Central Band Interosseous Membrane Reconstruction For Forearm Longitudinal Instability

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Abstract

Keywords

- interosseous membrane reconstruction
- forearm longitudinal instability
- forearm
- instability

Background The Essex-Lopresti injury results from injuries to the stabilizing structures of the forearm, the radial head, the interosseous membrane, and the triangular fibrocartilage complex.

Case Description/Literature Review We describe principles in approaching the patient with an acute or chronic Essex-Lopresti injury and describe surgical techniques to address these challenging cases both in the acute and chronic setting and describe outcomes of these techniques.

Clinical Relevance Further research into the role of the interosseous ligament in providing longitudinal and transverse stability to the forearm is likely to change our understanding of the Essex-Lopresti injury and alter management strategies.

The Essex-Lopresti injury results from a complex injury to the forearm axis with resultant longitudinal instability, which can be challenging to treat. The pathology includes issues at the wrist, forearm, and elbow and involves all three of these structures involved in forearm stability. Typically, this is represented by a radial head fracture and/or lateral ligament injury, distal radioulnar dislocation, and an injury to the central band of the interosseous membrane (IOM). Longitudinal instability may be apparent immediately, or may evolve over time when a damaged IOM fails over time.

In either case, the sequelae of forearm pain and weakness, ulnar impaction at the wrist, and radiocapitellar impingement proximally can ensue. Treatment in the acute setting is predicated upon recognition; and notably, early recognition and treatment result in improved outcomes. However, in one series there was an average delay in diagnosis of nearly 8 years, and in another series of 106 referred cases, the diagnosis was made only in 38% of cases.¹

Treatment is aimed at each site of pathology and different considerations are important in the acute and chronic setting. The most controversial, however, is the optimal treatment at

the forearm in terms of the IOM. This manuscript outlines strategies for treatment of the Essex-Lopresti injury, in particular, options for reconstruction of the IOM. We also document our experience with bone-patellar ligament-bone reconstruction and suture-button reconstruction of the central band of the interosseous ligament.

Surgical Technique

Treatment strategies for the Essex-Lopresti injury include considerations of the acuity versus chronicity of injury, and site-specific considerations (wrist, forearm, and elbow).

The elbow injury is typically a radial head fracture, but may alternatively or concomitantly be associated with a lateral-sided ligament injury. Treatment in the acute setting is aimed at restoration of the radial head and radial length, as the radial head is the primary stabilizer to the forearm against longitudinal instability. Radial head excision without radial head replacement is generally contraindicated in the acute setting for this reason. If radial head excision is considered in the setting of an unreconstructable radial head, one may use the

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"pull test" to ascertain the status of the IOM and the triangular fibrocartilage complex (TFCC). After radial head excision intraoperatively, 20 pounds of in-line traction is applied at the radial neck with the wrist being examined fluoroscopically for a change in ulnar variance.²

In contrast to the acute setting, in the chronic setting, prolonged radiocapitellar impingement as well as the inevitable damage to the capitellar cartilage both from original injury and continued impaction may make radial head replacement unsuccessful. Replacement of the radial head, although it improves forearm stability, without reconstruction of the IOM, does not result in restoration of normal forearm stability.³⁻⁶

Thus in the chronic setting, radial head excision may be a reasonable option, provided the IOM is reconstructed so that proximal migration of the radius and radiocapitellar impingement is halted. In addition or alternatively, replacement of the radial head and capitellum with radiocapitellar arthroplasty has been used as a treatment in the setting of chronic Essex-Lopresti elbow pain.⁷

At the wrist, in the acute setting, the distal radio-ulna joint (DRUJ) is reduced and stabilized, often with an open TFCC repair. In the chronic setting, ulnar impaction is a problem so the TFCC tear and synovitis is typically debrided arthroscopically, and a joint leveling procedure, most commonly an ulnar shortening osteotomy (USO), is performed.

Strategies at the forearm are varied and seem to be the most controversial part of treatment of the Essex-Lopresti injury. In the acute setting, some have proposed direct repair of the central band of the IOM, however, the nature of the disruption (typically intrasubstance tear), the location and muscle interposition which makes apposition of the thin central band components difficult, and the difficulty immobilizing the forearm make direct repair problematic.⁸ Others have suggested that simply restoring the stability at the wrist and elbow, and immobilizing the forearm may allow for some intrinsic healing. Augmentation or reconstruction of the IOM is our preferred treatment for the chronic setting.

Although a variety of materials have been proposed for augmentation or reconstruction of the IOM, we have favorable experiences with three different techniques. In the acute setting, the radial head is replaced, the wrist is stabilized, and the forearm IOM may be augmented with a strip of the pronator. This graft is less strong than reconstruction with a bone-ligament-bone graft, thus the latter is preferred in the chronic setting. A volar incision is made in the proximal radial forearm and the pronator is identified. The tendinous fibers are identified running from proximal ulnar to distal radial. The distal radial attachment site is left intact and the tendon fibers are traced proximally, carefully identifying and preserving the median nerve. The fibers proximally are detached from the muscle and rotated distally and ulnarly. Typically, the radial origin has to be "teased" away just a bit to allow the rotation of the graft. The graft is then rotated such that it is oriented 20 degrees to the long axis of the forearm to replicate the fibers of the IOM, and is passed under the soft tissues into a separate incision distally and ulnarly. It is secured to the distal ulna using bony tunnels and/or suture anchors (—Fig. 1)

Fig. 1 A 49-year-old woman bicyclist was involved in a bicyclist versus motor vehicle accident. She sustained a distal radio-ulna joint dislocation (A, B) and a comminuted radial head fracture (C). She underwent radial head replacement for her unreconstructable radial head (D, E), open reduction of the distal radio-ulna joint and triangular fibrocartilage complex repair, with a pronator graft augmentation of the interosseous membrane. At final follow-up of 2 years, she had no pain and slight change in ulnar variance (F). (Photo courtesy Julie E. Adams, MD.)

^{9,10}. An alternative in the acute setting is use of a suture-button construct, further described later.^{11,12}

The other technique for interosseous membrane reconstruction involves use of a bone-patellar tendon graft or a suture-button construct and is the favored technique in the chronic setting. If bone-patellar tendon-bone is used, most commonly allograft bone-ligament-bone is used. Autograft was used early in this series, but was accompanied by donor site morbidity with knee discomfort and risk of patellar fracture. The radial head is most commonly excised to eliminate pain at the radiocapitellar joint. Symptomatic ulnar impaction is addressed with a wrist arthroscopy, TFCC debridement and USO. The USO incision site represents the placement site of the ulnar portion of the bone-ligament-bone graft for reconstruction of the IOM. A trough is created on the ulna for inset of the bone portion of the graft, which is secured in place with a 3.5 mm screw. The graft is then passed under the extensor tendons and muscles dorsally aiming proximal and radial to replicate the 20-degree orientation of the central band of the IOM. A second incision is made proximally and radially over the graft which is passed with a Kelly clamp, and a trough is prepared in the radius for inset of the bony portion (→ **Fig. 2**). The graft is tensioned in semi-supination and secured with a screw through the bone and into the radius. Alternatively, a suture-button construct may be used. In this technique, a guide pin is passed from the radius at the interval between the radial wrist extensors and brachioradialis, toward ulna, exiting near the proximal portion of the USO plate,

Fig. 2 Bone ligament reconstruction may be particularly useful in the setting of a chronic Essex-Lopresti lesion. A bone-patellar tendon-bone graft may be obtained and will be oriented in a 20-degree orientation to the forearm axis, replicating the fibers of the central band of the interosseous membrane (A). The attachment site at the ulnar side is shown adjacent to the ulnar shortening osteotomy site (B). The graft passed beneath the extensor tendons and emerges between the extensor carpi radialis longus and brachioradialis; it is tensioned in semi-supination and secured to the radius. (Photo courtesy A. Lee Osterman, MD.)

Fig. 3 A patient with a chronic Essex-Lopresti injury had lateral-sided elbow instability addressed with a ligament reconstruction. The patient developed ulnar impaction, which was treated with an ulnar shortening osteotomy. The forearm interosseous membrane was reconstructed using a suture-button construct. (Photo courtesy Randall W. Culp, MD.)

mirroring the orientation of the IOM. A cannulated drill is used to overdrill and the suture is passed. It is then tensioned in neutral to 20 degrees of forearm supination, and tied over suture buttons on the radius and ulna (→ **Fig. 3**).¹¹⁻¹⁴

Results

In a series of 16 patients who underwent IOM reconstruction with bone-patellar tendon-bone autograft, 94% stated that wrist discomfort was improved. Grip strength improved 31% from preoperative values. Knee ache was problematic in 25%, particularly with weather changes. Ulnar variance, which preoperatively averaged +3 mm was average -2 mm postoperatively and remained relatively well preserved at -1.5 mm at final follow-up. Risks associated with this procedure include scarring about the extensor tendons, posterior interosseous nerve irritation, and failure of the bone to incorporate into the radial or ulnar troughs.^{13,14}

Instead of bone-tendon-bone graft, a suture-button construct has been used to reconstruct the central band of the IOM. In a series of 10 patients with chronic forearm instability, patients underwent IOM reconstruction with the suture-button construct, USO, and wrist arthroscopy. At mean follow-up of 34 months (range, 15-57 months), the disabilities of the arm, shoulder and hand scores (QuickDASH), ulnar variance, wrist range of motion, and elbow range of motion improved in a statistically significant fashion. Grip strength and forearm rotation also improved, although not statistically significant. Nine of

the ten patients reported subjective satisfaction following the procedure. Three patients required additional surgery following the reconstruction; one underwent further USO, another sustained a fracture through the radial bone tunnel of the suture-button construct and underwent an open reduction internal fixation, and a third patient had restricted forearm rotation due to dorsal subluxation of the distal ulna at the DRUJ, and underwent removal of the suture-button construct and correction at the DRUJ with a closing wedge osteotomy of the ulna.¹²

Discussion

In this manuscript we describe our algorithm and rationale for treatment of the Essex-Lopresti injury. Our understanding of the Essex-Lopresti injury and the IOM has evolved over time. Although the Essex-Lopresti injury was originally described as an injury of the radial head with DRUJ disruption, we now know that injury to the IOM is an important factor in the pathology. Interestingly, Essex-Lopresti recognized the importance of reconstructing the radial head and reducing the DRUJ in his original series,¹⁵ which remain cornerstones of treatment in the acute setting. Management strategies at the forearm remain a subject of controversy, however, these authors have favorable experiences with bone-ligament-bone allograft reconstruction of the central band of the IOM in the chronic setting. However, recent evidence challenges the notion that the most important function of the IOM is its role in longitudinal instability. It appears that the IOM not only plays a role in longitudinal stability of the forearm but is also important in transverse stability of the forearm, resisting the radius from dissociating transversely from the ulna. Likewise, the dominant importance of the central band portion of the IOM in stabilization of the forearm is likewise now contested. Although the central band contributes to transverse stability, it seems that the proximal band of the IOM and the annular ligament are equally important in providing transverse stability. Although the central band alone is reconstructed with most IOM reconstruction techniques, perhaps future reconstructive strategies will incorporate methods to reconstruct the other important factors.¹⁶

Conflict of Interest

One or more of the authors report a relationship with Arthex (J.E.A., A.L.O., R.W.C.), AM Surgical (A.L.O.), Bcomet (J.E.A., A.L.O.), Skeletal Dynamics (A.L.O.), Auxilium Pharmaceuticals (A.L.O., R.W.C.), ArthroSurface Inc. (R.W.C.), and Small Bone Innovations (R.W.C.).

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