Ian A. Trail
Andrew N. M. Fleming
Editors

Disorders of the Hand

Volume 3: Inflammation, Arthritis and Contractures

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Preface

In recent years there have been significant advances in the understanding and treatment of disorders of the hand and wrist. This has resulted in a significant improvement in the quality of life for many patients. The authors who have produced this text were chosen as they are hand surgeons who have led many of these exciting developments in the management of both elective and trauma hand surgery. All are internationally respected.

The topics covered are well illustrated with images, radiographs and line drawings and provide practical guidance on surgical procedures. The references at the end of each chapter have been chosen as they are either classic papers or are the most relevant to modern surgical management.

Thus we hope that we have produced a book that will enable improved care for current patients with hand and wrist complaints and inspire surgeons to think in greater detail about treatment options that will provide even better care in the future.

Finally, we would like to thank all the contributors as well as Diane Allmark for her help, but also our families for their patience and support.

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London, UK — Andrew N.M. Fleming, FRCS(Edin), FCS(SA)Plast

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We are indebted to all of our co-authors without whom this publication would not have been possible. Despite their busy clinical practices and numerous other commitments, they have produced high quality chapters which we have thoroughly enjoyed reading and hope that you will find helpful in the treatment of your patients.

We are also particularly grateful to Springer for allowing us to pursue this project and would like to especially thank Rachel Glassberg for all her helpful advice and prompting.

Finally we would like to thank our secretaries, particularly Diane Allmark, and respective families who, for longer than we dare think, have put up with us reading and re-reading manuscripts on what they think is only a small part of the body!

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Part I

Inflammation and Arthritis

Tendinopathy at the Wrist

1

Zafar Naqui and Ian A. Trail

Keywords
Tendinopathy • Tenosynovitis • Tendovaginitis • Rheumatoid Arthritis • Gout • Pseudogout • de Quervains's Disease • Finklestein's test • Intersection Syndrome • Extensor Carpi Ulnaris • Extensor Pollicis Longus • Flexor Carpi Ulnaris • Amyloidosis • Sarcoidosis

Introduction

Twelve extensor and 11 flexor tendons cross the wrist. Disorders afflicting these tendons as they traverse the wrist are a frequent cause of symptoms and make up a significant proportion of the workload of the hand surgeon. Broadly, tendons may be affected by either tenosynovitis or, more commonly, due to entrapment.

Tenosynovitis technically refers to inflammation of the synovial sheath around the tendon. Causes can be grouped as either (i) inflammatory arthropathies, such as rheumatoid arthritis (RA), (ii) deposition diseases, such as gout, calcific tendonitis and amyloid, (iii) infection or (iv) due to retained foreign body or implant.

Tendon entrapment is referred to as tendovaginitis. It can also somewhat erroneously be referred to as stenosing tenosynovitis, which does not accurately reflect the pathology being primarily that of a tendon being entrapped within its retinacular sheath. Histologically, there is a characteristic non-inflammatory hyperplasia of the retinacular sheath and corresponding thickening and nodularity in the tendon itself, as opposed to any synovial inflammation [1]. The most commonly entrapped tendons are those of the first extensor compartment.

Pertinent Anatomy

An understanding of tendon anatomy at the wrist is prudent to understanding the pathogenesis and management of tendonitis (Fig. 1.1). The 12 extensor tendons traverse the wrist through 6 fairly tight fibro-osseous membranes constituting the 6 extensor compartments. On the flexor

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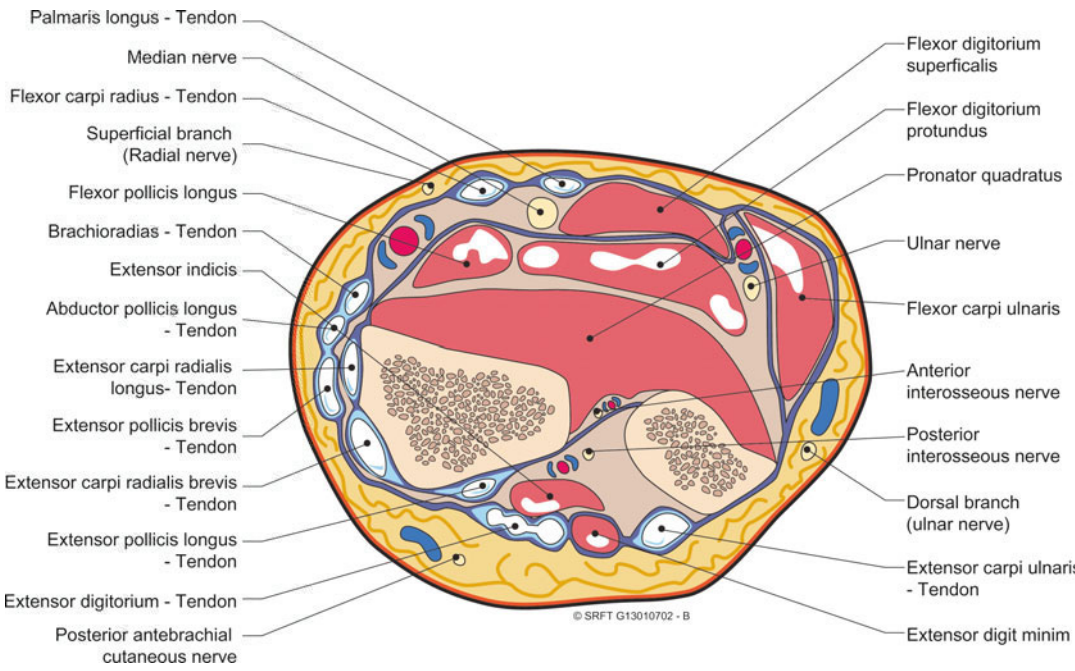

Fig. 1.1 Transverse section of the wrist showing the extensor and flexor tendons

aspect of the wrist, the carpal tunnel contains the 4 flexor digitorum profundus, 4 flexor digitorum superficialis and the flexor pollicis longus tendons. Flexor carpi radialis and flexor carpi ulnaris travel within their own tunnels.

Tenosynovitis

Rheumatoid Arthritis

Tenosynovitis at the wrist is a relatively common manifestation in RA patients, although the rate of presentation is now perceived to be subsiding due to improved medical management of the disease [2]. There is hypertrophy of the synovium, which may go on to infiltrate adjacent structures and unchecked can lead to tendon rupture. Patients may present with a history of pain when actively contracting or passively stretching the tendons. Often they can present with a relatively mobile, painless swelling, more evident on the dorsal side of the wrist, due to its expansile skin. There may be tenderness and crepitus felt on palpation of the swelling, which follows the course of the tendon and often there is a bulge on either side of the restrictive extensor retinaculum. This can help differentiate the tenosynovitic swelling from that of a ganglion or other tumour.

Inflammatory tenosynovitis can affect any dorsal compartment, but is most often present on the ulnar aspect of the wrist. Similar symptoms develop on the flexor surface, but presentation may be by sway of symptoms of carpal tunnel syndrome and/or flexor tendon triggering at the wrist level, due to the relatively rigid flexor retinaculum acting to entrap the median nerve and flexor tendons in the presence of synovial swelling.

The management of RA is covered in Chap. 7.

Deposition Diseases

The deposition of any material within the tendon sheath can precipitate an inflammatory response. There are a number of diseases which can lead to deposition within the tendon sheath, including gout, pseudogout, calcific tendonitis and amyloid. Patients present with intense pain, erythema and swelling.

Fig. 1.2 Clinical photo of gouty tophi affecting thumb and index finger DIPJ (Courtesy of Mr. Lindsay Muir, Salford Royal Hospital, Manchester, UK)

Gout

In gout, a disorder where urate metabolism leads to an overproduction of uric acid, hyperuricaemia and deposition of monosodium urate (MSU) crystals within the joints and soft tissues, including the tenosynovium. In longstanding, poorly controlled disease, gouty *tophi* may also be present. These are palpable, cheesy white, multilobular swellings formed by the deposition of crystals in the subcutaneous tissues of the digits (Fig. 1.2). Tophi in the hand are not usually seen without preceding deposits elsewhere in the body, typically the great toe and the pinna of the ear, the hand being an unusual primary site [3]. Gouty tendosynovitis will present in the extensor tendons in a similar way to RA and involvement of the flexor tendons can also present as carpal tunnel syndrome. Symptoms of sudden onset pain, erythema, warmth and swelling need to be differentiated from acute infection, which can also present in a similar manner. Conversely, it must also be kept in mind that deposition disease can simultaneously be present alongside infection. Unchecked, gouty tenosynovitis can lead to tendon rupture and skin ulceration at the sites of tophi [4].

A high uric acid level in the blood is not diagnostic for gout, as this is found in a small percentage of the normal population. Aspiration of the joint or tenosynovium is the most helpful diagnostic test. Examination of the synovial aspirate under a polarized light microscope will reveal strongly negatively birefringent crystals. Radiography may reveal intra-articular degenerative arthritic changes if the gout has been longstanding, whilst the use of ultrasound has recently been described in the detection of MSU crystals in subclinical gout [5].

The mainstay of management is medical and acute episodes usually respond well to a combination of colchicine and non-steroidal anti-inflammatory drugs. Surgery may be indicated by way of tendon synovectomy for adherent tendons, tendon transfers for tendon rupture, median nerve decompression for carpal tunnel and excision of painful tophi [4]. Peri-operative colchicine cover is recommended to prevent a flare up of gout post-operatively.

Other Deposition Diseases

CPPD

Calcium pyrophosphate dehydrate, or pseudogout, has been reported to cause an inflammatory synovitis. Symptoms and signs are similar to those already described for gout. Polarised light microscopy of aspirate reveals weakly positive bifringent rhomboid-shaped crystals. Debridement of the synovial sheath may be necessary [6].

Acute Calcific Tendonitis

As with other sites of calcific deposition in the body, such as the bursae of the shoulder, the aetiology of deposition is poorly understood. Calcific hydroxyapatite deposits are chalky white and their deposition within the tendon sheath can cause an intense, acute painful tenosynovitis. There is concomitant localised fluctuance, erythema and warmth. Diagnosis may be missed or delayed due to the presentation mimicking infection [7]. The patient is systemically well. Any wrist tendon may be affected and carpal tunnel syndrome in flexor tenosynovitis secondary to calcific deposition has been described [8].

The blood profile for infection will be negative and calcium levels in the blood are normal. Radiographs may reveal speckles of calcification within the soft tissues.

Acute episodes usually settle and are self-limiting and do not damage the tendon proper. Management can be confined to splintage and

anti-inflammatory drugs. Surgical debridement, however, can expedite the resolution phase.

Amyloidosis

In patients with renal failure undergoing dialysis, the serum protein β2-microglobulin is not filtered and can accumulate in soft tissues and bones. Amyloid deposition can occur along the tenosynovium of flexor tendons. Patients can present with reduced motion of the tendons, wrist tendon triggering and tendon rupture. Patients undergoing renal dialysis and who have carpal tunnel syndrome may well have amyloid plaques upon the flexor tendons. There are usually no signs of inflammation. Radiographs may reveal concomitant cystic lesions in the carpus and interphalangeal joints. Treatment is by way of the surgical debridement of thick amyloid plaques from tendon sheaths [9].

Sarcoidosis

Sarcoid tenosynovitis at the wrist is a rare but recognised condition. Both flexors and extensors at the wrist can be involved. Presentation is similar to other tenosynovitis as described above. Multiple non-caseating granulomatous nodules are found in this immune mediated condition, the aetiological trigger being unclear. Radiographs may reveal characteristic cystic lesions in the phalanges. Management is through the administration of corticosteroids and tenosynovectomy [10].

Infection

Acute or chronic infection within the tendon sheath can cause tenosynovitis. Pyogenic, gonococcus, tuberculosis, atypical mycobacterium and fungal infections all need to be considered.

Foreign Body and Implants

Any foreign body within the tendon sheath can incite an inflammatory response. Cases of plant thorns causing aseptic tenosynovitis have been described. In the absence of a clear history, ultrasound imaging may help localise the foreign body. Over the last decade, with the widespread use of volar locking plates for open reduction internal fixation of distal radius fractures, there has been an increase in reported extensor tendonitis, attrition and rupture. The surgeon must be careful of screw placement when performing this procedure and also have a low threshold of suspicion for this complication when presented with a patient complaining of pain, tenderness or reduced tendon motion on the extensor surface post-operatively. Management should be directed at surgical removal of the irritant.

Tendovaginitis

Quite distinct from tenosynovitis, tendovaginitis is a mechanical process caused by entrapment of the tendon within its retinacular sheath. Of note, inflammatory tissue is not found within the tenosynovium. However, an unduly thickened and degenerate sheath has been described in several histological studies. This has led authors to speculate on a more intrinsic, degenerate mechanism in these conditions, as opposed to an extrinsic, inflammatory one. The term stenosing tenosynovitis is thus felt not to reflect the pathological process [11].

It is not entirely clear why tendon entrapment occurs in some patients. Epidemiological trends are recognised, with patients often suffering from several conditions of the upper limb, including trigger finger, carpal tunnel syndrome, de Quervain's disease, epicondylitis and subacromial bursitis. This would suggest an, as yet, unrecognised underlying systemic process or predisposition. The condition is more prevalent in women and diabetics. Perhaps most controversial is the possible role that occupational factors may play in inducing tendon entrapment. Repetitive desk-based, computer and some manual work, sports or "overuse" have all been associated with tendovaginitis in some studies, but not in others. Whilst there may be some contribution by repetitive motions in the workplace and there has been some reported success with the modification of these activities, the condition may not fully be explained by this alone and other intrinsic factors may play a role [12].

De Quervain's Disease

The commonest site of tendon entrapment at the wrist is within the first dorsal compartment. Entrapment of the tendons of Extensor Pollicis Brevis (EPB) and Abductor Pollicis Longus (APL) was first described in 1895 by the Swiss surgeon Fritz de Quervain. It has also been referred to as washerwoman's sprain, gamer's thumb, mother's wrist or mother's thumb.

The two tendons run within a synovial sheath and enter a tunnel, the roof of which is formed by the relatively unyielding fibro-osseous extensor retinaculum (ER), with the EPB lying dorsal and ulnar to the APL. The ER acts to prevent bowstringing and thereby give the tendons a mechanical advantage. The floor of the tunnel is the groove of the radial styloid and the walls are the fibrous septae running up vertically from the radius to the ER. However, both the number of tendon slips and number of tunnels within the first extensor compartment have been found to be variable. Multiple slips of APL (1–7), multiple slips of EPB (0–3) and multiple tunnels have all been found in numerous anatomical studies [13, 14]. The literature suggests that the presence of a single EPB and APL within one sheath is present only in a minority of patients. This wide anatomical variation has significant implications in the conservative and surgical management of the condition.

Patients present with a history of a variable duration of pain, exacerbated by thumb movement, thumb pinching, grasping or twisting with the hand. They may complain of a general difficulty with movement around the radial aspect of the wrist. They may also notice slight swelling over the radial border of the wrist and infrequently complain of clicking or snapping in this region. The condition is most common in people in their sixth decade and far more common in women than men. The incidence is also higher in diabetics. The most striking subset of patients are post-partum, lactating mothers who classically present with de Quervain's during this period, postulated to be due to the new, repetitive positioning of their wrist whilst holding their infant. There may be a history of repetitive wrist movements involving abduction of the thumb with ulnar deviation of the wrist. This movement is thought to put the tendons under most tension and a greater anatomic angulation of these tendons in women has been thought to account for the increase prevalence. Examination usually reveals swelling and tenderness overlying the tendons approximately 1–2 cm proximal to the radial styloid. The location of tenderness is important diagnostically, as a number of conditions which present on the radial side of the wrist need to be differentiated. Patients may present with intersection syndrome, classically 4–5 cm proximal to the radial styloid. Distal to the radial styloid, carpo-metacarpal thumb arthritis, scaphotrapezial-trapezoid arthritis, scaphoid fracture or radio-carpal arthritis may all cause pain in this region. Careful palpation of the radial border of the wrist can often elucidate the exact site of tenderness, which would correspond to the respective pathology. A positive Finklestein's test is diagnostically helpful. The test is correctly performed by holding the affected thumb in abduction and then forcibly ulnar deviating the hand away from the thumb to reproduce the symptoms. It is often incorrectly attributed to a test originally described by Eichhoff, in which the patient clasp's their thumb within their palm and then forces the wrist into ulna deviation – a test which may well invoke pain within an asymptomatic wrist. Other signs include triggering of the APL, pain on resisted active extension of the thumb and loss of ulnar deviation.

Radiographs may reveal a bony osteophyte within the first compartment, proximal to the styloid and will also help differentiate radio-carpal arthritis. Ultrasound (US) and magnetic resonance imaging (MRI) modalities have been used to diagnose de Quervain's. Characteristic tendon thickening, synovial sheath thickening and peritendinous oedematous changes are visible with both modalities. Useful information about the number of tendon slips and intertendinous septae can also be gleaned [15].

Non-operative Management

Rest alone, analgesia, splintage and steroid injection have all been advocated as methods of treating the condition.

Studies of lactating mothers have found complete resolution of symptoms following cessation of lactation without any intervention [16]. A number of papers have attempted to address the relative efficacy of splintage alone versus steroid injection. Although controlled clinical trials are few [17], consensus is that injection is by far more successful in achieving speedier resolution of symptoms, with success being quoted as up to 86 % [18, 19]. Splintage alone has not been shown to give lasting relief with failure rates as high as 70 % [20]. The surgeon should allow a minimum of 6 weeks before evaluating the success of injection. Further trials of injections may be considered, although the risks of steroid extravasation in this superficial, sensitive part of the wrist must be borne in mind. For this reason we advocate only one further injection attempt. Failure of complete relief of symptoms may be due to the presence of multiple septae within the first dorsal compartment. Recent studies have described the use of ultrasound to help identify differing sub-compartments in which to place the needle and to avoid superficial placement of the needle as a useful therapeutic adjunct [21, 22].

Technique

The patient should be advised of both the risk of steroid extravasation and of incomplete relief of symptoms. Using an aspetic technique, a 2 ml syringe with a 22-guage needle is used to administer a mixture of local anaesthetic and corticosteroid. The exact mixture may be the surgeon's preference as to what is locally available. The more soluble and short acting solutions of steroid may be safer and thereby reduce the likelihood of fat necrosis, subcutaneous atrophy and depigmentation. We use 1 ml of 1 % lidocaine and 40 mg of methylprednisolone acetate. The needle is placed 1 cm proximal to the radial styloid at a 45° angle to the longitudinal axis of the radial border of the forearm. To avoid a too superficial placement of the needle and the risk of steroid extravasation, we advocate inserting the needle into to the APL tendon and gently pressing on the syringe plunger, at which resistance will be felt. Whilst maintaining the pressure on the plunger and without trying to force the solution into the tendon proper, the syringe is slowly withdrawn. As the syringe exits the tendon, a flush of fluid may be seen to pass proximally and distally within the first compartment. An attempt should also be made to infiltrate the EPB subsheath by injecting part of the solution dorso-ulnarly. The patient should get immediate relief of symptoms due to the local anaesthetic.

Surgery

In cases of failed steroid injection, release of the first compartment is the recommended treatment. In getting consent from the patient, specific mention needs to made of the risks of superficial radial nerve injury and incomplete relief of symptoms. A thorough understanding of the surgical anatomy is important to minimise the risk of complications (Figs. 1.3 and 1.4). Most at risk are the superficial branches of the radial nerve, which overlie the extensor retinaculum. Over zealous retraction, accidental laceration or suture of these branches can lead to exquisitely painful neuroma, sensitivity or numbness. Underlying the snuff box, just distal to the styloid is the radial artery, which is at risk if the surgeon strays too deep or distal.

The procedure is performed under local anaesthetic, with an inflated tourniquet for the duration. A 2 cm transverse incision is made 1 cm proximal to the styloid, taking care not to incise too deeply (Fig. 1.5). Use of skin hooks to elevate the skin allow it to be teased off from the subcutaneous fat by blunt dissection, which will allow for better visualisation and protection of the branches of the radial superficial nerve. The retinaculum can then be visualised and incised longitudinally at its most dorsal aspect (Fig. 1.6). At this point a thorough attempt for all possible tendon slips and compartments should be undertaken; all of which should be decompressed. All tendons are gently delivered out of the wound to confirm complete release (Fig. 1.7). Traction on the EPB will be confirmed by extension at the thumb MCP. If this does not occur, re-check that all sub-compartments have been identified and released. The patient is then asked, in turn, to actively abduct and then extend the thumb to again confirm full release. The proximity of the nerve is illustrated by it's position following

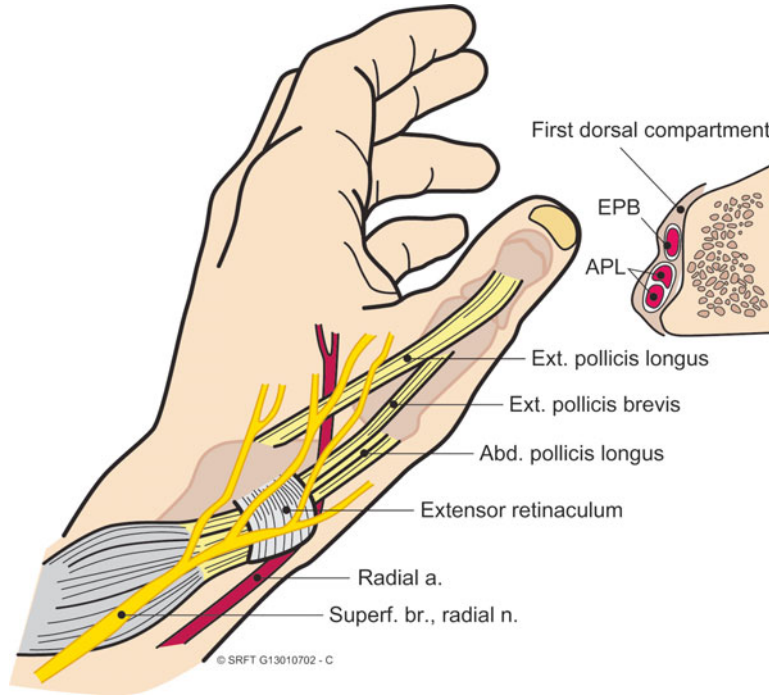

Fig. 1.3 Surgical anatomy of the 1st dorsal compartment. – Note the overlying superficial branches of the radial nerve and the possible sub-compartments within

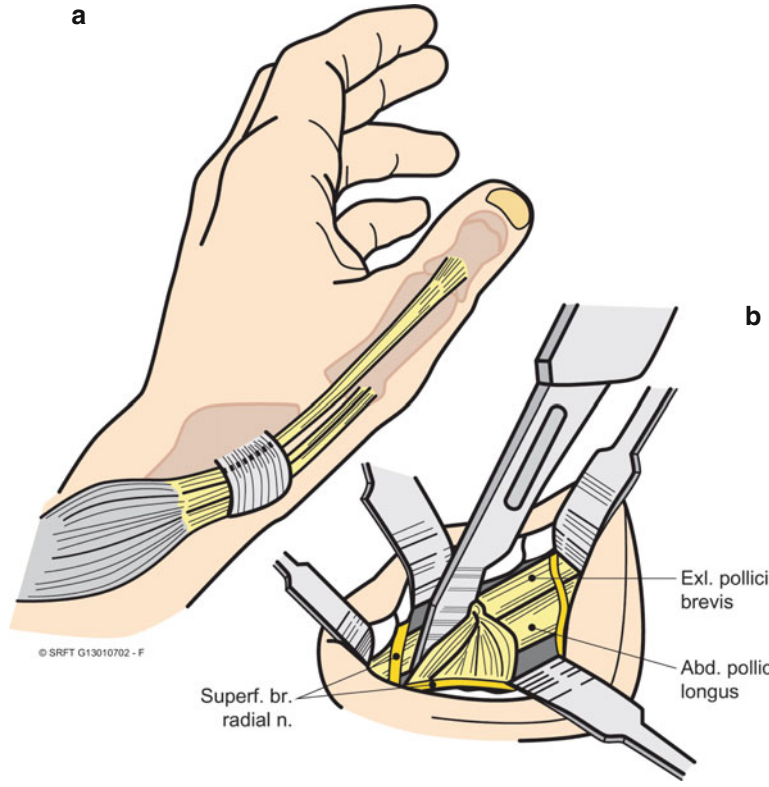

Fig. 1.4 Diagram of a de Quervain's release. (a) Noe the dorsally based longitudinal incision of the retinaculum. (b) Care is taken to protect the superficial branches of the radial nerve

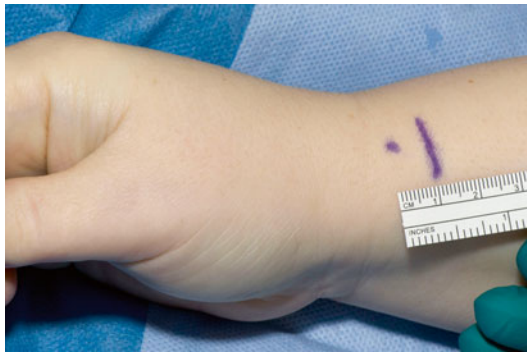

Fig. 1.5 Photograph showing surgical markings for release of 1st compartment. The radial styloid is marked with a *dot* and the site of the transverse incision is 1 cm proximal

Fig. 1.6 Photograph demonstrating release of the 1st dorsal compartment. The nerve is retracted and the retinaculum incised longitudinally on it's dorsal aspect

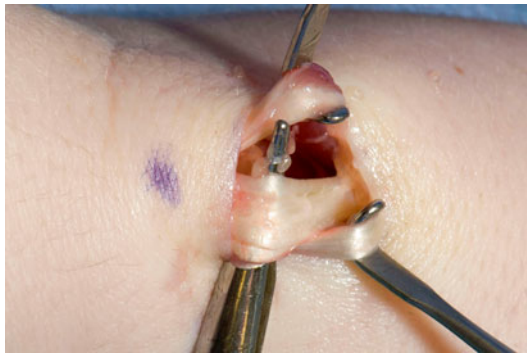

Fig. 1.7 The three tendons of 1st Compartment – a fleshy looking EPB dorsally and two slips of APB volarly (the most frequent pattern)

release (Fig. 1.8). After haemostasis is achieved, the skin is closed with a subcuticular 3/0 monofilament suture. A thick bulky dressing is applied

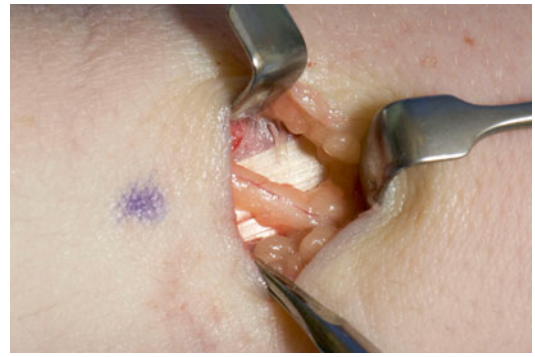

Fig. 1.8 Superficial branch radial nerve intact following full release of the 1st compartment

for 48 h and mobilisation is commenced immediately to avoid any tendon adherence. Heavy lifting with the hand is avoided for the first 6 weeks. No formal hand therapy is usually required.

Open surgery is reported to have a high success rate with a resolution of symptoms quoted as high as 91 % with a patient satisfaction rate of 88 % in a long term review [23].

Complications

There are three main complications to consider; nerve injury, incomplete compartmental release and volar subluxation of the tendons.

By far the most troublesome is injury to the superficial branches of the radial nerve, which can lead to numbness, or worse; a sensitive and painful neuroma. Some authors advocate a longitudinal but less aesthetic incision, to offer safer exposure. Scheller et al. reported no neuromas in a long term follow up of 96 cases, reporting only four cases of transient nerve lesions using a longitudinal approach [24, 25]. Care must be taken, not only during the initial dissection and retraction, but also skin closure when the nerve is at risk of either laceration or retraction. Management of an established neuroma can be challenging and is addressed in Vol 2, chapter 1.

Failure of release of all possible subcompartments is a well recognised complication. In particular, failing to release the EPB subsheath is cited as one reason for incomplete relief of symptoms. For this reason, the surgeon should

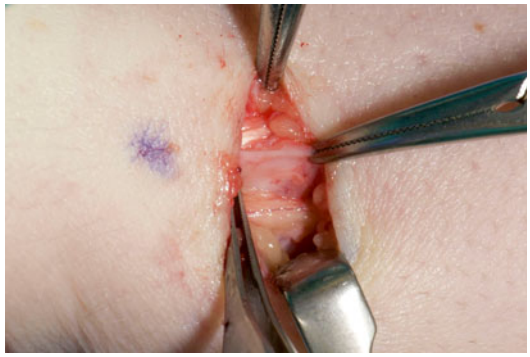

Fig. 1.9 The larger volar leaf of the extensor retinaculum is identified buttressing the tendons of the 1st Compartment

recognise, as previously discussed, the anatomical variations found within this compartment. Suspicion of incomplete release may be investigated further by way of US or MRI and, if positive, the patient should be re-explored. Patients who have had no resolution of symptoms should be also assessed for co-existing pathologies on the radial border of the wrist, as previously discussed.

Finally, volar subluxation of the APL and EPB following release has been cited as an infrequent but problematic complication. To avoid this complication, the majority of authors advocate incising the retinaculum as dorsal as possible and not to excise the entire retinacular sheath (Fig. 1.9). Some suggest suturing of the retincular flap to the subcutaneous tissue to act as a ledge upon which the tendons can sit, thus preventing subluxation [26]. Various techniques have been described to address established volar subluxation by pulley reconstruction using a part of the extensor retinaculum or brachioradialis, reporting good resolution of symptoms [27, 28].

Alternative techniques to the classic open de Quervain's release have been described to achieve relief of symptoms and mitigate against complications of nerve injury and tendon subluxation. Kang et al. reported success using an endoscopic technique [29], whilst Okada and Kutz described a technique of removal of accessory APL tendon slips to successfully decompress the compartment [30].

Clinical Pearls

Initially incise the skin gently to avoid direct laceration of the superficial branches of radial nerve.

Incise the ER on its most dorsal aspect to avoid tendon subluxation

Undertake a thorough search for all tendon slips and sub-compartments, incising each septum encountered.

Retract released tendons gently to visualise passive, smooth abduction and extension of the thumb.

Ask the patient to actively abduct and extend the thumb to confirm full release.

Intersection Syndrome

The second dorsal wrist compartment contains the tendons of extensor carpi radialis longus (ECRL) and extensor carpi radialis brevis (ECRB). Intersection syndrome describes the symptoms and signs of pain and swelling that occur 4–5 cm proximal to the radial styloid as the muscle bellies of EPB and APL cross over the wrist extensors in the second compartment. However, this syndrome is not due to any friction between the groups of tendons crossing over. The pathology itself is distal and ulnar to this location, within the tendon sheath of the wrist extensors underlying the tight extensor retinaculum of the second compartment. As there is not much space under the retinaculum, swelling extends proximally to the point of "intersection" [31].

The syndrome has been linked to wrist "overuse", usually in athletes performing activities such as rowing, weight-lifting or racquet sports. The use of MRI can help diagnose the condition, with peri-tendinous oedema evident on imaging [32]. Conservative management is the first line treatment and patients are encouraged to modify their activities and rest the wrist in a splint. An injection of local anaesthetic and steroid can also be inserted. A recent study successfully used soft tissue taping in five athletes to resolve symptoms in all at 3 weeks, with patients being symptom

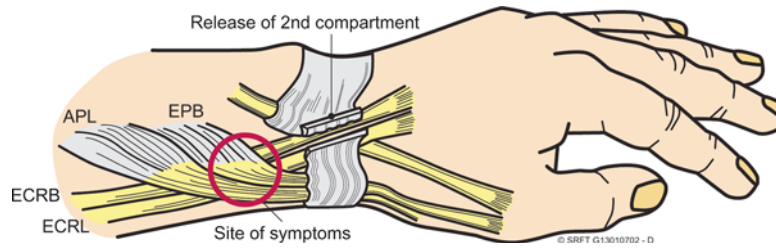

Fig. 1.10 Diagram of intersection syndrome anatomy and point of release at the 2nd extensor retinaculum

free for 1 year [33]. Conservative treatment is usually sufficient for resolution of symptoms. In resistant cases, the second compartment is released by a longitudinal incision overlying the ECRL and ECRB (Fig. 1.10). Post-operatively the wrist is splinted in slight dorsiflexion [31]. Care is taken to protect superficial branches of the radial nerve and avoid damage to the extensor pollicis longus tendon which is adjacent in the third compartment (Fig. 1.5).

Extensor Pollicis Longus

The EPL travels within the third dorsal compartment, through a relatively lengthy fibro-osseous tunnel, which angles sharply in a radial direction around Lister's tubercle as the tendon travels towards the thumb's inter-phalangeal joint. Within it's synovial tunnel, the tendon is relatively avascular, being dependant on synovial fluid for it's nutrition. Entrapment and subsequent rupture of the tendon is sometimes seen following undisplaced extra-articular distal radius fractures. It is thought that in an undisplaced fracture a haematoma builds up and exerts pressure within the fibro-osseous tunnel leading to ischaemia to the avascular portion of the tendon [34]. EPL rupture has also been reported secondary to synovitis of the extensor carpi radialis tendons [35].

Patients present with pain and swelling, exacerbated by thumb IP joint movement. Triggering of the tendon at Lister's tubercle is also a recognised symptom [36]. Tenderness and crepitus may be noted on palpation. As the EPL has a tendency to rupture, patients may present 6–7 weeks on following their fracture, or in clinic following removal of their cast, with an inability to retropulse the thumb.

As there is a definite risk of rupture, when the patient presents with swelling and pain, urgent surgical debridement is the first line of treatment and steroid injection is contra-indicated. The tendon is approached through a small, dorsal incision just ulnar to Lister's tubercle. Superficial branches of the radial nerve must be protected. The extensor retinaculum is divided and the EPL tendon gently lifted. The tunnel is debrided of any osteophytes. The tendon can then be transposed radial to the tubercle and the tunnel closed to prevent the tendon from slipping back. The thumb can be mobilised immediately. In the case of acute rupture, a palmaris longus interposition graft can be used and in delayed presentation, extensor indicis proprius to EPL tendon transfer is the reconstruction of choice [37].

Forth and Fifth Dorsal Extensor Compartments

The tendons of EIP and EDC travel within the fourth compartment, with extensor digiti minimi travelling in its own fifth fibrous compartment. Far less common than at other sites, patients can present with symptoms of swelling, pain, crepitus, tenderness, snapping and triggering within these compartments. Extensor indicis proprius syndrome is well recognised and thought to be due to hypertrophy of its muscle belly extending distally under the tight retinacular sheath. The patient will complain of pain, particularly in wrist flexion and asking the patient to actively extend the index finger against resistance whilst maintain the wrist in flexion will induce pain just radial to Lister's tubercle. Anomalous, additional tendons within these compartments are a well recognised cause of dorsal wrist pain and swelling

and may be mistaken for a dorsal wrist ganglion [38]. If conservative measures fail, one should consider the possibility of anomalous tendons. Partial release of the extensor retinaculum, or in the case of anomaly, a partial excision of tendon can be performed to relieve symptoms [39].

Extensor Carpi Ulnaris Tendonopathy

An understanding of the anatomy of the ECU as it crosses the wrist is imperative, both in diagnosis and management. The ECU muscle becomes tendinous approximately 2 cm proximal to the ulna head and at this point passes through a fibro-osseous tunnel on its way to attach to the base of the 5th metacarpal. The fibro-osseous tunnel is composed of an investing fascia of the forearm, termed the ECU subsheath, which fully encircles the tendon sitting in the osseous grove of the ulna. This osseous groove is situated on the dorsal aspect of the distal ulna, between the ulna head and it's articular facet with the radius at the DRUJ. The subsheath itself is tightly adherant to the osseous groove. The subsheath ends distally, by blending with the dorsal capsule over the dorsum of the triquetrum. The extensor retinaculum forms the 6th dorsal compartment as it arches over this fibro-osseous tunnel, extending ulnarward, draping over the ulna, going on to attach to the triquetrum and pisiform. The retinaculum does not attach to the ECU, ECU subsheath or the ulna (Fig. 1.11). This allows for the wrist to prono-supinate. The relative adherence of the ECU subsheath within the fibro-osseous groove results in the ECU tendon being both bound tightly to the ulna and being placed under significant stresses when the wrist goes from pronation to supination. This anatomical arrangement is thought to account for the tendons preponderance to tendonitis, entrapment and instability.

Tendinopathy of the ECU is not uncommon and is regarded as second only to de Quervain's disease in frequency of tendinopathy at the wrist [40]. As the symptoms are often poorly localised, it may well be that it is more prevalent than perceived.

Tendonitis can be secondary to overuse, simple soft-tissue trauma following a fall or twist, or be related to instability of the ECU. There is a propensity for those involved in stick or racquet sports to develop ECU tendinopathy, due to the forceful wrist, flexion and supination movements involved, leading to tension and abrasion of the tendon [41]. It may also occur in association with either degeneration or injury of an adjacent

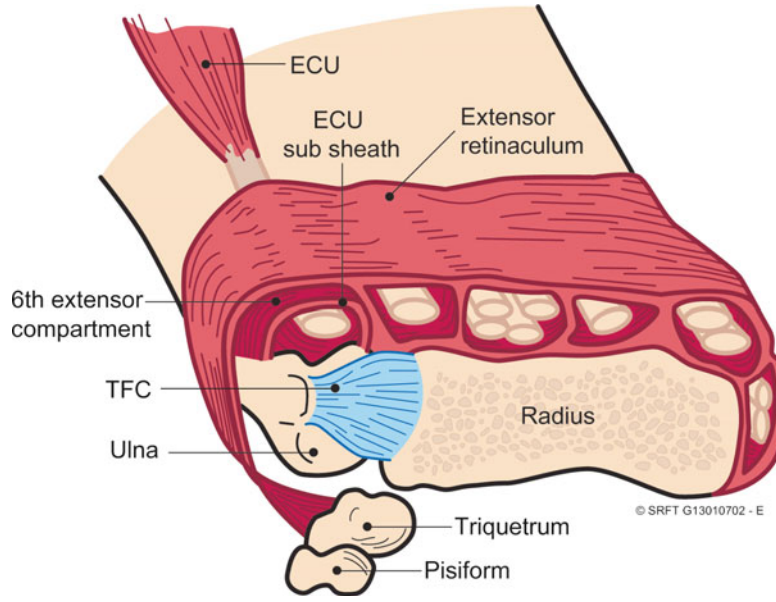

Fig. 1.11 Diagram illustrating the relationship of the ECU, ECU subsheath and 6th extensor compartment in which it lies

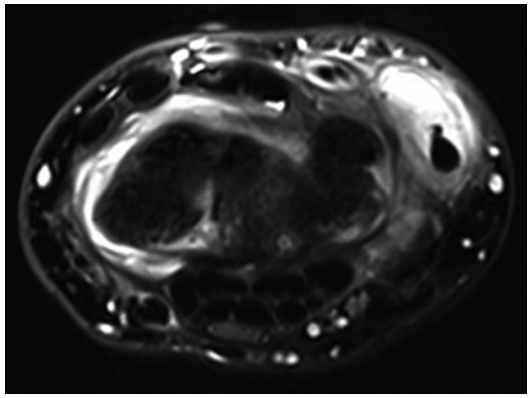

Fig. 1.12 Gadolinium enhanced MRI demonstrating florid tendonitis of the ECU within its sub-sheath (*top right* of the image) (Courtesy of Mr. Lindsay Muir, Salford Royal Hospital, Manchester, UK)

structure, such as the luno-triquetral ligament, TFCC, ulnar styloid or distal radial ulnar joint. As in other dorsal compartments, tenovaginitis may also be secondary to an anomalous accessory tendon slip within the 6th extensor compartment [42]. The proximity of adjacent structures, which may be involved in isolation or in combination with the ECU, as mentioned above, make this condition diagnostically challenging [40, 43].

Patients may present with an acute onset of diffuse ulnar-sided swelling and pain. However, the pain may be difficult to pinpoint accurately. The proximity of branches of the ulna nerve may give rise to patchy paraesthesia or dysaesthesia. There may also be tenderness and crepitus on palpation of the tendon. All active movements of the wrist are painful, in particular extension and ulnar-deviation [40]. Passive prono-supination of the wrist may elicit subluxation or "snapping" of an unstable ECU as the wrist is moved into flexion and supination. Injection the ECU sheath with local anaesthetic will confirm the diagnosis, if the symptoms settle [43].

Dynamic ultrasound can be very useful in diagnosing an unstable ECU. MRI is also particularly useful in evaluating tendinopathy, tendonitis and tendon rupture (Fig. 1.12) [44].

Conservative management by way of rest, splintage and analgesia is the first line of treatment and has been shown to be effective. In resistant cases, injection of corticosteroid may be sufficient to resolve symptoms [45]. If conservative measures fail, a release of the tunnel can be performed. This is done through a dorsal approach, centred over the ulnar groove, just radial to the ulna head. The superficial branches of the ulna nerve are identified and carefully preserved. The extensor retinaculum is divided to access the tunnel, which is then released fully. The osseous groove is inspected and debrided if necessary. The retinaculum is then repaired for ECU stability, although some authors have found no adverse effects from leaving the retinaculum open [45, 46].

Flexor Carpi Radialis

The flexor carpi radialis (FCR) tendon is lined with synovium as it passes through a fibro-osseous tunnel on the volar radial aspect of the wrist (Fig. 1.13). The tendon ultimately inserts onto the base of the second metacarpal. The distal aspect of the tunnel wall is composed mainly of the medial facet of the trapezium. Proximal to the trapezium, to the radial side of the tendon, is the tubercle of the scaphoid. As the tendon travels through this narrow fibro-osseous tunnel it is prone to stenotic tendovaginitis, particularly if there is a degenerative process involving the trapezium, scaphoid or scaphotrapezial joint [47, 48].

It is more frequent in women of late middle age, who are likely to have concomitant scaphotrapezial osteoarthritis. Sporting activities involving strenuous wrist flexion may also bring on symptoms [49].

Patients will present with pain on the volar radial aspect of the wrist. On examination there may be swelling and tenderness along the course of the tendon and pain may be reproduced by resisted flexion. The surgeon needs to differentiate FCR tendonditis from de Quervain's disease, scaphotrapezial arthritis, scaphoid fracture, base of thumb arthritis and ganglion cysts. An injection of local anaesthetic into the FCR sheath may assist diagnosis by transient relief of symptoms.

Conservative management by analgesia, rest and splintage is again the first line treatment. If this is not successful, corticosteroid injection of

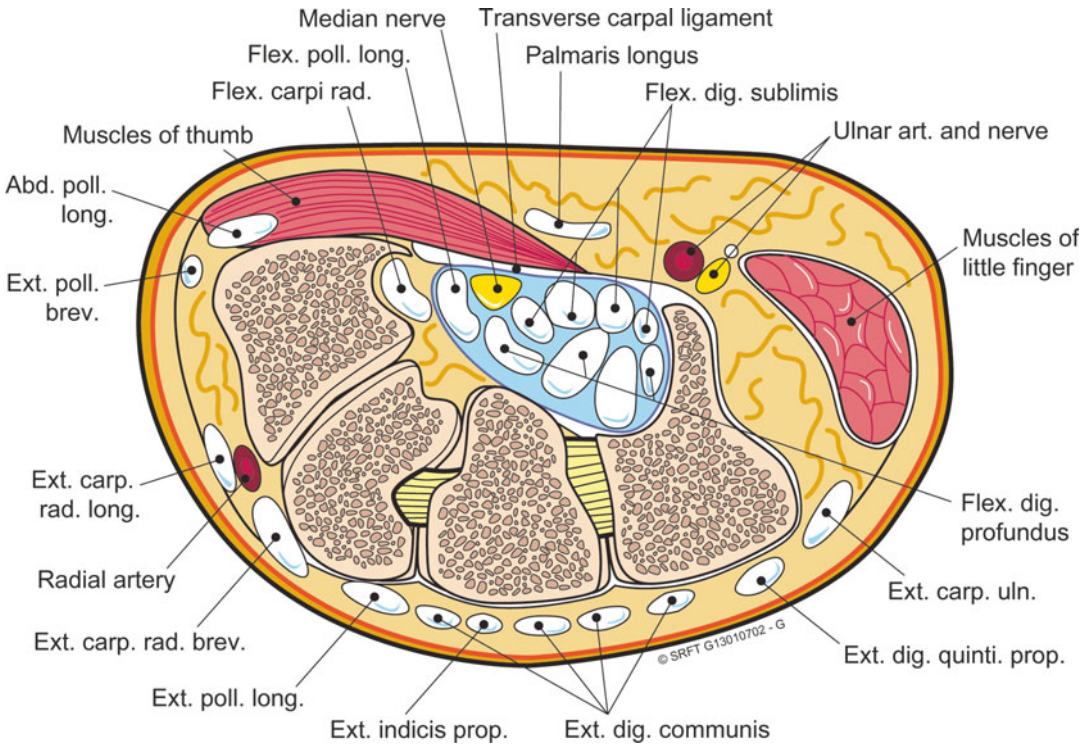

Fig. 1.13 Cross-sectional diagram showing journey of FCR sitting adjacent and ulnar to the side wall of the trapezium which roofs over it

the sheath may resolve symptoms. If this is ineffective then the tunnel is released. An incision is made over the tubercle of the scaphoid. The palmar cutaneous branch of the median nerve is avoided, as the tendon is identified and a release is performed from proximal to distal, opening up the entire fibro-osseous tunnel. The tendon is retracted gently to allow for inspection and debridement of the tunnel, which may well contain sharp osteophytes, secondary to the degenerative processes at the trapezium and/or scaphoid [48].

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