

# 15

## Hand and Wrist Tendinopathies

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### Introduction

More than half of all occupational disorders can be attributed to chronic tendinous pathologies [1]. A large percentage of these involve the hand and wrist, and constitute a significant economic burden to society. The risk of hand and wrist tendinopathy in patients who perform highly repetitive and forceful jobs is 29 times greater than in patients who perform jobs that are low in repetitiveness and force [2]. A number of terms have been used to categorize wrist and hand tendon disorders in the literature, including overuse injury, repetitive strain injury and, more recently, cumulative trauma disorder (CTD). These terms reflect a common presumed etiology based on repetitive loading leading to tendinopathy and/or tenosynovitis. Chronic tendon disorders are also frequently seen in various sporting activities, both at professional and amateur levels. Racquet sports in particular are commonly associated with wrist and hand tendinopathies [3,4]. Other sports commonly associated with wrist tendinopathies include golf, weightlifting, gymnastics, and bicycling [3,4,5].

Because of the complex organization of tendons about the wrist and hand, reaching an exact diagnosis can be difficult. This chapter has been arranged by anatomical site in order to contrast diagnoses. Common differential diagnoses for each region are presented in tabular form (Table 15-1). Regardless of the etiology, chronic tendon disorders generally respond to nonoperative management, but frequently require lengthy treatment with unpredictable outcomes. The initial course of nonoperative treatment is generally the same regardless of anatomical site. Surgical intervention in tendon pathology can present important technical challenges. The authors' preferred surgical approach will be discussed in detail within each anatomical subsection.

### Diagnostic Approach

As with the evaluation of any musculoskeletal disorder, a thorough history and physical examination is essential. This is followed by selective anesthetic injections (often the best diagnostic test) and by imaging when necessary. Particularly important in hand and wrist tendinopathies is the precise definition of the exact location of pain. In acute pathology, patients can frequently localize the area of most significant pain with one finger and this can be the most important diagnostic clue (Table 15-1). In chronic situations, the pain becomes more diffuse, and accurate diagnosis becomes more dependent upon provocative testing and selective anesthetic injections. The role of magnetic resonance imaging (MRI) and ultrasound is still controversial, although, in selected cases, both of these imaging techniques can be important for accurate diagnosis.

### Nonoperative Management

As with chronic tendon disorders in other parts of the body, nonoperative therapy is almost always the initial management of choice in hand and wrist tendon disorders. This may include rest, with limitation of the inciting activity, part-time immobilization using removable splints, complete immobilization using casts or, more commonly in the hand and wrist, nonremovable orthoses. Nonsteroidal anti-inflammatory drugs (NSAIDs) may play a role, but should be used with caution when the inciting event is not discontinued (in a professional athlete or laborer), as their analgesic effect may allow increased mechanical loading, leading to rupture. Physiotherapy offers both acute anti-inflammatory management (ice, ultrasound, and electrical modalities) and long-term proprioceptive rehabilitation, which may play a role in

TABLE 15-1. Differential diagnosis of wrist pain

Site of maximal wrist pain	Common differential diagnoses
Dorsoradial	<ol style="list-style-type: none"> <li>1. De Quervain's tenosynovitis (1st extensor compartment)</li> <li>2. Intersection syndrome (2nd extensor compartment)</li> <li>3. EDB manus syndrome</li> </ol>
Middorsal	<ol style="list-style-type: none"> <li>1. Dorsoradial ganglion</li> <li>2. EPL tenosynovitis (3rd extensor compartment)</li> <li>3. EIP tenosynovitis (4th extensor compartment)</li> <li>4. EDC tenosynovitis/4th extensor compartment syndrome</li> </ol>
Dorsoulnar	<ol style="list-style-type: none"> <li>1. ECU stenosing tenosynovitis (6th extensor compartment)</li> <li>2. ECU recurrent subluxation/dislocation (6th extensor compartment)</li> <li>3. EDM stenosing tenosynovitis (5th extensor compartment)</li> </ol>
Volar-radial	<ol style="list-style-type: none"> <li>1. De Quervain's tenosynovitis (1st extensor compartment)</li> <li>2. OA of 1st CMC joint</li> <li>3. Ganglia</li> <li>4. Scaphoid cysts/fracture</li> <li>5. FCR tendinopathy</li> <li>6. Linburg's syndrome</li> </ol>
Midvolar	<ol style="list-style-type: none"> <li>1. Carpal tunnel syndrome</li> <li>2. Linburg's syndrome</li> </ol>
Volar-ulnar	<ol style="list-style-type: none"> <li>1. FCU tenosynovitis</li> <li>2. Guyon's canal syndrome</li> <li>3. Pisotriquetral arthritis</li> </ol>

secondary prevention. Steroid injections of tendon sheaths remain an effective form of treatment, although controversy continues to exist regarding their safety and the number and frequency of injections [6]. The effects of direct intratendinous injection of corticosteroids have not been scientifically studied, and such treatment can therefore not be recommended.

Once the patient is asymptomatic (whether by operative or nonoperative means), a period of rehabilitation emphasizing proprioception and controlled activity simulation prior to returning to full activity is essential. Recurrence of the tendinopathy can be common if this part of the treatment protocol is ignored. For laborers, a work hardening program involving occupational therapy might be considered.

## Dorsal-Radial Wrist Pain

### 1. De Quervain's Tenosynovitis

Described in 1895 by de Quervain, this tendon disorder involves both the extensor pollicis brevis (EPB) and the

abductor pollicis longus (APL), which originate from the middorsal aspect of the radius and ulna. They travel through a fibro-osseous tunnel (first dorsal extensor compartment) and form the radial border of the anatomical snuffbox. The APL inserts at the base of the first metacarpal, and the EPB inserts at the base of the first proximal phalanx. Both cadaveric and surgical dissections have demonstrated significant variations in the anatomy of the first extensor compartment. Further division within the fibro-osseous tunnel by a septum has been noted in 34% to 60% of cases [7–10]. This septum effectively creates a separate compartment for the EPB tendon within the first dorsal extensor compartment, and plays an important role in the effectiveness of steroid injections and surgical release. The APL has been noted to have more than one tendinous slip (usually 2 to 4) in 58% to 94% of dissections, while the EPB is almost always represented by a single tendon [7–10].

Despite the anatomic variations, the clinical presentation is fairly characteristic. The classic triad consists of tenderness over the radial styloid, swelling over the first extensor compartment, and a positive Finkelstein's test. More specifically, the patient usually presents with a complaint of pain of insidious onset localized over the radial styloid and exacerbated by wrist or thumb movement (usually ulnar deviation). The symptoms are often present for many months prior to seeking medical attention. If the condition is related to athletic activity, it is most commonly associated with golf, racquet sports, and fly fishing [3]. Swelling along the course of the first extensor compartment is inconsistent. Tenderness over the retinaculum is constant [11]. Extensor triggering or locking, demonstrated by a palpable and sometimes audible "click" with active extension of the thumb, is an uncommon (prevalence of 1.3%) but recognized component of long-standing stenosing tenosynovitis [12].

Objectively, the most reliable sign is Finkelstein's test, although it can be negative when the EPB alone is involved [11]. The test is performed *passively* by deviating the wrist ulnarly with the thumb lying along the palmar aspect of the index lightly clenched within the fingers. Clenching the thumb too tightly causes pain even in normal wrists [13]. Finkelstein's test reproduces the patient's symptoms, with pain along the first extensor compartment. Resisted thumb extension can also provoke the symptoms but is a less reliable test. In difficult cases, ultrasonography has recently been reported as a reliable method of diagnosing de Quervain's tenosynovitis [14]. The differential diagnosis includes intersection syndrome, which usually presents with pain more proximally (see Intersection Syndrome).

*Provocative test:* Finkelstein's test (see text).

## Management

Nonoperative treatment is generally successful. In particular, steroid injection into the tendon sheath is the preferred initial treatment, with an 80% success rate [15]. Failure of steroid injection is usually associated with the existence of a septum forming a separate EPB subcompartment. Steroid injections can be repeated up to 3 times. Failure at this point is an indication for operative release, which is generally successful. Extensor triggering is a relative indication for operative decompression, as nonoperative intervention, including steroids, has poor results [12].

Decompression can be performed through a transverse or longitudinal incision over the first extensor compartment at the level of the radial styloid. Care must be taken to avoid traction on the dorsal radial sensory nerve. The compartment is released on the dorsal aspect to prevent volar subluxation of the tendons with thumb motion. It is important to accurately identify all slips of the APL tendons and to completely divide any septations creating EPB subcompartments. Complications of this procedure include injury to the dorsal radial sensory nerve, volar tendon subluxation, hypertrophic scarring, tendinous adhesions, and persistence of symptoms due to incomplete decompression (missed subcompartments). Postoperatively, a thumb spica is used for 2 to 3 weeks before beginning rehabilitation. Inciting activities are restricted for another 6 weeks or until rehabilitation is completed.

## 2. Intersection Syndrome

Intersection syndrome presents with pain and swelling localized to the dorsum of the distal forearm, approximately 4 to 6 cm proximal to the wrist. In this area, the abductor pollicis longus (APL) and extensor pollicis brevis (EPB) intersect the extensor carpi radialis brevis (ECRB) and longus (ECRL) (see Figure 15-1). The basic pathology is thought to result from friction at this intersection point between the muscle bellies and tendons, leading to tendinopathy and/or bursitis. The exact pathoanatomy of the intersection syndrome remains elusive, thus explaining the plethora of terms used to describe it including abductor pollicis longus bursitis [16], crossover tendinitis, squeaker's wrist, and peritendinitis crepitans [17].

A high index of suspicion is the key to diagnosis. Symptoms occur after prolonged repetitive activity, usually involving flexion and extension of the wrist with eccentric loading of the extensor compartment (e.g. hammering). Although predominantly seen in the work environment, certain athletic activities can lead to intersection syndrome. "Bugaboo forearm" in deep-powder helicopter skiers has recently been described, resulting from repetitive extension and radial deviation of the wrist against the resistance of deep snow on withdrawal of

the planted pole [18]. Racquet sport players [19] and oarsmen [17] are also vulnerable to this condition. In addition to localized pain and swelling, crepitus is sometimes palpable (and audible) with flexion and extension of the wrist. This is pathognomonic of the syndrome. Weak pinch and diminished grasp may also be seen. The differential diagnosis includes de Quervain's tenosynovitis, which presents with pain and swelling more distally in the first extensor compartment [20,21]. The Finkelstein's test may be positive in patients with intersection syndrome, but the pain experienced is more proximal, in contrast to de Quervain's tenosynovitis, where the pain is in the first extensor compartment (Figure 15-1A).

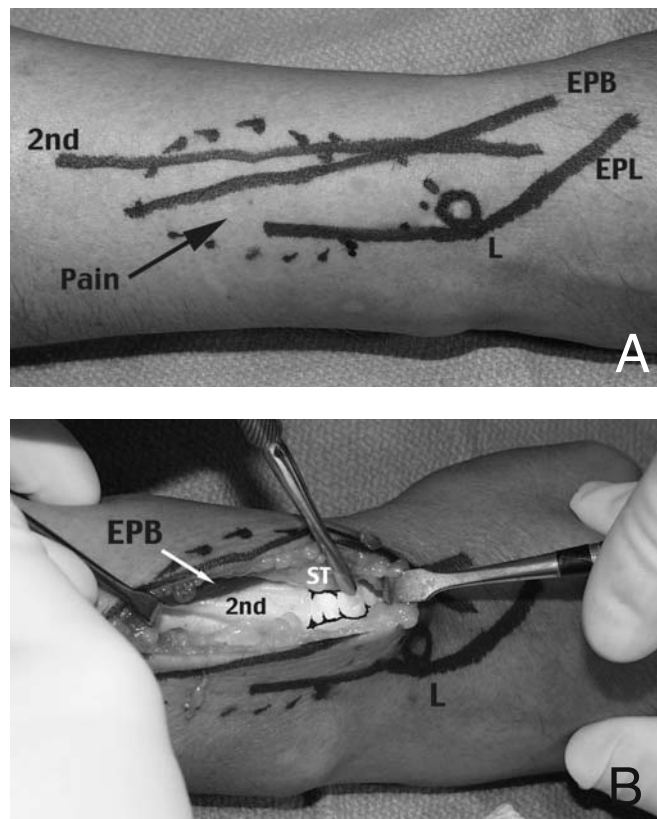


FIGURE 15-1. (A) A 44-year-old janitor with long-standing dorso-radial wrist pain exacerbated by daily activity. Failure of treatment with braces and multiple injections for de Quervain's tendinitis brought the patient for another opinion. Note that the pain, described as burning and crepitus, is more proximal and dorsal than normal for de Quervain's (as indicated by dark arrow and dotted lines). (B) At surgery, the EPB (white arrow) is reflected from the second compartment. There is an area of stenosis (ST) in the second sheath just proximal to Lister's tubercle (L). Release of this stenotic area allowed early return to manual labor.

*Provocative test:* Direct pressure at the point of intersection producing pain and crepitus with flexion/extension of the wrist.

### Management

Appropriate nonoperative management will yield complete and permanent relief in 60% of patients [22]. Failing this, there are two schools of thought regarding appropriate surgical intervention. The standard operative decompression involves a longitudinal incision over the site of maximum swelling at the point of intersection in line with the APB and EPB muscle bellies [17]. The fascia and sheath around the APB and EPB are then released. This approach directly addresses the site of symptomatology, namely the point of intersection. Williams [17] described operative results in 11 athletes (mostly rowers) who underwent standard decompression at the site of intersection between 2 weeks and 18 months from onset of symptoms. All patients had excellent results, with resumption of normal activities and return to full athletic training within one week. There were no recurrences up to 4 years postsurgery.

Grundberg and Reagan [22] have described an alternative intervention based on operative findings in 13 patients. They propose that the basic pathology involves tenosynovitis of the second extensor compartment (ECRB and ECRL) causing referral of pain and swelling more proximally. A similar presentation is noted in carpal tunnel syndrome secondary to flexor tenosynovitis, with pain and swelling localized in the distal aspect of the forearm. These authors reported complete relief of symptoms in all 13 patients by decompressing the second compartment, thus confirming their hypothesis. No intervention was performed more proximally at the site of intersection. Persistent symptomatology in 2 of the 13 patients who had undergone previous operative intervention more proximally was relieved by decompression more distally of the second compartments, thus further supporting their hypothesis. Operative intervention involving decompression of the second extensor compartment resulted in 100% relief of symptoms at an average 10 months follow-up. All patients returned to their previous employment [22].

Our operative technique involves a longitudinal incision in line with the radial wrist extensors extending from the wrist joint proximal to the swollen area. Incision of the fascia reveals the swollen APB and EPB. The EPB muscle belly is released to expose the second compartment. Only upon decompression of the second compartment significant tenosynovitis of the ECRB and ECRL is seen (see Figure 15-1). The wrist is then immobilized in a plaster forearm splint for 10 days. The inciting activity should be avoided for at least 12 weeks postoperatively.

### 3. Extensor Digitorum Brevis Manus Syndrome

The extensor digitorum brevis manus (EDBM) muscle is a rare aberrant muscle found on the dorsum of the hand that is frequently confused with a ganglion or a tumor [23]. The incidence of the EDBM muscle is 1.1% to 3.0% based on cadaveric dissections of 3404 and 559 hands, respectively [21,23]. Its anatomy and phylogeny are controversial. Ogura et al. suggest that the EDBM muscle is a variant of the extensor indicis proprius (EIP) muscle [23]. Riordan et al. point out that the muscle probably represents a homologue of the extensor digitorum brevis of the foot. Still others maintain that it is a derivative of the dorsal interosseous musculature [24].

Ogura et al. dissected 559 hands [23]. The EDBM originates from the distal radius and its periosteum, or from the radiocarpal ligament in some cases. Gama et al. [21], on the other hand, dissected 3404 hands and found its origin to be the wrist capsule beneath the dorsal carpal ligaments at the level of the scaphoid, lunate, capitate, or hamate, or occasionally at the level of the distal radial epiphysis. The insertion is usually on the ulnar side of the extensor mechanism at the level of the metacarpophalangeal (MCP) joint of the index finger. In some cases, it also inserts on the radial side of the long and ring finger [24]. The EDBM muscle is innervated by the posterior interosseous nerve that also supplies sensation to the dorsal wrist capsule. The EDBM muscle may hypertrophy through heavy use of the hand, leading to compression of the muscle belly against the distal edge of the extensor retinaculum [24–26]. Symptoms likely result from the associated synovitis.

The key to diagnosis of the syndrome is an awareness of its existence. It should be noted that presence of an EDBM muscle is usually not symptomatic, and patients may present because of an unusual painless mass, which should prompt an evaluation as mentioned below. There may be a hereditary component [24,27]. When it is symptomatic, patients are usually heavy laborers and present with dorsoradial or middorsal wrist pain and swelling during or after excessive use of the affected hand. Physical exam reveals an easily identifiable fusiform mass, usually on the proximal second metacarpal space. The mass is soft, freely mobile, and usually nontender, unless there is significant associated synovitis. It becomes firm when the wrist is slightly flexed and the fingers are fully extended [23]. Resisted extension of the fingers reproduces the pain [21], as does pressure on the palm of the hand against a table with the wrist in full extension [23]. The mass does not transilluminate nor fluctuate. Radiographs are usually normal, and aspiration is negative. The differential diagnosis includes ganglions, tenosynovitis, synovial cysts, exostosis, and carpal bossing [28–30]. Diagnosis can be aided with electromyography [23].



*Provocative test:* Pressure on palm of hand against table with wrist in full extension

### *Management and Results*

If the diagnosis from the clinical exam and EMG studies is certain, then no treatment is necessary for a painless EDBM muscle mass other than reassurance for the patient. When the diagnosis is in doubt, however, MRI can be utilized. If the EDBM muscle is identified, then no intervention is necessary. If identified at surgery, the muscle is left in situ as a useful finger extensor.

For symptomatic EDBM syndrome, a trial of non-operative therapy is warranted, including NSAIDs, corticosteroid injections, and splinting. Failure will frequently lead to operative release. A simple release of the extensor retinaculum through a dorsal approach may be effective, although recurrence of symptoms necessitating reoperation to excise the muscle has been documented [26,28]. When excising the EDBM muscle, attempts to leave the EIP tendon intact should be made [23]. Exploration for coexisting ganglions should also be undertaken, as 25% of EDBM syndromes are associated with ganglions [23,25].

## Middorsal Wrist Pain

### 1. Extensor Pollicis Longus Tenosynovitis

Extensor pollicis longus (EPL) tenosynovitis is most commonly seen in patients with rheumatoid arthritis. In athletes, it is generally related to racquet sports. A non-rheumatic form can occur after distal radius fractures when fracture fragments cause impingement of the EPL tendon. Early diagnosis in this case is important to prevent rupture at the level of Lister's tubercle.

The EPL originates from the posterior surface of the middle one-third of the ulna and interosseous membrane, and passes just ulnar to Lister's tubercle through the third extensor compartment, where it makes an acute angle before inserting on the posterior surface of the base of the distal phalanx of the thumb. Two anatomic variations that may contribute to EPL tenosynovitis have been noted in cadaveric dissections by Morgensen and Mattson. First, the thickness and length of the septum between the third and fourth compartments is quite variable when compared to the septum between the second and third compartments. Second, the distance between the EPL musculotendinous junction and the proximal edge of the extensor retinaculum varies from 12 to 25 mm (thumb in neutral) with one-quarter of the junctions ending within the extensor sheath [6].

The patient generally presents with a several-months history of dorsal wrist pain, swelling, and occasionally

crepitus at the level of Lister's tubercle. There is usually no specific traumatic event, although the patient may relate the symptoms to a new sporting activity or a repetitive maneuver at work. Upon examination, there is tenderness and swelling along the EPL tendon, particularly at Lister's tubercle. The pain is reproduced at the level of the wrist with active and resisted thumb extension. Passive flexion of the thumb interphalangeal (IP) joint can also reproduce pain along the EPL sheath. Severe cases of EPL tenosynovitis may present with triggering of the thumb IP joint with active motion.

Patients with EPL ruptures after distal radius fractures usually present several months to years after the trauma complaining of acute inability to fully extend the thumb associated with pain along the tendon sheath at the level of Lister's tubercle [32]. Lateral radiographs of the wrist or computed tomography (CT) scans help to delineate bony pathology that may be amenable to simple excision. *Provocative test:* Reproduction of pain with resisted thumb extension.

### *Management*

Nonoperative management including steroid injection and splinting is usually successful, although some authors recommend that steroids be used with caution, as increased local tissue pressure may increase the risk of tendon rupture [33,34]. For chronic nonresponsive cases, operative decompression is indicated. There are 4 reported operative cases in the English literature in 3 articles [6,31,36]. All 4 cases resolved with surgical release, one of which remained symptom free at 10 year follow-up. The extensor retinaculum is often thickened with a stenotic indentation visible in the underlying swollen EPL tendon. There are two operative techniques. In the first [6], a standard longitudinal incision is made over the third extensor compartment retinaculum. The septa between the third and fourth as well as second and third compartments are released. The extensor retinaculum is closed over the EPL to prevent bowstringing.

We prefer the second technique, in which a longitudinal incision is made centered on Lister's tubercle. The EPL tendon is completely released and simply transposed to the underlying subcutaneous tissue. The extensor retinaculum is then closed to prevent relocation of the EPL tendon. In our experience, as well as in that of other authors [36], bowstringing has not been a problem with this technique. It may require an extended period before the patient returns to baseline function.

Treatment of an acute degenerative rupture is either benign neglect or a tendon transfer from the extensor indicis proprius (EIP) to the remnant of the EPL, depending on the patient's activity requirements. Primary repair is usually impossible due to the chronic degenerative nature of the rupture. In the prerupture phase where

a bony prominence is seen on lateral radiographs, consideration should be given for an exostosectomy. This may prevent complete attenuation of the tendon and reverse the degenerative process, relieving pain and swelling.

## 2. Extensor Indicis Proprius Syndrome

The extensor indicis proprius (EIP) originates from the dorsal aspect of the distal third of the ulna and the adjacent interosseous membrane. After passing through the fourth extensor compartment deep to the extensor digitorum communis (EDC), it inserts on the dorsoulnar expansion of the index EDC. The musculotendinous junction lies predominantly within the confines of the fourth dorsal compartment. Anatomical studies further noted this compartment to become extremely tight when the wrist was held in flexion as the bulky musculotendinous portion of the EIP muscle passed under the proximal edge of the extensor retinaculum [37]. Repetitive irritation of the tenosynovium as the EIP junction passes under this proximal retinacular edge is felt to initiate the syndrome. Hypertrophy of the EIP with athletic training is also considered a contributing factor [37].

The patient presents with point tenderness and swelling over the middorsal aspect of the wrist corresponding to the fourth compartment and the EIP musculotendinous junction. The symptoms are commonly noted after repetitive activity involving wrist flexion and extension. The provocative maneuver begins with the wrist in maximum pain-free flexion. The examiner resists active index extension with pressure on the proximal phalanx. The patient will describe a sudden pain localized to the ulnar aspect of Lister's tubercle just distal to the extensor retinaculum [43]. The differential diagnosis includes EDC tenosynovitis, EPL tenosynovitis, dorsoradial ganglion, and Kienbock's disease.

*Provocative test:* Resisted index extension with the wrist in full flexion.

### *Management*

Nonoperative management (including rest, splints, and local corticosteroids) is usually successful. If this fails, surgical decompression is indicated. The literature to date provides only sporadic case reports describing operative intervention. Spinner et al. documented 3 patients with persistent symptoms after failing conservative management. All 3 responded to surgical release. Ritter et al. performed surgical release on 2 patients, both of whom returned to full, unrestricted activity, remaining pain free at 1- to 2-year follow-up. This is performed through a middorsal longitudinal incision over the ulnar aspect of the fourth compartment. Typically, the muscle belly of

EIP extends into the fourth compartment with marked synovitis surrounding both the tendon and the muscle [37].

## 3. Extensor Digitorum Communis Tenosynovitis and Fourth-Compartment Syndrome

Extensor digitorum communis (EDC) tenosynovitis is exceedingly rare. It is suspected when a patient presents with diffuse pain over the fourth extensor compartment that is aggravated by passive wrist and finger flexion. Triggering is generally not seen [40]. Pain may be reproduced with resisted finger and wrist extension. EIP syndrome must be ruled out using appropriate provocative maneuvers. (See the EIP section.)

*Provocative test:* Diffuse pain with resisted finger and wrist extension.

### *Management*

It is frequently very difficult to identify the exact source of the pathology, and a global therapeutic treatment program targeting dorsal wrist pain must be instituted [41,42]. Failure to respond to nonoperative measures should raise suspicion of an anatomic abnormality that must be addressed with surgical exploration and possible release of the fourth extensor compartment [43,44]. Hayashi et al. [39] have recently proposed a theory which they have termed "fourth-compartment syndrome." They describe several pathological conditions (including EDC tenosynovitis, muscle anomalies, carpal bone anomalies, and occult ganglion) that can increase pressure within the fourth extensor compartment, ultimately compressing the posterior interosseous nerve (PIN) directly or indirectly causing dorsal wrist pain. Surgical decompression releases the pressure on the PIN eliminating wrist pain.

## Dorsal-Ulnar Wrist Pain

### 1. Extensor Carpi Ulnaris Tenosynovitis

Extensor carpi ulnaris (ECU) tenosynovitis is the second most common wrist tendinopathy seen in sports, and is particularly associated with rowing and racquet sports [3]. The ECU originates from the common extensor origin on the lateral epicondyle as well as the posterior one-third of the ulna and inserts at the base of the fifth metacarpal after traversing the sixth extensor compartment. ECU is the only extensor that has its own fibroosseous tunnel that is not made up of the extensor retinaculum [38]. This tunnel overlies 1.5 to 2 cm of the distal ulna. The ECU is held within this groove by its tendon sheath.

Patients present with a history of chronic pain localized to the dorsal-ulnar aspect of the wrist just distal to the dorsum of the ulna. There is frequently associated swelling and “thickening” in this area. Sometimes there is a history of trauma, but usually the pain is of insidious onset. Examination reveals tenderness over the ECU tendon and ulnar head. Pain is increased with resisted wrist ulnar deviation combined with extension. Local injection is usually diagnostic. The differential diagnosis includes ECU subluxation/dislocation, extensor digiti minimi (EDM) tenosynovitis, and triangular fibrocartilage complex (TFCC) disorders.

*Provocative test:* Resisted wrist ulnar deviation and extension.

### Management

A standard nonoperative approach will yield satisfactory results in most cases. Hajj et al. [44] describe 3 cases of ECU tenosynovitis that failed conventional nonoperative treatment requiring surgical release of the sixth extensor compartment. All 3 patients had complete relief of symptoms at an average 16 months follow-up, with return to full activity. Crimmins and Jones [45] performed a retrospective review of 15 patients with 10 to 14 months follow-up. Seven of 15 patients failed conservative therapy consisting of splinting and steroid injections. Six of these 7 had good or excellent results with surgical release. Surgical release of the sixth compartment is the treatment of choice if conservative management fails. This is performed through a longitudinal incision over the sixth extensor compartment. The thickened fibro-osseous canal is released on the radial side of the sixth compartment, allowing tight repair of the extensor retinaculum to prevent residual subluxation of the ECU postoperatively [44] (see Figure 15-2). The wrist is then immobilized for 2 to 3 weeks postoperatively in a volar-based splint with 20 degrees of extension.

## 2. Extensor Carpi Ulnaris Subluxation/Dislocation

ECU subluxation/dislocation usually results from an athletic trauma with a fairly well-defined mechanism of hypersupination combined with ulnar deviation and wrist flexion. This causes a volar displacement of the tendon as an acute longitudinal tear of the fibro-osseous tunnel occurs on the ulnar side. Unfortunately, this tendon disorder is rarely seen in its acute stage, the pain most commonly being attributed to a “wrist sprain.” Patients will generally present many weeks or months after the injury with persisting dorsal-ulnar wrist pain and a clicking sensation, which is sometimes audible. Clinical examination reveals minimal tenderness over the sixth extensor com-

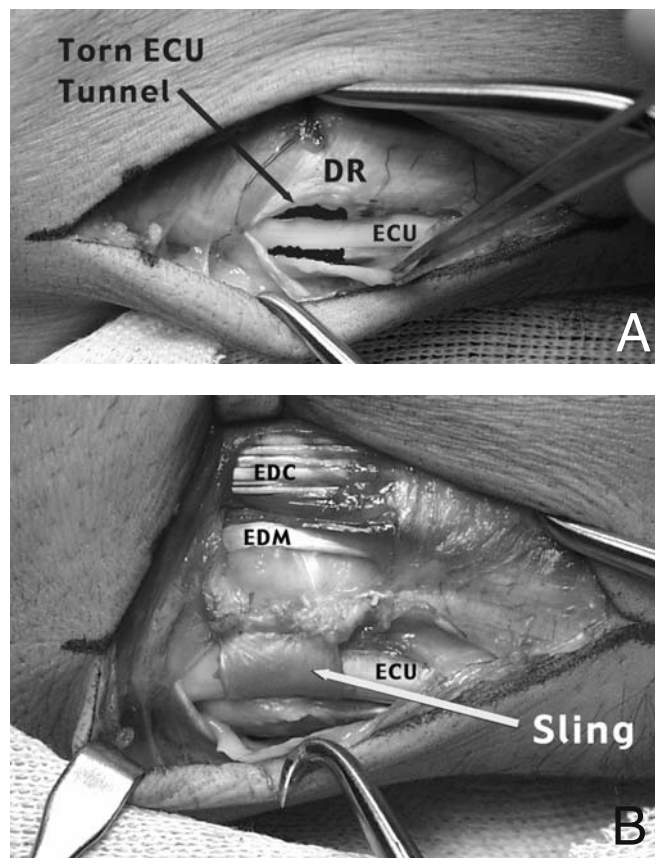


FIGURE 15-2. (A) A 33-year-old professional athlete who sustained direct trauma to the dorsum of the wrist 10 weeks before coming to our attention. He had been treated with taping, but continued to have pain on daily activities, particularly with pronosupination of the wrist. He had pain radiating from the wrist up the arm, particularly with supination, and has been diagnosed with tendinopathy. The edges of the ruptured ECU tunnel are marked in black below the dorsal retinaculum (DR). The forceps are grasping the edge of synovium that is often infolded and tacked down to the tunnel, giving the appearance of a normal tunnel. Only when this synovium is peeled back can the rupture be truly appreciated. (B) The tunnel is reconstructed. The arrow points to the sling that has been constructed from the dorsal retinaculum. The synovial side is toward the tendon to prevent tenodesis. This is accomplished by taking a band of dorsal retinaculum and bringing it under the ECU before suturing the end back to the edge of the 4-5 compartments. It is necessary to reinforce the 4-5 interval before final suturing.

partment with normal range of motion (ROM). The pain and clicking sensation are reproduced with active forearm supination and wrist extension as the ECU tendon dislocates from its fibro-osseous tunnel. Performing these maneuvers passively will rarely reproduce the symptoms. Pronation of the forearm returns the tendon

to its anatomical position. If the ECU tendon is dislocatable, then the diagnosis is obvious. If not, then the differential diagnosis must include intra-articular pathology as a possible source of the clicking sensation, in particular TFCC tears. Otherwise, all dorsal-ulnar pathologies (Table 15-1) must be considered.

*Provocative test:* Combined forearm supination with wrist extension.

### Management

When acute recognition of the condition occurs, first-line nonoperative management includes long-arm casting with the forearm in pronation and the wrist in slight radial deviation and extension for 6 weeks. This will potentially allow healing of the torn ulnar border of the fibro-osseous tunnel, preventing further displacement of the ECU tendon. While nonoperative management is suggested for management of acute ECU subluxation [46], Rowland et al. [49], in their experience with a 59-year-old physician, suggest that primary operative repair is preferable to casting. Clearly the data are limited, as recognition of acute ECU injuries is rare.

If symptoms of pain and clicking persist despite an adequate course of casting followed by rehabilitation, then surgical repair is indicated. Uniformly good results have been achieved with operative reconstruction of the fibro-osseous tunnel in chronic cases by a number of authors [46–48] using several techniques. Once again, these results are based on a limited number of case reports (11 in total for these 3 authors) but the results are encouraging. This is performed through a dorsoulnar, longitudinal incision over the sixth extensor compartment. The subluxating tendon is identified, and a longitudinal rent in the ulnar-restraining wall of the fibro-osseous tunnel is visualized. Except in an acute situation, primary repair without augmentation will rarely be successful. Most often, reconstruction using a radially based sling about the ECU tendon with a portion of the extensor retinaculum, in addition to primary repair, will be necessary (Figure 15-2) [46]. Postoperatively the arm is maintained in a long-arm cast at 90 degrees of elbow flexion, neutral forearm rotation, and 30 degrees of wrist extension for 6 weeks. If the dorsal structures are attenuated, then a portion of flexor carpi ulnaris (FCU) can be passed through a drill hole in the ulna and used to reconstruct the tunnel [46].

### 3. Extensor Digiti Minimi Tenosynovitis

The extensor digiti minimi (EDM) originates from the common extensor origin of the lateral epicondyle. It inserts at the proximal phalanx of the little finger and into

the dorsal expansion of the finger extensor tendons after passing through the fifth extensor compartment. Schenk dissected 57 hands and found duplications of the EDM in 48 (84%) [51]. Thus, it is unlikely that duplication presents a predisposing factor as it does in de Quervain's tenosynovitis.

Patients present with pain and swelling on the ulnar-dorsal aspect of the wrist just distal to the head of the ulna. It can be seen following wrist injury but generally occurs after repetitive use of the hand, such as with handwriting activities. The patient has pain with gripping and is unable to extend the little finger. On examination, there is reproduction of the pain with attempts to flex the wrist after making a fist. The differential diagnosis includes ECU tenosynovitis/subluxation, TFCC pathology, and posttraumatic ulnar impaction.

*Provocative test:* Flexion of the wrist after making a fist.

### Management

If the patient is not responsive to standard nonoperative therapy, surgical decompression should be performed through a longitudinal incision over the swelling of the fifth extensor compartment. The dorsal branches of the ulnar nerve must be preserved. The sheath will be thickened and is completely released.

### Results

There is only one documented case report in the last 40 years where surgical decompression was performed for EDM tenosynovitis [51,52]. The patient's pain completely resolved with release of the fifth extensor compartment. There is one report of EDM tendon sheath stenosis resulting in triggering of the little finger which, upon surgical release, resulted in complete resolution of symptoms [52].

## Volar-Radial Wrist Pain

### 1. Flexor Carpi Radialis Tendinopathy

The flexor carpi radialis (FCR) musculotendinous unit originates from the common flexor origin on the medial epicondyle and inserts via 3 distinct bands, predominantly into the base of the second metacarpal but also into the third metacarpal, with a smaller band connecting to the trapezium crest. The tendon enters a fibro-osseous tunnel at the proximal border of the trapezium, where it occupies 90% of the available space and is prone to compression [53].



FCR tendinopathy presents as pain and sometimes swelling along the radiovolar aspect of the wrist following the course of the FCR, usually at the level of the distal wrist crease. The onset of pain is generally insidious, with no history of acute trauma and frequently no identifiable source of repetitive trauma, although activities involving repetitive wrist flexion may have been performed. Movements that exacerbate the symptoms include resisted flexion and radial deviation, as well as passive wrist extension. Confirmation of diagnosis can sometimes be obtained with the use of local anesthetic injected into the area of maximum tenderness. Differential diagnosis includes osteoarthritis of the first carpometacarpal joint, scaphoid cysts, fracture, ganglia, de Quervain's tenosynovitis, and Linburg's syndrome. A lack of clinical suspicion commonly results in delayed diagnosis and treatment [54].

*Provocative test:* Combined wrist flexion and radial deviation resisted from a neutral wrist position.

### Management

Failing nonoperative management, surgical decompression is warranted. This is performed through a volar longitudinal incision immediately radial to the FCR curving radially onto the thenar eminence. Care must be taken to protect the palmar cutaneous branch of the median nerve ulnarly and the antebrachial branch of the superficial radial nerve radially. The thenar muscle origin is raised from the transverse carpal ligament radially to expose the FCR sheath. The sheath is incised in a proximal-to-distal direction. Complete release includes mobilization from the trapezial groove, releasing the trapezial insertion. Operative findings include synovitis, adhesions, complete rupture, exostosis, stenosis, and anomalous tendon insertion. Consequently, additional procedures are frequently required at the time of initial surgery. Complete decompression is usually sufficient to relieve symptoms, and complete synovectomy is rarely indicated.

### Results

A review of the English literature reveals only 5 relevant articles targeting this uncommon disorder. A retrospective study by Gabel et al. [54] reviewed the results of surgical decompression in 10 patients (mean age 44 years) who failed nonoperative treatment. At an average follow-up of 44 months, 9 of 10 patients had relief of symptoms and were able to resume their preoperative employment and leisure activities. Fitton et al. [55] obtained good results with surgical decompression in 11 of 12 patients. Long duration, workers' compensation, and failure to

respond to local injections are associated with poor results.

## Midvolar Wrist Pain

### 1. Carpal Tunnel Syndrome

Although carpal tunnel syndrome (CTS) can be related to FDP/FDS tenosynovitis [59], it is more appropriately categorized as a nerve compression syndrome and as such will not be discussed any further in this chapter.

### 2. Linburg's Syndrome

Linburg's syndrome involves an anomalous connection between flexor pollicis longus (FPL) and the index flexor digitorum profundus (FDP). This is a fairly common anomaly found unilaterally in 20% to 31% and bilaterally in 7% to 14% of the general populace [60,61]. The pathological form of this anomalous connection has been termed thumb-index flexor tenosynovitis [62]. In symptomatic patients, there is some controversy as to whether or not this anomalous tendinous connection is the result of tenosynovial adhesions [61] (acquired lesion) or simply a congenital anomaly that predisposes the development of thumb-index flexor tenosynovitis (congenital lesion). It was once hypothesized that carpal tunnel syndrome was associated with Linburg's syndrome [60]. This has subsequently been disproved [62].

Patients with symptomatic Linburg's syndrome (thumb-index flexor tenosynovitis) present with a several-months history of vague, poorly localized, activity-related pain on the distal aspect of the volar forearm and wrist. There may be a sensation of tightness and sometimes cramping of the thumb [43]. The patient may have noted a lack of independent flexion of the thumb and index finger prior to the development of symptoms, although this is a very subtle finding. There is usually no history of trauma, and the symptoms are of insidious onset. Physical examination reveals simultaneous flexion of the index finger with active flexion of the thumb interphalangeal (IP) joint. Passive extension of the index finger while actively flexing the IP joint of the thumb may reproduce the pain [63].

*Provocative test:* Passive extension of the index finger while actively flexing the IP joint of the thumb.

### Management

In the absence of symptoms, the presence of the anomalous intertendinous connection, as demonstrated by the

above-mentioned provocative test, does not warrant any form of treatment. In the symptomatic individual, non-operative therapy is rarely effective but should still be attempted, since the diagnosis may not always be clear. Steroid injections of the FPL sheath may give short-term relief but rarely provide long-term relief [62].

Operative release of the intertendinous connection between the FPL and the index FDP is relatively simply accomplished through a longitudinal incision over the FCR/radial artery interval (distal part of Henry approach) extending into the carpal tunnel. Once the FPL and index FDP are identified and the neurovascular bundle is protected, the interconnecting tendinous slip or hypertrophic tenosynovium is isolated and divided.

## Results

Lombardi et al. [62] explored 26 wrists in 24 patients with volar wrist and forearm pain and a positive provocative test in whom conservative management, including steroid injection, had failed. All patients had hypertrophic tenosynovium connecting the FPL and index FDP and more than half had a tendinous slip. In 17 wrists with greater than 6 months follow-up, 76% were improved by surgical management.

## Volar-Ulnar Wrist Pain

### 1. Flexor Carpi Ulnaris Tenosynovitis

Flexor carpi ulnaris (FCU) tenosynovitis is seen most commonly in golf and racquet sports athletes [4]. Overall, it is the most common wrist flexor tendinopathy [63]. It presents clinically with pain and swelling just distal to the pisiform, hence the difficulty in differentiating it from pisotriquetral arthritis, which is also seen in this group of athletes. Also in the differential diagnosis is Guyon's canal syndrome, which may result from localized inflammation and ulnar nerve compression or neuritis [63]. In FCU tenosynovitis, pain is reproduced with passive wrist extension as well as resisted wrist flexion combined with ulnar deviation, thus differentiating it from other pathological conditions. Twenty-degree supinated oblique lateral radiographs may occasionally aid in diagnosis by revealing calcific deposits at the FCU insertion near the pisiform [16].

*Provocative test:* Pain with resisted wrist flexion and ulnar deviation.

### Management

Nonoperative treatment including steroid injections and dorsal splinting is generally successful. Surgical interven-

tion may simply involve excision of calcific deposits, lysis of peritendinous adhesions [4], or, in more advanced cases, lengthening of the FCU using a 5-mm Z-plasty with excision of the pisiform [64].

## Results

Despite FCU tenosynovitis being the most common wrist flexor tendinopathy, there are few published results of operative intervention in the English literature. This is probably a result of the high success rate of nonoperative intervention.

### 2. Trigger Finger

This is one of the few tendinopathies that manifests in the hand itself. It is most commonly idiopathic [4] but can occur from repetitive blunt trauma to the A1 pulley at the base of the fingers or thumb [43]. It is associated with other tendinopathies, bursitis, and diabetes among other disease entities. It can be associated with racquet sports due to direct pressure on the A1 pulley from a forceful grip on the racquet handle. Other sports associated with trigger finger include handball, baseball (catchers), gymnastics, weightlifting, and golf. Ultimately, inflammation of the tendon occurs, and the pathological triggering results from a disproportion between the flexor tendon and its sheath (pulley) [4].

Patients present with a complaint of snapping or triggering with flexion or extension of the involved digit, which may or may not be painful. Occasionally patients will present with a locked digit. It is usually seen in the dominant hand of a woman in her fifth or sixth decade. It most commonly affects the ring and middle fingers, and less frequently the thumb. On examination, a nodule is often palpable at the level of the metacarpal head and A1 pulley. With prolonged locking, a flexion contracture can develop at the proximal interphalangeal (PIP) joint. The differential diagnosis of triggering includes a locked metacarpophalangeal (MCP) joint, a subluxating MCP joint, a tendon tumor, or a partial tendon laceration [63].

### Management and Results

Nonoperative management including corticosteroid injections into the tendon sheath and splinting in 15 degrees of flexion [67] is successful in 36% to 84% of the cases [68–76]. Up to 28% of patients will require more than one injection [75]. Lapidus reported spontaneous resolution in 29% of patients with trigger finger. Predictors of poor outcome with conservative management include systemic inflammatory conditions such as rheumatoid arthritis [71] and diabetes [65,77,78], multiple digit involvement [74], and duration of symptoms longer than several months [79,72,76].

Failing conservative management, surgical release of the A1 pulley is indicated. Pathological changes of hypertrophy in the sheath are the most remarkable feature of trigger finger. The incision can be done in an open [14] or percutaneous fashion [67,80,81] under local anesthesia [82]. We prefer the open technique, as it ensures complete release of the pulley and allows visualized protection of the digital nerve. Very little recovery time or functional improvement gain results from percutaneous release. The A1 pulley is approximately 1 cm wide extending from 1 to 2 cm proximal to the proximal digital crease. A 1.5-cm transverse incision is made at the level of the metacarpal neck. The palmar fascia and flexor tendons and sheath are exposed with blunt dissection as the digital nerves are identified and protected. The demarcation between the A1 and A2 pulley is identified. The A1 pulley is then split longitudinally along the radial border for D2, D3, and D4, and along the ulnar border for D5. The digit is then taken through ROM to ensure complete release. In the thumb, a transverse incision should be made at the level of the MP flexion crease. Particular attention should be paid for the radial digital nerve, as it lies close to the deep layer of dermis at the flexion crease and can be easily transected.

Surgical release is very successful. Complete resolution of triggering can be expected in up to 97% of patients [83]. Important complications include nerve injury, painful scars (the most common complication), stiffness, infection, bowstringing, and recurrence or incomplete release [63]. Thorpe [84] reported a 40% complication rate in a series of 43 patients. Thus, surgical release, although highly successful, is not necessarily a benign procedure. Failure of resolution may be attributable to more distal stenosing tenosynovitis. Rayan [85] reported 3 patients with stenosis of the A3 pulley that resolved with surgical release.

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