Distal radioulnar joint instability: proprioceptive rehabilitation, neuromuscular control and active stability

Educational article - English edition

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Source article: Mesplié G et al. Rehabilitation of distal radioulnar joint instability. Hand Surgery and Rehabilitation, 2017.

1. General introduction

Distal radioulnar joint (DRUJ) instability is a complex wrist and forearm condition. Understanding long focused on passive structures, especially the TFCC. Mesplié and colleagues propose an approach integrating biomechanics, sensorimotor control and active stabilisation.

Stability depends not only on ligaments, bone surfaces and the TFCC, but also on muscular control, proprioception, reflex mechanisms and neuromuscular anticipation. This parallels modern knee, shoulder and ankle rehabilitation models.

2. The radioulnar complex: a whole biomechanical unit

The DRUJ cannot be assessed in isolation. The complex comprises the distal and proximal radioulnar joints, interosseous membrane, radius and ulna.

Under the “three locks” concept, one injury generally does not produce global instability because other elements compensate mechanically. Two simultaneous injuries, however, can destabilise the system. This helps explain occult instability, persistent pain after distal radius fracture, complex Essex-Lopresti instability and paradoxical restrictions of forearm rotation.

3. Functional anatomy

The DRUJ is intrinsically unstable: surfaces are relatively incongruent, have different radii of curvature and provide little bony interlocking. Approximately 60% of the articular surfaces contact in neutral, falling to around 10% in extreme pronation or supination.

Stability therefore relies principally on capsuloligamentous and muscular structures. This explains frequent instability, variable symptoms, dependence on muscle control and the difficulty of purely mechanical treatments.

4. The TFCC: a major passive stabiliser

Ligament function: the TFCC acts as a distal radioulnar ligament; superficial and deep bundles tension differently according to forearm rotation.

Load transmission: approximately 20% of axial carpal loading reaches the ulna through the TFCC.

Dynamic stabilisation: during gripping or “clamping”, it opposes radioulnar separation.

Proprioception: ligament structures contain mechanoreceptors contributing to neuromuscular regulation.

Only 10-40% of the ulnar side is vascularised; the radial zone is virtually avascular. This helps explain poor spontaneous healing, persistent chronic lesions and limitations of conservative care for some tears.

5. The interosseous membrane

This often underestimated structure transfers loads, stabilises the forearm and dynamically controls translation. Approximately 80% of loading passes through the radius at the wrist, whereas approximately 60% passes through the ulna at the elbow. The membrane progressively redistributes these forces.

This is essential because the radial head could not alone sustain all loading from the carpus, while the proximal ulnar compartment is better suited to compression. Intermediate ligament fibres form the membrane’s most functionally important part.

6. Pronator quadratus: an active stabiliser

Traditionally considered an accessory pronator, pronator quadratus (PQ) is presented as the principal active DRUJ stabiliser. It has a transverse superficial head with a mainly motor role and an oblique deep head with a mainly stabilising role.

The authors describe a radioulnar coapting component greater than the rotational component, especially in the deep head. This draws radius and ulna together and actively stabilises the DRUJ. Cited electromyographic studies show the deep head remains active even in supination, supporting a stabilising rather than predominantly movement-producing role.

7. Other muscles

Extensor carpi ulnaris (ECU) contributes through contraction and its sheath, regarded as integral to the TFCC. Potential contributions from supinator, pronator teres, radial wrist flexors and radial wrist extensors are also discussed, although their precise roles remain incompletely understood.

8. Proprioception

The authors distinguish spinal reflexes, brainstem control and cortical control. Joint stability depends on mechanical structures and the quality of neuromuscular responses.

Conscious proprioception involves perception of position, movement and loading. Unconscious proprioception involves automatic tone regulation, co-contractions, motor anticipation and stabilising

reflexes. This changes the goals of hand therapy.

9. Rehabilitation principles

Early phase: immobilisation in a stable range, pain and inflammation management, gentle isometric contractions and proprioceptive activation. Proposed approaches include RICE, motor imagery, TENS, vibration and joint-perception exercises.

Later phase: gradual range recovery, neuromuscular work, dynamic stabilisation and perturbation training. Exercises use an unstable ball, closed-chain activity, Powerball, reflex exercises and plyometrics.

The goal is to restore feedforward control-motor anticipation-and feedback-reflex corrective responses.

10. Clinical applications

Applications include chronic instability, recovery after distal radius fracture, TFCC injuries, persistent rotational pain and postoperative instability.

Rehabilitation should address not only mobility or overall strength, but especially dynamic stability, quality of motor control and reflex coordination.

11. Conclusion

Radioulnar stability is biomechanical, sensory, muscular and neurological. This perspective integrates anatomy, biomechanics, neurophysiology and motor control, bringing hand therapy closer to contemporary neuromuscular rehabilitation models used in sports medicine and advanced functional rehabilitation.