpal instability: pisiform support, dorsal-ulnar counterpressure and control of the clunk.

# 11. Early rehabilitation

Initial aims are pain and inflammation management, tissue protection, safe range and conscious proprioception. Proposed techniques include RICE, TENS, vibration, motor imagery, pain-free active movement and isometrics of protective muscles. Medicine-ball exercises can provide early sensorimotor work in a semi-closed chain.

# 12. Conscious proprioception

This involves joint-position sense and kinaesthesia. Position sense is trained with eyes closed, active repositioning and goniometric monitoring; the article regards an error below 3° as normal.

Kinaesthesia is the ability to detect passive movement and can be assessed manually or with robotic devices.

# 13. Unconscious proprioception

Sensory information is integrated by the cerebellum to regulate tone, anticipate perturbations and generate protective responses. Improving latency, recruitment, coordination and contraction quality improves dynamic stability.

# 14. Neuromuscular rehabilitation

The article describes static, concentric, eccentric, auxotonic and isokinetic contractions. Static contractions impose the least tissue loading. Dynamic work progressively incorporates changing loads, speed, functional movements and PNF diagonals. Three-dimensional isokinetic systems may support advanced functional training.

# 15. Reflex muscle activation

Reflex activation restores automatic joint locking. Feedforward anticipates a perturbation; feedback corrects an unpredictable one. Proposed exercises use rackets, oscillating bars, Powerball, Inimove and unstable tasks. Plyometrics are introduced late to optimise sensorimotor adaptation.

## 16. Reconditioning and return to sport

The final phase reproduces sporting movements, analyses compensatory biomechanics and addresses the whole kinetic chain. The spine, shoulder girdle and proximal control are particularly important: proximal control directly influences distal carpal loading.

## 17. Conclusion

The article brings together biomechanics, neuromuscular control, proprioception, hand therapy and advanced sports rehabilitation. Carpal stability never depends on ligaments alone: it also requires quality motor control, anticipatory strategies and sensorimotor adaptation to sporting demands.