Forearm Instability: Anatomy, Biomechanics, and Treatment Options

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Continuing Medical Education

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All authors of this journal-based CME activity have no relevant conflicts of interest to disclose. In the printed or PDF version of this article, author affiliations can be found at the bottom of the first page.

Planners

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Learning Objectives

Upon completion of this CME activity, the learner should achieve an understanding of:

- Injury patterns leading to longitudinal forearm instability (Essex Lopresti)
- Anatomy of the interosseous membrane
- Structures involved that may lead to instability
- Diagnosis of longitudinal forearm instability
- Treatment options for forearm instability

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The forearm unit consists of the radius and ulna, a complex and interrelated set of joints (distal radioulnar joint, proximal radioulnar joint) and the soft tissue stabilizers between the 3 bones. Distally, this is represented by the triangular fibrocartilage complex at the wrist, proximally by the annular ligament at the elbow, and in the forearm by the interosseous membrane. Disruptions in any of these structures may lead to forearm instability, with consequences at each of the remaining structures. *(J Hand Surg Am. 2017;42(1):47–52. Copyright © 2017 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Forearm instability, Essex Lopresti, Galeazzi fracture, Monteggia fracture.

Additional Material at jhandsurg.org

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The radial head is the primary contributor to longitudinal forearm stability. Secondary stabilizers are the triangular fibrocartilage complex (TFCC) and the interosseous membrane (IOM), particularly its most functionally important component, the central band (CB), which functions as a restraining ligament. The roles of the TFCC and the IOM in forearm stability after radial head excision seem to be equivalent in importance.[1–3]

The IOM is a structure arising between the radius and the ulna that has multiple roles (Fig. 1).[4,a] We now know that it confers stability to the distal radioulnar joint (DRUJ) as well as providing longitudinal stability to the forearm and an origin for forearm musculature. Five discrete components of the IOM have been identified: the CB, the distal oblique bundle (DOB), an accessory band, a dorsal oblique accessory cord, and a proximal oblique cord. One of the most important functional components of the IOM is the central band which has a 21° proximal-radial to distal-ulnar orientation to the long axis of the ulna. The radial origin, which is slightly more narrow than the ulnar insertion, lies at approximately 60% of the length of the radius from the styloid, whereas the wider ulnar insertion is at about the junction of the middle two-thirds and the distal one-third of the ulna.[4,5]

The DOB of the IOM is a component running from the dorsal ulna, arising at approximately the level of the pronator quadratus, to the inferior rim of the sigmoid notch and the DRUJ capsule. Although the presence and anatomy of this bundle is variable across specimens, when present, it is involved in stability of the DRUJ in all forearm rotation positions and seems to be isometric in all positions.[4,6,7]

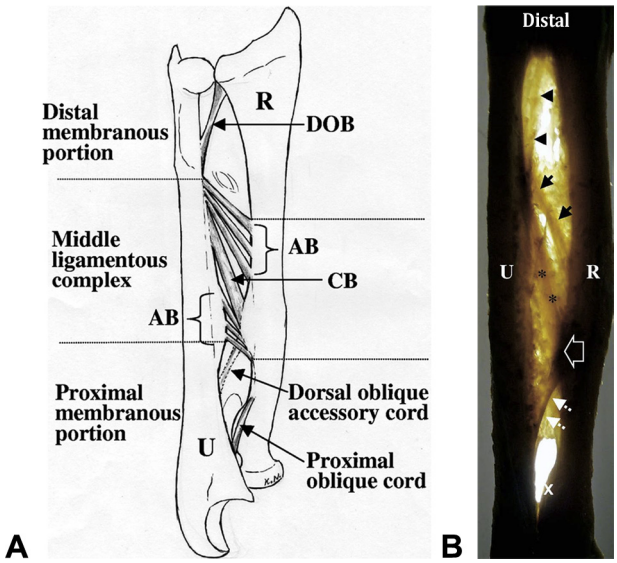

FIGURE 1: A Schematic structure of the IOM. Right forearm viewed from the anterior aspect. The IOM consists of distal, middle, and proximal portions. The middle portion is a ligamentous complex (middle ligamentous complex) that is further divisible into the central band (CB) and the accessory band (AB). Distal and proximal portions on either side of the middle portion comprise transparent membranous tissue (distal and proximal membranous portions) with holes for perforation of the interosseous artery. The DOB is present within the distal membranous portion. The proximal oblique cord is present on the anterior side of the forearm and the dorsal oblique accessory cord on the posterior side in the proximal membranous portion. R, radius; U, ulna. **B** Backlit photograph of IOM ligaments. Asterisks indicate the CB as part of the middle ligamentous complex, which originates from the interosseous crest of the radius (white arrow), runs distally and ulnarly, and inserts into the interosseous border of the ulna. Black arrows indicate the AB, which runs in a similar way to the CB. Black arrowheads indicate the DOB within the distal membranous portion, which originates from around the distal one-sixth of the ulnar shaft and inserts into the inferior rim of the sigmoid notch of the radius. Broken white arrows indicate the dorsal oblique accessory cord on the posterior aspect of the forearm, which originates from around the distal two-thirds of the ulnar shaft and inserts into the interosseous crest of the radius. The proximal oblique cord cannot be distinguished in this photograph because this cord is in contact with the surface of the radial tuberosity (x). R, radius; U, ulna. (**A** Reprinted from Noda K, Goto A, Murase T, Sugamoto K, Yoshikawa H, Moritomo H. Interosseous membrane of the forearm: an anatomical study of ligament attachment locations. *J Hand Surg Am.* 2009;34(3):415–422, Figures 2 and 3, with permission from Elsevier.)

INJURY PATTERNS

Galeazzi fracture-dislocation (reverse Monteggia, Piedmont fracture, or "fracture of necessity")

A fracture of the radial shaft, typically at the junction of the middle and distal thirds, may result in shortening and angulation and, therefore, disruption of the DRUJ. The typical mechanism of injury involves direct impact to the radius with forearm pronation.[8] Cadaver studies demonstrate that shortening of 0.5 cm or more is accompanied by DRUJ instability and shortening of > 1 cm occurs with concomitant disruption of the TFCC and the IOM, whereas shortening of 0.5 to 1 cm presents with disruption of either the TFCC or the IOM.[9]

Treatment of Galeazzi fractures is surgical fixation of the radius and stabilization of the DRUJ. The eponym "fracture of necessity" was coined to emphasize that surgical treatment is typically necessary. The diaphyseal bow of the radius is critical to restoring pronation and supination of the forearm as the radius rotates about the fixed ulna.

If the DRUJ is stable following fixation of the fracture, typically immobilization in neutral or supination for 2 to 4 weeks is adequate. If the DRUJ is