Midcarpal Instability
A Comprehensive Review and Update

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KEYWORDS

• Midcarpal instability • Wrist injury • Ligament • Snapping

KEY POINTS

- Midcarpal instability (MCI) has been well described as a clinical entity but the pathokinematics and pathologic anatomy continue to be poorly understood.
- MCI can be classified into intrinsic and extrinsic categories. The intrinsic category can be further subdivided into palmar, dorsal, or combined MCI instability.
- The midcarpal shift test is often diagnostic for assessment of MCI. Videofluoroscopy of the wrist can assist in diagnosis of MCI.
- Three-point splinting and proprioceptive training of dynamic wrist stabilizers (such as the extensor carpi ulnaris) can effectively manage many forms of MCI.
- The most common form of MCI is palmar MCI (PMCI). Reefing of the dorsal capsule can stabilize PMCI that persists after nonoperative management.

INTRODUCTION

Midcarpal instability (MCI) has been well described as a clinical entity but the pathokinematics and pathologic anatomy of this disorder are not fully understood. This discrepancy occurs because most theories on MCI pathomechanics and pathologic anatomy are derived from empiric clinical observations rather than quantifiable laboratory analyses. As a result, several clinical descriptors have been given to the entities resulting from the observed pathomechanics. These include the snapping wrist,[1] palmar MCI,[2] capitolunate instability pattern,[3] chronic capitolunate instability (CCI),[4] adaptive carpal instability,[5] and carpal instability nondissociative.[6] Although each of these descriptors has circumstantial evidence that suggests a specific, unique cause, they have in common some form of altered anatomy that leads to hypermobility of the proximal row. This results in changes in the flow of normal joint reaction forces across the midcarpal joint. An understanding of this normal flow of forces is essential to understanding MCI.

WRIST BIOMECHANICS

Since the 1500s, scientists have been intrigued by the mechanics of the wrist joint. Early descriptions of the wrist by Sir Charles Bell depicted the wrist as a "composite ball and socket articulation." In the following century, several illustrative models of wrist mechanics were developed to explain carpal structure and function. Among these were Navarro's[7] columnar model, the link theory described by Gilford and colleagues,[8] which was later modified by Taleisnik and Watson,[5] and

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the "slider crank" analogy envisioned by Linscheid and colleagues.[6] Their 1972 paper introduced the concepts of dorsal intercalated segment instability (DISI) and volar intercalated segment instability (VISI), further linking radiographic deformity to existing biomechanical models.

Although the carpus does behave as an intercalated link in certain pathologic circumstances, thinking of the scaphoid as a "slider crank" or the wrist as a "columnar" force model leads to confusion when trying to understand or predict the deformities and pathologic carpal interactions seen in various carpal instabilities. For this reason, the ring theory of wrist kinematics was introduced in 1981.[9] This concept envisions the carpus as 2 distinct transverse carpal rows connected by physiologic links at the scaphotrapezial (STT) and triquetrohamate (TH) joints. A key concept of the ring theory is that reciprocal motion occurs between the proximal and distal carpal rows during radial and ulnar deviation of the wrist. Each row, however, is intrinsically stable with individual components within the row moving synchronously in the same direction. In the normal wrist, radial deviation of the distal row (and hand) concentrates forces at the STT link, causing the proximal row to rotate into flexion; whereas ulnar deviation concentrates forces at the TH link, causing the proximal row to rotate into extension. External forces initiate radial and ulnar deviation but flexion and extension of the proximal row is induced and guided strictly by physiologic reactive forces acting across the radiocarpal and midcarpal joints. When the wrist is motionless, opposing joint reaction forces are balanced across the proximal row. In this balanced state, axial compression does not cause intercarpal motion or instability. Carpal instability occurs when there is a disruption of the bony or ligamentous ring within or between the proximal and distal carpal rows. In these circumstances the bony components are no longer connected, the intercarpal forces are no longer balanced, and each bony component is free to react to forces acting on it locally. Within the proximal row, this disruption leads to nonphysiologic dissociative deformities (ie, scapholunate or lunotriquetral instability) and between the 2 rows it results in MCI. Visualizing the ring model in this way, the clinically observed intercalated deformities and pathokinematic patterns are predicable based on the location of the pathologic anatomy and the locally applied force vectors.

In 1985, Palmer and colleagues[10] described the primary functional motions of the wrist to be radial deviation with extension and ulnar deviation with flexion, as in throwing a dart. This "dart thrower's motion" occurs primarily at the midcarpal joint. Preservation of normal biomechanics within the midcarpal joint is likely critical for this motion and has important implications clinically, particularly in cases of MCI.

CLASSIFICATION OF CARPAL INSTABILITIES

Carpal instabilities can be divided into perilunate (scapholunate and lunotriquetral), midcarpal, and proximal carpal instability patterns (**Box 1**). Linscheid and colleagues[6] preferred the terms dissociative, midcarpal nondissociative, and proximal carpal nondissociative, respectively. Perilunate instabilities are caused by disruptions between discrete components of the proximal carpal row as described by Mayfield and colleagues[11] in the

Box 1
Classification of carpal instabilities

- Perilunate instability (carpal instability dissociative)
  - Lesser arc pattern
    - Scapholunate instability
    - Lunotriquetral instability
    - Complete perilunate dislocation
  - Greater arc pattern
    - Scaphoid fracture
      - Stable
      - Unstable (DISI)
    - Naviculocapitate syndrome
    - Transscaphoid transtriquetral perilunate dislocations
    - Variations and combinations of greater arc injury patterns
- MCI (carpal instability nondissociative)
  - Intrinsic (ligamentous laxity)
    - Palmar MCI (VISI)
    - Dorsal MCI (DISI)
    - Combined
  - Extrinsic
- Proximal carpal instability
  - Ulnar translocation of the carpus
  - Dorsal instability (after dorsal rim fracture)
  - Palmar instability (after volar rim fracture)
- Miscellaneous
  - Axial
  - Periscaphoid