Graft Reconstruction of the Interosseous Membrane in Conjunction With Metallic Radial Head Replacement: A Cadaveric Study

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Purpose: Longitudinal radioulnar dissociation (Essex-Lopresti injury) occurs when traumatic axial loading through the wrist disrupts the interosseous membrane (IOM) of the forearm and fractures the radial head. Proximal migration of the radius results in an ulnar-positive wrist, which can lead to painful ulnar-sided wrist degeneration and distal radioulnar joint instability. The purpose of this study was to measure the ability of an IOM reconstruction used in combination with a metal prosthetic radial head implant to reduce distal ulnar forces in a cadaveric model. The effects of varying the initial graft pretension on distal ulnar force were also studied.

Methods: Twelve fresh frozen and thawed cadaveric forearms had a miniature load cell installed to record force in the distal ulna as the wrist was loaded axially to 134 N of compression force in neutral rotation. Intact forearms were tested first with the elbow in valgus and varus alignments. Loading tests were repeated after (1) insertion of a metal radial head implant that restored radius anatomic length, (2) excision of the IOM (with a radial head implant), and (3) reconstruction of the IOM using a palmaris longus tendon autograft (with a radial head implant). The implant then was removed and loading tests were repeated using 3 levels of initial graft pretension.

Results: Mean distal ulnar forces with an intact forearm were 23% of applied wrist force in the varus alignment and 12% in the valgus alignment. Mean force levels after insertion of the implant were 18% (varus) and 13% (valgus); these were not significantly different from corresponding values for the intact forearm. Mean force levels after section of the IOM were 30% (varus) and 14% (valgus); these were not significantly different from corresponding values for the intact forearm (varus and valgus) but the mean for varus was significantly greater than the corresponding value with an implant. After IOM reconstruction with a palmaris longus tendon tensioned to 22 N mean distal ulnar forces were 8% (varus) and 7% (valgus); these means were significantly less than the corresponding values for all prior test conditions. With the radial head removed increasing the level of graft pretension reduced significantly mean distal ulnar force.

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Conclusions: With the IOM resected insertion of a metal radial head implant alone did not reduce distal ulnar forces to intact forearm levels. When an IOM reconstruction was performed in combination with the implant mean distal ulnar force was reduced significantly to a level below that for the intact forearm. Applying pretension to the graft displaced the radius distally thereby making the wrist more ulnar negative and reducing distal ulnar force. Our results suggest that an IOM reconstruction used in combination with a metal radial head implant theoretically could help reduce distal ulnar impaction in an Essex-Lopresti injury. (J Hand Surg 2005;30A:335–342. Copyright © 2005 by the American Society for Surgery of the Hand.)

Key words: Essex-Lopresti, graft reconstruction, interosseous membrane, radial head replacement.

In 1946 Curr and Coe[1] described fracture-dislocation of the radial head in conjunction with distal radioulnar joint (DRUJ) dislocation. Today this pattern of injury is named after Essex-Lopresti, who in 1951 described traumatic axial loading through the wrist resulting in DRUJ instability, interosseous membrane (IOM) rupture, and fracture of the radial head.[2] In 1992 Trousdale et al[3] reported on proximal migration of the radius after comminuted radial head fracture and IOM injury, giving the condition the term *longitudinal radioulnar dissociation* (LRUD). During gripping activities proximal migration of the radius results in an ulnar-positive wrist with subsequent ulnocarpal impaction, painful ulnar-sided wrist degeneration, and DRUJ instability.[4–7] Interosseous membrane reconstruction has been studied in cadavers and performed in patients for the treatment of LRUD[3,7–10] (Pfaeffle et al, presented at the 49th annual meeting of the Orthopaedic Research Society, 2003; Osterman et al, presented at the 67th annual meeting of the American Academy of Orthopaedic Surgeons, 2000). Radial head replacement with a metal prosthesis also has been recommended in cases of comminuted radial head fracture in which internal fixation was not feasible.[6,8,11]

The purpose of this study was to measure the ability of an IOM graft reconstruction to alter distal ulnar forces when used in combination with a metallic radial head implant. The experimental objectives were to measure directly distal ulnar forces at the wrist as the forearm was loaded axially to 134 N under the following test conditions: forearm with IOM intact, after removal of the radial head and insertion of a radial head implant that restored anatomic radial length (IOM sectioned), after IOM graft reconstruction (radial head implant in place), and after varying the initial graft pretension (radial head removed).

Methods

Twelve fresh frozen and thawed cadaver forearms were used for this study. The donors ranged from 65 to 91 years of age (mean, 76 years); 8 were men and 4 were women. All cadaver forearm radiographs showed normal anatomy without significant prior wrist, forearm, or elbow pathology. All forearms were potted proximally at the distal humerus and distally using the central 3 metacarpals. The first and fifth metacarpals were removed. A specially designed miniature load cell was connected to prongs cemented into the distal part of the ulna for measurement of distal ulnar force. The potted humerus was mounted to a fixture attached to the crosshead of a materials testing system (MTS) machine (Model 812, MTS Systems Corp, Minneapolis, MN); and the elbow was flexed to 90° (Fig. 1). Load was applied to the potted central 3 metacarpals of the hand at a rate of approximately 1 mm/s; the maximum load applied was 134 N. All testing was performed with the wrist in neutral flexion–extension which was established by aligning the plane of the 3 potted metacarpals with the flexion–extension plane of the elbow.

Prior studies from this laboratory have shown that load sharing at the wrist is affected by the varus–valgus position of the elbow.[12–15] Valgus testing position was defined by applying a 2.5-Nm moment to the elbow that forced the radial head to contact the capitellum. Varus testing position was defined by applying a 2.5-Nm moment to the elbow that created a gap between the radial head and the capitellum. Further details on specimen mounting, load cell installation, and testing procedure are documented in our prior publications.[12,14]

The radial head implant used for this study (Evolve Modular Radial Head System, Wright Medical Technology, Arlington, TN) is a 2-part modular prosthesis with separate stem and head components of varying lengths and diameters. Using a hand-held micrometer with an accuracy of 0.05 mm we took a