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Ligament reconstruction using the Fulkerson-Watson method to treat chronic isolated distal radioulnar joint instability: short-term results

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Objective: Isolated distal radioulnar instability may remain unrecognized during the acute period of trauma as it is difficult to diagnose, and does not become obvious until later when it has become chronic. We present early results in patients who underwent stabilization with extraarticular ligament reconstruction (Fulkerson-Watson reconstruction).

Methods: Four women and 1 man underwent surgery for chronic isolated distal radioulnar joint instability demonstrated in X-rays and magnetic resonance images. Arthroscopy revealed avulsion of the triangular fibrocartilage complex from the point of insertion in 3 patients, and peripheral tears in 2 patients. The peripheral tears were debrided arthroscopically. All patients had an adequate sigmoid notch and therefore underwent ligament reconstruction using the Fulkerson-Watson method. Postoperative evaluations were done with MRI.

Results: Mean follow-up was 15.5 months (range 6–26 months). Stability was achieved in all patients. The mean Quick-DASH symptom score decreased from 18.63 (15.90–22.72) to 6.81 (2.27–9.09) after surgery. A mean visual analogue score to assess pain decreased from 7.32 (6.30–8.40) to 1.88 (1.50–2.30) after surgery. Preoperative and postoperative measurements were 26° (passive 44°) and 47° (passive 65°) for active supination, 18° (passive 45°) and 49° (passive 68°) for active pronation, 20° (passive 43°) and 42° (passive 60°) for active wrist flexion, and 38° (passive 52°) and 45° (passive 59°) for active wrist extension.

Conclusion: Surgical revision of distal radioulnar joint instability using Fulkerson-Watson reconstruction is easier than intraarticular techniques and satisfactorily re-establishes stability, provided that the sigmoid notch is adequate.

Key words: Distal radioulnar joint; instability; ligament reconstruction; triangular fibrocartilage complex.

The distal radioulnar joint (DRUJ) works together with the proximal radioulnar joint in providing longitudinal rotation of the hand. The stability of the DRUJ is provided by the geometry of the joint and radioulnar ligaments, and the triangular fibrocartilage complex (TFCC) contributes significantly to this stability.[1-3] Instability of the DRUJ is often associated with fractures of the radius and ulna, and isolated distal radioulnar instability is rare.[4,5] The lesion causing instability is frequently not recognized during trau-

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Fig. 1. A tendon graft is passed through a hole drilled vertically into the distal radius; after looping around the ulnar diaphysis, it is then sutured over itself tightly (as described by Fulkerson and Watson).

Fig. 2. Increased distance between the radius and ulna in anteroposterior X-ray.

ma, and patients present later with significant pain that interferes with daily activities, with decreased grip strength and limitation of wrist movement. This study evaluated short-term results in patients with DRUJ instability treated with ligament reconstruction as described by Fulkerson and Watson.

Patients and methods

Five patients, 4 women and 1 man mean age: 26.2 years; range: 20 to 38 years), who had undergone surgery for isolated DRUJ instability were retrospectively evaluated. The dominant hand was affected in all patients. None had a history of bone injury to the radius or ulna. Symptoms, interval between trauma and referral to hospital, pain on DRUJ compression test and translation test were documented. X-ray studies, with full pronation and supination, and magnetic resonance imaging (MRI) were performed, and all patients underwent arthroscopy. Surgery was performed using a lazy S incision beginning at the distal radioulnar joint and extending proximally to the ulnar diaphysis. A vertical hole was drilled in the distal radius, and a palmaris longus tendon graft was harvested and passed through this hole. The graft was then passed around the ulnar diaphysis and finally sutured over itself under tension (Fig. 1). The volar aspect of the 5th extensor compartment was repaired. An above-elbow cast in neutral position was applied for 4 weeks, followed by rehabilitation.

The Quick Disabilities of the Arm, Shoulder and Hand Questionnaire (Quick-DASH) and a visual analogue scale (VAS) were applied pre- and postoperatively.

Results

The mean interval between trauma and referral to hospital was 4.9 years (range: 1 to 15 years) All had chronic wrist pain, pain in the DRUJ compression test, a positive translation test with pain and limitation during rotation. A painful sliding movement of the ulna over the radius was observed in two patients.

X-rays showed an increased radioulnar space in 2 patients (Fig. 2), and subluxation of the distal ulna in 3 patients (Fig. 3). MRI showed lesions of the TFCC in 3 patients, increased joint fluid (Fig. 4), and injury to volar or dorsal DRUJ ligaments in all patients (Fig. 5).

At arthroscopy, 3 patients showed avulsion of the TFCC from the radial insertion point, and the remaining two had peripheral tears which were debrided. All patients underwent surgical revision using the Fulkerson-Watson method.

Mean follow up was 15.5 months (range: 6 to 26 months). Stability was achieved in all patients, and all returned to their previous occupations. Postoperative X-rays showed that the tendon graft formed an indentation on the point where it rotates around the ulna, causing a decrease in the diameter of the bone (Fig. 6). The mean preoperative Quick-DASH score was 18.63 (15.90–22.72) and decreased to 6.81 (2.27–9.09) after surgery. The mean VAS score decreased from 7.32 (6.30–6.40) to 1.88 (1.50–2.30) after surgery (Table 1).

Preoperative and postoperative measurements were 26° (passive 44°) and 47° (passive 65°) for active supination, 18° (passive 45°) and 49° (passive 68°) for active pronation, 20° (passive 43°) and 42° (passive 60°) for active wrist flexion, 38° (passive 52°) and 45° (passive 59°) for active wrist extension (Table 2).

Discussion

The proximal and distal radioulnar joints work together in the axial rotation of the forearm, which normally has a range of motion of more than 150 degrees. This movement involves all structures in the forearm and is enabled proximally by rotation of the radial head on the immobile ulna, and distally by the rotation of the ulnar head on the radius. The ulnar head is important in the more proximal transmission of axial loads applied to the radius.[1,6]

Fig. 3. Lateral X-ray shows dorsal subluxation of the ulna.

In the distal radius, a semicylindrically shaped sigmoid notch articulates with the convex ulnar head. It is, however, very shallow and therefore contributes very little to the stability of the DRUJ. The ulnar head is separated from the carpal bones by the TFCC.[2-7] The normal ulnar head is inclined 20°

Fig. 4. MRI shows increased joint fluid in the DRUJ.

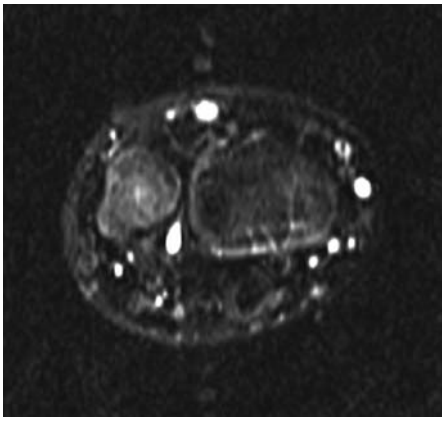

Fig. 5. MRI shows increased fluid and detachment of DRUJ volar ligaments.

Table 1. The pre- and postoperative Quick-DASH and VAS scores.

Patient	Quick-DASH		VAS (cm)	
	Preoperative	Postoperative	Preoperative	Postoperative
1	18.18	9.09	6.3	2.1
2	20.45	6.82	7.8	2.3
3	22.72	4.55	8.4	1.7
4	15.90	2.27	6.9	1.5
5	15.90	4.55	7.2	1.8

from the central axis of the ulna, and the inclination of the sigmoid notch of the radius is the same.[8] The relationship between the radius sigmoid notch and ulnar head allows rotational and translational movements. The TFCC inserts on the corner between the lunate face of the radius and sigmoid notch. The TFCC and radioulnar ligaments play a significant role in DRUJ stability. The TFCC also contributes to longitudinal stability of the DRUJ by preventing distal migration of the radius.[2,6,7,9] During forearm rotation, the tightening of soft tissues provides stability. During supination, the dorsal radioulnar ligaments tighten, and during pronation the palmar radioulnar ligaments tighten. The pronator quadratus, extensor carpi ulnaris, the joint capsule and interosseous membrane also play important roles in stability.[1,4,6,10]

Posttraumatic loss of integrity of these structures leads to instability, presenting with decreased grip power and mechanical symptoms.[9] The ulnar head is displaced proximally during supination and distally during pronation. This is more evident when there is a length discrepancy between the radius and ulna, also termed ulnar variance.[6] Instability of the DRUJ may be seen in conjunction with radial head fractures, radius diaphysis fractures, distal ulnar dislocations (Galeazzi) or comminuted fractures of the radial head. Instabilities of the DRUJ often go unnoticed in acute trauma.[5,11,12] If they are suspected, appropriate radiological studies will enable early diagnosis.[5] Although isolated DRUJ instability is uncommon, dorsal and volar dislocation may occur after falls with the forearm in hyperpronation and hypersupina-

Fig. 6. X-ray shows that the graft formed an indentation in the ulna.

Fig. 7. X-ray of a patient with a more proximal location of the graft and the indentation in the ulna.

Table 2. The pre- and postoperative ranges of motion.

Patient	Supination (°) active (passive)		Pronation (°) active (passive)		Wrist flexion (°) active (passive)		Wrist extension (°) active (passive)	
	Preoperative	Postoperative	Preoperative	Postoperative	Preoperative	Postoperative	Preoperative	Postoperative
1	30 (50)	50 (65)	20 (50)	50 (70)	15 (40)	40 (60)	30 (40)	40 (60)
2	25 (40)	40 (60)	15 (40)	60 (80)	20 (45)	45 (60)	40 (50)	40 (60)
3	20 (40)	40 (60)	10 (50)	30 (60)	10 (30)	35 (50)	35 (50)	45 (60)
4	40 (60)	55 (70)	25 (40)	50 (70)	25 (50)	40 (60)	40 (60)	50 (60)
5	15 (30)	50 (70)	20 (45)	55 (65)	30 (50)	50 (70)	45 (60)	50 (55)

tion. Four of our patients had a history of a fall directly onto the wrist which was followed by wrist pain.

The mean interval between the trauma in 4 patients and second referral to the clinic due to instability was 4.9 (range: 1-15) years. The patient with the longest duration of symptoms presented due to intense pain that had worsened during the past year along with a visible click during rotation. Only one of these patients had received splinting during the acute phase, and all had been treated with analgesics. Mittal et al. described a patient with isolated volar DRUJ dislocation treated completely during the acute phase with 4 weeks of above-elbow casting.[13] Such cases becomes difficult to diagnose if the instability is not detected during the acute phase.

The DRUJ in such patients must be palpated for tenderness. The anteroposterior translation between the radius and ulna is tested with the DRUJ piano test.[14] Diagnosis is easier in patients who have visible dislocation and reduction of the ulnar head in and out of the sigmoid notch. Two of our patients had an evident click due to easily visible instability. Pain in the compression test was especially noted close to the volar aspect, between the flexor carpi ulnaris and ulnar styloid. All patients had increased translation of the ulna around the radius. Translation, supination, and pronation were evaluated in neutral rotation. We believe that translation should be evaluated in the neutral position. Bilateral hyperlaxity is possible and mandates bilateral evaluation in such patients.

Radiologic studies for the diagnosis of DRUJ instability include plain X-rays, CT or MRI. Increased DRUJ space, dorsal or volar subluxation in lateral views, ulnar impaction and DRUJ arthritis suggest DRUJ instability. However, X-rays may not always show DRUJ instability. A true lateral view is mandatory.[9-13] Only three of our patients had findings in plain X-rays. Two of these had increased DRUJ space in the anteroposterior view, and all had dorsal displacement of the ulnar head relative to the radius. MRI is helpful in the evaluation of joint surfaces, ligaments and tendons, and especially in showing lesions of the TFCC in chronic wrist pain.[15,16] Taken together with physical examination, detection of increased DRUJ fluid and injury to the volar and dorsal ligaments at MRI is helpful in establishing the diagnosis of DRUJ instability.

The suitability of the sigmoid notch must be evaluated before ligament reconstruction. Although this is best done with CT, it is also possible with MRI. The presence of a congenital straight sigmoid notch and the adequacy of the volar and dorsal corners of the notch to provide stability must be confirmed.[9,15] If the DRUJ is not congruent, ligament reconstruction is contraindicated. Arthroscopy enables examination of the scapholunate and lunotriquetral ligaments, and the diagnosis of arthrotic changes and TFCC injuries.

Diagnosis of TFCC injuries in the radial insertion site using MRI is difficult. Arthroscopy is better in such lesions and also enables immediate minimally invasive debridement of TFCC lesions.[16] One patient in our series underwent ligament reconstruction for scapholunate instability. None of the others had chondral pathologies or injuries to the scapholunate or lunotriquetral ligaments. Arthroscopy revealed avulsion of the TFCC at the radial insertion in 3 patients, and two others underwent debridement for peripheral TFCC tears. Arthroscopy is needed prior to debridement, as it can help in the evaluation of

TFCC injuries at the radial insertion site. Failure to recognize and treat TFCC lesions in DRUJ instability will lead to persistence of pain in the ulnar wrist.

DRUJ surgery has three access routes: dorsal, volar and ulnar. Volar access is used more commonly for fractures and malunions of the distal radius, and recently it has been described for the exposure of DRUJ and retraction of the flexor tendons. Guyon's canal must be opened and the neurovascular bundle retracted to gain access to the DRUJ. The ulnar subcutaneous approach is often used for styloid fractures.[17] The dorsal approach requires a shorter incision and there is less danger of disturbing neurovascular structures. We used a modified dorsoulnar approach in our patients and believe that this allows sufficient exposure of the DRUJ, distal radius and ulnar diaphysis. Tendon reconstruction requires that a vertical drill hole be made in the distal radius; the tendon is passed through this tunnel, then passed around the ulna, and finally sutured over itself. Therefore, instead of an incision over the fifth extensor compartment, we used an S-shaped dorsoulnar incision beginning at the DRUJ and extending proximally to the ulnar shaft.

The pathogenesis of DRUJ instability is complex and poorly understood. Numerous ligament reconstruction methods have been described for the treatment of DRUJ instability.[9,18,19] Soft tissue procedures can be classified into 3 groups: extraarticular direct radioulnar tethering, methods that provide indirect radioulnar stability with tenodesis or an ulnocarpal sling, and methods involving radioulnar ligament reconstruction.[9,13]

Ligament reconstruction can be performed extra- or intraarticularly. Extraarticular repairs aim to establish stability between the radius and ulna and are easier than intraarticular techniques.[9,18] Ulnocarpal tenodesis does not provide sufficient stability. Intraarticular procedures in general are technically demanding, and affect secondary stabilizers such as TFCC remnants, the extensor retinaculum and the joint capsule when for radioulnar ligament reconstruction.[9,17] The extensor retinaculum and the joint capsule are opened to apply the technique. Also, most anatomical reconstruction techniques require drilling a hole for the passage of a graft in the foveal part of the ulna, which is the exit point of vessels that feed the TFCC. We therefore gave preference to an extraarticular technique. Preserving balanced rotation of the forearm after reconstruction around the ulnar head is difficult, and limitation of supination and pronation is a possible sequela.[9,18] We did not observe any such postoperative problems with rotation.

We tried to keep the drill hole on the radius as close to the joint as possible. From our experience, however, we believe that the distance to the DRUJ does not affect stability. We drilled a more proximal hole in one case, and here an indentation formed on the ulna, which we believe is a sign of adequate tension (Fig. 7). After the hole is drilled in the radius, passage of the tendon graft and recovery through the volar aspect is difficult, but is facilitated by the passage of a cerclage wire before the tendon. The tendon must be placed to allow the two ends to meet at the midpoint. If the graft is adequate, a knot is made in the tendon itself before fixation with 4/0 prolene. In one patient with severe instability of the DRUJ, we first fixed the joint with a K-wire under fluoroscopy and then reconstructed the ligament. The joint was not prestabilized in this way in the other patients and, after tendon repair, stability was satisfactory. If this manoeuvre shows decreased and persistent instability, temporary fixation of the DRUJ for 3 weeks may be considered.

Isolated instability of the DRUJ is rare and difficult to diagnose. It should be suspected in patients with wrist pain and no history of fractures. In patients with an adequately deep sigmoid notch, the operation described by Fulkerson and Watson is less complicated than intraarticular techniques and yields satisfactory results.[19]

Conflicts of Interest: No conflicts declared.

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