Athletic Injuries of the Wrist and Hand

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OVERUSE SYNDROMES OF THE WRIST

Upper-extremity overuse syndromes from sports participation are quite common. It has been estimated that 50% of athletes will sustain injury, and 25% to 50% of these are from overuse. These syndromes are most frequently seen in racquet sports, rowing, volleyball, handball, and gymnastics.

Overuse may be defined as a level of repetitive microtrauma sufficient to overwhelm the tissues’ ability to adapt. Microtrauma represents damage at the molecular level and can be produced by either a tension or shear load. The pathophysiology of tendon failure has been well worked out but is beyond the scope of this review.

De Quervain’s Syndrome

Stenosing tenosynovitis of the first dorsal compartment (De Quervain’s syndrome) is the most common tendinitis about the wrist in the athlete. It is the result of shear microtrauma resulting from repetitive gliding of the first dorsal compartment tendons (abductor pollicis longus [APL] and extensor pollicis brevis [EPB]) beneath the sheath of the first compartment over the radial styloid. Activities requiring forceful grasping coupled with ulnar deviation or repetitive use of the thumb predispose the athlete to this condition. These include golf, fly fishing, and certain racquet sports (squash and badminton).

The athlete presents with radial wrist pain and tenderness over the first dorsal compartment. Finkelstein’s test is pathognomonic in making the diagnosis: the patient flexes the thumb into the palm while the examiner ulnarly deviates the wrist producing the patient’s symptoms.

Treatment is dictated by the stage of the disease. Rest and immobilization may be helpful in very early stages (25% to 72% cure rates reported); however, corticosteroid injection into the first dorsal compartment results in reported cure rates of 62%, 91%, 80%, and 100%. Additional injections may be indicated, and if no progress occurs, surgical release of the first dorsal compartment may be performed. Patients with de Quervain’s disease have a high incidence of EPB tendon traveling in a separate compartment, and this must be decompressed as well as that of the APL. During the surgery, care must be taken to protect the branches of the superficial and radial nerves that dorsally overlie the first dorsal compartment.

Intersection Syndrome

Intersection syndrome is an inflammatory condition located at the crossing points of the first dorsal compartment muscles (APL and EPB) and the radial wrist extensors (extensor carpi radialis longus and extensor carpi radialis brevis [ECRP]) that lies 4 to 6 cm proximal to the radial carpal joint. This entity is frequently seen in oarsmen, racquet sports, weight training, and other sports requiring repetitive wrist extension.

Physical exam reveals tenderness and swelling at the intersection point, and frequently crepitus is noted as the
wrist is actively extended and flexed (hence, the term *squeakers*). Symptoms normally respond to a course of rest, splinting, nonsteroidals, and plus or minus injection. In rare cases that do not respond, surgical decompression of the second-compartment tendons, release of the fascia of the APL and EPB muscles and debridement of the bursa are indicated.27,31,85 A graduated return to weight training and sport is recommended once symptoms are relieved.

**Extensor Carpi Ulnaris (ECU) Tendinitis**

ECU tendinitis is second to de Quervain’s in frequency in the athlete.44 ECU tendinitis is seen in rowing and racquet sports and is quite common in the nondominant wrist of tennis players caused by the two-handed backhand. Biomechanical studies have shown that the wrist in tennis is in ulnar deviation for most shots and the nondominant wrist is in extensive ulnar deviation during the two-handed stroke. Osternan et al.69 have shown that ECU tendinitis may be the result of underlying ulnar wrist pathology such as triangular fibrocartilage complex (TFCC) injury (see previous section).

Treatment of ECU tendinitis involves splinting, rest, nonsteroidals, occasional steroid injection of the sheath, and attention to the technique modification to avoid recurrence. Failure to respond to this treatment regimen may indicate underlying pathology, and a further workup is recommended.

**Subluxation of the ECU**

Although not truly an overuse syndrome, subluxation of the ECU tendon should be considered in the diagnosis of the athlete with ulnar wrist pain. Subluxation of the ECU results from rupture or attenuation of the ECU subsheath usually due to a sudden volar flexion ulnar deviation stress such as hitting a low forehand in tennis. It has also been reported in golfers, weightlifters, and rodeo bronco riders.59,72,79

The anatomy has been well described by Taleisnik,85 and involves rupture of the medial wall of the subsheath, which is separate from the overlying supratendinous retinaculum.

Diagnosis may be made by having the athlete actively ulnarily deviate the wrist in full supination observing the ECU tendon subluxing ulnarward over the styloid.86

Diagnosis may be confirmed by injecting Lidocaine into the ECU sheath, which should result in complete relief of pain. Underlying pathology such as TFCC injuries should be considered.

In acute injuries, some authors recommend casting for 6 weeks with the wrist pronated and dorsiflexed.7,86 Rowland78 recommended open repair in acute injuries for a more predictable outcome. If performed, a more aggressive rehabilitation program may be recommended.

In chronic cases, reconstruction of the subsheath may be performed. In a series of 19 cases of acute and chronic injuries, direct repair to the fibrous rim attached to the ulnar aspect of the ulnar groove resulted in good/excellent results with return to sport in an average of 3 months (unpublished data, Rettig, Mathis).

**Wrist Flexor Tenosynovitis**

Flexor carpi radialis (FCR) tendinitis is rare in the athlete, but the treating physician should be aware of the condition. Prior to insertion at the base of the second metacarpal, the FCR passes through a tunnel formed by the transverse carpal ligament, scaphoid tuberosity, trapezial ridge, and the radial margin of the FCR tunnel. The condition usually responds to rest and splinting, although injection into the tunnel may be indicated.

Flexor carpi ulnaris (FCU) tendinitis is more common and has been reported in golf and racquet sports such as badminton and squash.30 Pisotriquetral compression syndrome may be an accompanying condition since the pisiform is a sesamoid bone within the substance of the FCU. Pisotriquetral arthritis is best visualized on a lateral radiograph of the wrist in slight supination and mild extension.

Treatment of rest, splinting in 25° of volar wrist flexion, and corticosteroid injection into the sheath or pisotriquetral joint results in resolution of symptoms in 35% to 40% of cases according to Palmieri.70 In refractory cases, pisiform excision with or without Z-plasty lengthening of the FCU is usually curative with return to racquet sports in 6 to 8 weeks.70

Trigger finger may be produced by direct pressure on the metacarpophalangeal (MP) joint flexion crease from repeated racquet use and is occasionally seen in the athlete. Cortisone injection is the preferred treatment in non-diabetics with cure rates that range from 36% to 91%.52,75 Open release of the A-1 pulley under local anesthetic is indicated in refractory cases.

**Carpal Tunnel Syndrome**

The young athlete will occasionally present with acute carpal tunnel syndrome due to significant tenosynovitis of the digital flexors secondary to repetitive digital flexion activities. In the majority of these cases, symptoms will resolve with rest, immobilization, nonsteroidals, and with or without steroid injection. A short course of oral corticosteroids may be indicated if initial treatment fails. EMG is usually normal, and it is rare that the athlete requires carpal tunnel release.23

**Dorsal Impingement Syndromes**

Dorsal impingement syndromes are common in all sports where repetitive dorsiflexion occurs particularly accompanied by axial loading. Gymnasts have a high incidence of wrist pain reported at >50% in some series.51,67

Gymnasts’ wrist injury includes distal radius stress fractures, scaphoid stress fracture, avascular necrosis of the capitate, ulnar carpal abutment, and dorsal impingement.26 Distal radius physeal stress fracture is typically seen (89% to 90%) in females 12 to 14 years of age with a
HAND INJURIES IN THE ATHLETE

Hand injuries in sports are usually traumatic in nature and may occur from falls, axial loading of digits, or rotational traumatic injuries from grasping activities.

Metacarpal and Phalangeal Fractures—Extra-articular

Each of the phalanges and metacarpals have common fracture patterns and are related to each bone’s location and susceptibility to failure under external loads. Most mid-phalangeal fractures are caused by direct blows and result in transverse fractures, whereas distal phalangeal fractures are usually a result of crushing injuries occasionally accompanied by nail-bed injuries. Deviation forces imparted to the flexed digit lend to proximal phalanx fractures frequently resulting in spiral fractures of the proximal phalanx or metacarpal which may be unstable. Deviation forces to the flexed digit are transferred to rotational stress frequently resulting in spiral fractures of the proximal phalanx or metacarpal, which may be unstable.

Most fractures due to athletic trauma are stable due to lower energy of injury as opposed to motor vehicle accidents or falls from a great height. In one study, 80% of metacarpal fractures from athletic trauma were stable. These stable fractures were treated by casting or splinting with return to sport in 2 to 8 weeks depending on the sport and position. Average return to football was 12 days and to basketball was 19 days.

If the fracture is deemed unstable or the position is unacceptable—that is, if malrotation or clawing of the digit is noted on clinical exam—closed reduction percutaneous pin fixation or open reduction internal fixation is indicated. For details, the reader is referred to Strickland and Rettig’s textbook. For transverse displaced metacarpal fractures, intermedullary bouquet pinning is less invasive and may facilitate return to sport with minimal scarring and preserved range of motion.

Similarly, most phalangeal fractures are stable in athletic trauma, and treatment may consist of buddy taping and early range of motion with or without splinting. Pun et al. described this technique in more than 400 stable phalangeal fractures. For details of management of unstable fractures, refer to Strickland and Rettig.

Joint Injuries

The most common joint injuries in the hand involve the proximal interphalangeal (PIP) joint of the digits, MP joint of the thumb, and basilar joint of the thumb.

PIP Joint Injuries

The PIP joint is the most commonly injured joint in sports. The joint is a hinged joint the stability of which depends on a three-sided box configuration consisting of volar plate and proper and accessory collateral ligaments. The volar plate is thickened distally with a firm attachment to the base of the middle phalanx. The plate thins proximally in the central position then thickens laterally as it attaches to the proximal phalanx to form two checkrein ligaments.

PIP injuries include collateral ligament injuries, dislocations, fractures/dislocations, volar plate injuries, and intra-articular fractures. Collateral ligament injuries of the PIP joint are quite common due to axial loading and dorsiflexion forces. The radial collateral ligament is most frequently injured, usually from its proximal attachment (Fig. 1). Most injuries are incomplete ruptures with minimal instability and are treated with buddy taping, splinting, and early range of motion. Return to sport may be immediate in sports where play with splinting is possible or 10 to 21 days when full range of motion is required. If moder-
ate laxity is present, splinting may be employed for 2 to 3 weeks and range of motion begun. Return to full sports may require 4 to 6 weeks.

Complete tears of the radial collateral ligament of the PIP joint are rare. Indications for repair include irreducible position where soft-tissue interposition is present or in dynamic instability where simply flexing or extending the digit results in subluxation of the joint. If the radial collateral ligament of the index finger is involved, many recommend repair. McCue et al., Redler et al., and Rodriguez et al. advocated open repair for most complete ruptures.56,76,78 New mini-suture anchors may be employed to reattach the torn ligament to the proximal phalanx.

PIP joint dislocations are the most common dislocations seen and may be dorsal, volar, or lateral. These injuries are commonly seen in ball-handing sports such as basketball, football, and baseball. The most common dorsal dislocations are due to hyperextension with axial loading. The volar plate ruptures from its distal attachment with or without avulsion fracture of the base of the middle phalanx.

Most PIP dislocations are stable and can be treated with splinting or simple buddy taping. Palmer reported on 100 cases that were stable and treated with immediate range of motion and return to sport as tolerated with no residual instability.

Volar PIP joint dislocation (Fig. 2) may be straight volar, lateral volar, or rotatory. Volar dislocation results from a varus or valgus force coupled with a volar thrust to the middle phalanx. The pathologic pathology involves injury to the collateral ligament central slip and transverse retinacular ligament with or without partial volar plate injury.6

Figure 1. Lateral dislocation with ruptured collateral ligament and (not shown) the partial tear of the volar plate from its distal attachments.

Figure 2. Radiographs of the volar proximal interphalangeal dislocation.

Treatment involves closed reduction and if successful may recommend treatment with splinting to protect the central slip as one would treat a boutonniere injury. McCue and Cabrera recommended repair of the central slip and collateral ligaments in most cases.57 If closed reduction is not possible, which occurs in rotational cases where the condyle of the open repair of the slip with pinning of proximal phalanx “buttonholes” between the central slip and lateral bands (Fig. 3), open repair of the central slip with pinning of the PIP joint in extension for 2 to 3 weeks following repair is recommended.

Fracture/dislocation of the PIP joint results from similar mechanism to dorsal dislocation. These injuries must be evaluated with respect to reduction of the PIP joint and stability once reduced. A true lateral of the digit involved must be obtained and critically assessed with regard to concentric reduction. If stable, these injuries may be treat-
ed with simple splinting or buddy taping with re-x-ray in 5 to 7 days to confirm stability.

If the volar fragment in the middle phalanx represents greater than 30% to 40% of the articular surface, the injury must be regarded as unstable. If any doubt exists, exam under fluoro with a digital block should be performed.

Unstable fracture dislocations are significant injuries that may keep the athlete from return to sports for 6 to 8 weeks. Treatment varies from the dorsal extension block splint described by MacElfrish et al. to closed reduction, percutaneous pin fixation of the joint for 10 to 14 days, followed by extension block splinting to open reduction and internal fixation if the fragment is of adequate size. Chronic unreduced fracture dislocations are not uncommon and may compromise hand function due to lack of full flexion of the digit. Volar plate avulsion injuries described by Eaton and Mallerich is a salvage procedure that is usually employed in such cases.

Volar plate injuries at the PIP joint may occur as isolated entities or in association with other injuries such as collateral ligament tears. McCue et al. studied 143 surgically treated PIP joint injuries, and of these 13 were isolated volar plate injuries.

Distal volar plate avulsions occur due to dorsiflexion and axial load stress and when not treated appropriately may lead to a swan neck deformity. These are frequently disabling with locking, catching, and discomfort due to hyperextension at the PIP joint. In most cases of posttraumatic swan neck deformities, conservative treatment is not helpful, and exploration with repair of the distal thick volar plate to the base of the middle phalanx is indicated. This may be performed with suture anchors or pullout wires technique, and the joint should be pinned in 20° to 30° flexion for 2 to 3 weeks to allow initial stages of healing to occur.

If the volar plate is torn proximally in the membranous portion, scar tissue forms in the checkrein ligaments and a flexion contracture may develop. This is called a pseudo boutonniere deformity and is accompanied by mild hyperextension at the distal interphalangeal (DIP) joint versus a true boutonniere, in which hyperextension is more severe. The x-rays reveal calcification in the proximal volar plate area. McCue et al. recommended conservative treatment with splinting for contractures less than 40° with mild disability. In contractures greater than 45°, splinting was not helpful, and surgical release of the checkrein ligament and debridement of the osteophyte are indicated.

Intra-articular fractures are common at the PIP joint and frequently are overlooked until malunion has occurred—the coach’s finger, a term coined by McCue and Cabrera. It is recommended that all PIP injuries with swelling and limited motion be x-rayed to prevent this occurrence.

The most common isolated fracture of the PIP joint is the condylar fracture of the proximal phalanx, which may be unicondylar, T-bicondylar, or comminuted. Principles of fracture care must be followed, and anatomic joint alignment, whether by closed or open reduction techniques, must be achieved. Stability is obtained by K-wires or mini–screw fixation (1.5 to 2.0 mm). Return to sports may be as early as 1 to 2 weeks in stable fractures. If internal fixation is necessary, return should be delayed at least 3 to 4 weeks and protective splinting should be used for an additional 3 to 4 weeks.

Thumb Carpometacarpal (CMC) Joint Injuries

Dislocation of the CMC joint of the thumb without fracture is rare and involves rupture of the volar beak ligament with dorsal displacement of the first metacarpal. Partial ruptures may occur and can be assessed by stress x-rays taken with a posteroanterior view of the thumbs pressed together.

Management of acute injuries involves closed reduction and assessment of stability. If the reduction appears stable, cast immobilization for 4 weeks is usually adequate. If stability is not present, percutaneous K-wire fixation is indicated. If gross instability exists or reduction cannot be achieved due to soft-tissue interposition, open reduction and reconstruction of the volar ligament is performed using the radial one-half of the FCR routing through the first metacarpal base and around its remaining half (Fig. 5). This procedure may be used in chronic cases and also acutely in the high-performance athlete, particularly in the quarterback’s throwing hand.

Injuries to the CMC joint of the thumb are more commonly associated with fractures, the most common of which is a Bennett’s fracture. The injury occurs due to adduction force on a partially flexed thumb such as occurs to a quarterback’s throwing hand impacted on an opponent’s helmet during follow-through. A two-part intra-articular fracture results with the volar-ulnar fragment attached to the volar beak ligament, and the remaining metacarpal may be displaced/dislocated. True lateral radiographs of the thumb ray and CT scans are helpful in making an accurate diagnosis.

Treatment involves closed reduction percutaneous pin fixation if the fragment is less than 15% to 20% of the articular surface with the trapezium first metacarpal joint fixed. If the fragment is large enough, open reduction internal fixation with a 1.5- to 2.0-mm screw may be used (Fig. 6). Range of motion may begin 5 to 10 days with screw fixation versus 4 weeks with pin fixation. Nonthrowers may return to football in protective devices in 2 to 3 weeks. However, a quarterback usually may not return for 6 to 10 weeks.

Thumb MP joint injuries are common in all sports. Dorsal dislocations are most commonly caused by hyperextension with complete rupture of the volar plate usually proximally but occasionally distally. Plain radiographs may reveal the type of injury by the position of the sesamoids.

Thumb MP joint dislocations are usually amenable to closed reduction performed with the metacarpal flexed and adducted and the interphalangeal joint flexed to decrease the block of the thenar muscles. Once reduced,
stability should be assessed and simple immobilization employed for 10 days to 4 weeks. If the dislocation is not reducible, the metacarpal head is usually entrapped by the two heads of the flexor pollicis brevis, and reduction is blocked by interposition of the volar plate, collateral, or flexor pollicis longus. In these cases, open reduction is indicated and usually stable after reduction.

Collateral ligament injuries of the thumb MP joint are quite common in all sports. The skier’s or gamekeeper’s thumb results from a radially directed force on an abducted thumb as is frequently seen in football, basketball, and other contact collision sports, as well as in skiing. Although ulnar collateral ligament (UCL) injuries are

Figure 4. (A) On the preoperative roentgenogram, note the displaced single condylar fracture. (B) Postoperative reduction with internal fixation.

Figure 5. Rerouting of the distally based radial one-half of the FCR tendon through the base of the thumb metacarpal for stabilization of the thumb carpometacarpal joint.
common though much more frequent than radial collateral ligament (RCL) injuries, a recent study by Melone found that 40% of thumb metacarpal injuries involve the RCL and 60% the UCL.

When evaluating UCL injuries, the challenge is to differentiate partial tears from complete tears with Stener’s lesion, in which the distal portion of the UCL avulses from its attachment on the proximal phalanx and herniates through the adductor aponeurosis. Malone has shown that this does not occur in radial-sided injuries due to the orientation of the adductor and abductor tendons (Fig. 8). Partial tears may be treated by simple immobilization, whereas unstable injuries with Stener’s lesions should be treated surgically.

Physical findings indicating Stener’s lesions are 1) presence of a mass over the ulnar side of the MP joint and 2) lack of end point to stress at both full extension and flexion at 30°. Melone emphasized the importance of stress radiographs: difference of greater than 30° of angulation between the injured and uninjured thumb plus greater than 33% subluxation of the proximal phalanx relative to the metacarpal head are an indication of a complete tear, which requires surgical repair. If an avulsion fracture at the base of the proximal phalanx is present, displacement of greater than 3 mm with rotation is an indication for surgical repair, according to Melone.

In most cases of UCL injuries, ligament disruption occurs at the insertion into the proximal phalanx at 90% to 100%. Radial collateral injuries occur with disruption proximally 40%, distally 20%, and centrally 40%. Primary repair may be performed up to 8 weeks postinjury. If greater than 8 weeks from injury, reconstruction using free tendon graft may be necessary. In chronic cases of UCL, many athletes have minimal symptoms. Many reconstructive procedures have been recommended for those with symptomatic chronic instability, but they are beyond the scope of this review. We recommend no surgery in cases that are asymptomatic, and if symptoms recur, we recommend MP joint arthrodesis when the athletic career is completed.
Closed Tendon Injuries

Mallet finger refers to disruption of the terminal extensor tendon at its insertion on the distal phalanx. Also known as drop finger or baseball finger, it is especially common in softball, baseball, basketball, or in a receiver in football. It may occur due to the impact of the fingertip on a ball or other object resulting in flexion force to the DIP joint or less commonly to an extension axial load force. McCue and Wooten classified the pathology into five types: 1) tendon attenuation, 2) tendon rupture, 3) rupture with avulsion fragment, 4) fracture, and 5) physeal fracture. Doyle subclassified fractures into 1) transepiphyseal, 2) hyperflexion injury with a fragment involving 20% to 50% of the articular surface, and 3) hyperextension injuries in which the fragment involves greater than 50% of the articular surface and frequently is accompanied by volar subluxation of the joint (Fig. 9).

Treatment of mallet injury depends on the type; however, most authors recommend splinting of the DIP in extension allowing free PIP motion. Success has been reported with splinting in cases presenting as late as 3 months postinjury. In cases of fracture/subluxation of the DIP joint, controversy exists as to treatment. Crawford recommended open repair since the extensor pollicis longus insertion is thicker than the terminal extensor of the digits, and they noted a presence of a gap in those cases at exploration. Miura et al. noted 84% satisfactory results in mallet thumbs treated with splinting and that better results were obtained in those treated less than 2 weeks from injury.

Mallet Thumb

Mallet thumb injuries constitute only 2% to 3% of all mallet injuries. Most authors continue to favor interphalangeal splinting in extension. Din and Meggitt recommended open repair since the extensor pollicis longus insertion is thicker than the terminal extensor of the digits, and they noted a presence of a gap in those cases at exploration. Miura et al. noted 84% satisfactory results in mallet thumbs treated with splinting and that better results were obtained in those treated less than 2 weeks from injury.

 Boutonniere Injuries

The boutonniere injury refers to rupture of the central slip of the extensor mechanism at its insertion into the base of
the middle phalanx. Injury results from direct trauma to the dorsum of the PIP joint, an acute flexion force at the DIP, or more commonly following a lateral volar dislocation of the PIP joint that results in injury to the central slip and collateral ligament.  

In acute cases, an obvious extension lag may not be present. Tests described by Lovett and McCalla, in which a digital block was administered and extensor strength was checked, or by Carducci, in which wrist and MP joint are flexed greater than 15% to 20% loss of active PIP extension, indicate rupture or attenuation of the central slip.  

Treatment of the boutonniere injury depends on chronicity and stage of the process. If full passive extension is present, splinting in extension for 6 to 8 weeks with DIP flexion usually yields excellent results. In sports such as basketball, football, and hockey, the athlete may proceed with play and practice with extension taping as long as the splint is worn at all other times. Leddy and Coyle stated that the only indication for repair of acute central slip injuries is 1) an un-reducible PIP dislocation and 2) a large displaced intra-articular PIP fracture at the dorsal base of the middle phalanx.  

In the chronic boutonniere, frequently a flexion contracture may exist, and treatment is directed at serial casting or splinting to correct the contracture. If this is successful, no further treatment is indicated if symptoms are minimal and the contracture is less than 30°. If casting or splinting fails, a two-stage surgical procedure may be performed with a release followed by an Elliott-type repair once full extension is obtained.  

A true boutonniere should be differentiated from a pseudo boutonniere described previously in which the proximal volar plate is injured resulting in PIP joint flexion contracture.

**Extensor Tendon Injuries at the MP Joint Level**

The extensor hood of the finger MP joint is composed of a longitudinal central tendon (extensor digitorum communis [EDC]) and transverse peripheral fibers (sagittal bands) that insert into the central tendon and arise from the transverse intermetacarpal ligaments and volar plate. This structure glides over the underlying MP joint capsule. Injury to the structure may occur due to repetitive direct trauma to the knuckle, such as in the boxer, or from a laterally directed force that ruptures the sagittal band.

**Boxer’s Knuckle**

Boxer’s knuckle is due to disruption of the extensor hood due to repetitive trauma to the MP joint. It may also be accompanied by underlying capsular disruption. Hame and Melone and Araki et al. have noted that the long finger is most commonly involved. The boxer presents with
swelling and pain over the MP joint occasionally with a palpable defect in the extensor hood.

In a series of 27 injuries studied by Hame and Melone, the rupture involved the radial sagittal band in 12 cases, ulnar in 7, central in 4, and 4 at all 3 sites. Subluxation of the central tendon was present in all sagittal band ruptures. Treatment involves repair of the extensor hood with relocation of the extensor tendon. Repair is performed in 60% to 70% of MP joint flexion, and capsular tears are not repaired to avoid stiffness postoperatively. Immobilization in 60° of flexion for 6 weeks is recommended by Hame and Melone, and punching may be resumed when the hand is pain free with full range of motion and normal grip strength is achieved. This results in an average of 5 months to full recovery in the boxer.

**Subluxation of the EDC**

Subluxation of the EDC may occur from an ulnar-directed force to a digit, usually the long finger. The pathology is usually rupture of the radial sagittal band with ulnar subluxation of the EDC. Treatment is similar to that described above, although in acute cases splinting of the digit in MP extension for 6 weeks may result in healing. In late cases, reconstructive procedures may be indicated.

**Flexor Digitorum Profundus Rupture**

Avulsion of the flexor digitorum profundus at its insertion on the distal phalanx occurs most often in football, rugby, and flag football and usually occurs from grasping a jersey or the pants of an opposing player. The finger is forcibly extended while the profundus contracts resulting in avulsion—hence, the name *jersey finger.*

McMasters noted that a normal tendon most commonly ruptures at its insertion, followed in frequency by the musculotendinous junction, and the tendon itself is the strongest link in the musculotendinous chain. The ring finger is involved in 75% of cases due to the common flexor muscle belly of the long, ring, and small fingers, and the strength of insertion is less at the ring finger in cadaver studies.

Diagnosis should be suspected in all injuries to the DIP joint in most sports and depends on testing of the profundus independently of the sublimis. Blood supply to the tendon is twofold: 1) from vinculae that arise from the tenosynovium and directly supply the tendon and 2) from nutrients in synovial fluid that bathes the tendon in the tendon sheath.

Leddy described three types of profundus avulsions: type 1 in which the tendon retracts into the palm; type 2 in which the tendon retracts to the PIP level, and type 3, in which bone fragment is avulsed with the FDP; in type 3B, the bone fragment is present but the tendon is avulsed from the fragment. Treatment depends on the type of injury.

In type 1, the tendon retracts into the palm and substantial blood supply is lost. Exam reveals full PIP motion and swelling in the palm. Treatment of this type should include repair within 7 to 10 days before the tendon becomes scarred and redundant.

Repair has been classically described using a pullout wire technique. Use of mini-suture anchors has been proposed as an alternative technique; however, long-term results are not available. Following repair, return to sports is not allowed usually for 8 to 12 weeks.

In type 2 injuries, the tendon retracts to the PIP level leaving the long vincula intact and preserving a portion of the nutritional blood supply from the sheath. Exam reveals swelling at the PIP joint, decreased flexion, and no palmar mass. Although most favor early repair with the type of injury, treatment may be delayed 6 to 8 weeks in some cases. It may be desirable for the athlete in midseason to continue play and undergo repair post-season. The athlete should be counseled that delay may result in a suboptimal result and that further retraction of the tendon could occur during athletic activity.

In type 3, the bony fragment is tethered distally by the A-4 pulley. The diagnosis may be made by lateral x-rays. Delayed repair or fracture fixation is possible, although one must be aware of the 3B variant in which the tendon is avulsed from the bone and retracts.

The athlete commonly presents to the physician with a chronic untreated profundus avulsion. If delayed primary repair is not possible, options include the following: 1) leave it alone, 2) flexor tendon graft through the intact sublimis, and 3) arthrodesis of the DIP joint if unstable. Most authors recommend neglect as the PIP function is usually normal and the disability is minimal. The athlete may complain of a painful mass in the palm, and simple excision is indicated.

If symptomatic instability exists, arthrodesis is a predictable procedure that will not interfere with sublimis function. Although many have advocated flexor tendon grafts, the risk of interfering with sublimis function is significant and is rarely indicated.

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