Review Article

Closed Sagittal Band Injury of the Metacarpophalangeal Joint

Benjamin P. Kleinhenz, MD
Brian D. Adams, MD

Abstract

Although it is an uncommon injury, traumatic rupture of the sagittal band often results in subluxation or dislocation of the extensor digitorum communis tendon. The radial sagittal band prevents ulnar subluxation of the extensor tendon at the metacarpophalangeal joint. Injury may result from a direct blow to the hand or from relatively low-energy mechanisms. Symptoms range from metacarpophalangeal joint pain and edema to dislocation of the extensor tendon. Associated injuries include collateral ligament sprains, capsular injury, and osteochondral fractures. Many acute injuries can be managed nonsurgically with extension splints. Optimal management of subacute or chronic injuries remains undefined. Surgical management consists of repair or reconstruction of the radial sagittal band. Numerous adjunctive surgical techniques have been described to prevent subluxation of the extensor tendon.

From TriHealth Hand Surgery Specialists, Cincinnati, OH (Dr. Kleinhenz), and the Joseph Barnhart Department of Orthopedic Surgery, Baylor University, Houston, TX (Dr. Adams).

Dr. Adams has received royalties from and is a member of a speakers' bureau or has made paid presentations on behalf of Integra LifeSciences and Extremity Medical; serves as a paid consultant to Integra LifeSciences, Extremity Medical, and Tornier; has received research or institutional support from Tornier; and serves as a board member, owner, officer, or committee member of the American Association for Hand Surgery. Neither Dr. Kleinhenz nor any immediate family member has received anything of value from or has stock or stock options held in a commercial company or institution related directly or indirectly to the subject of this article.

J Am Acad Orthop Surg 2015;23: 415-423

http://dx.doi.org/10.5435/JAAOS-D-13-00203

The sagittal band is a vital component of the extensor mechanism. Traumatic or attritional injuries to the band or incompetence can lead to extensor tendon subluxation at the metacarpophalangeal (MP) joint. Attenuation of the sagittal band associated with chronic synovitis, such as that seen in rheumatoid arthritis, has been well described. Here, we focus on spontaneous or traumatic rupture of the sagittal band in patients without a history of inflammatory arthropathy.

Historical Perspective

First described by Legouest[1] in 1868, dislocation of the extensor digitorum overlying the MP joint remains an uncommon injury that is primarily reported in small case series. After examining a series of four prize fighters, Gladden[2] coined the term "boxer's knuckle" to describe a closed injury to the MP joint capsule or the extensor tendon itself. Although he did not explicitly describe subluxation or dislocation of the tendon, boxer's knuckle has been used synonymously with sagittal band injury and associated extensor tendon instability in subsequent descriptions. Sagittal band injuries represent a continuum of injury ranging from dorsal MP capsulitis to extensor tendon dislocation and potential collateral ligament injury.

Anatomy

The extensor digitorum communis (EDC) tendon crosses the dorsum of the MP joint and is stabilized by a complex retinacular structure often referred to as the dorsal hood. The transverse, oblique, and sagittal bands are the principal components of the dorsal hood (Figures 1 and 2). The transverse and oblique bands serve as an extension of the intrinsic

Figure 1

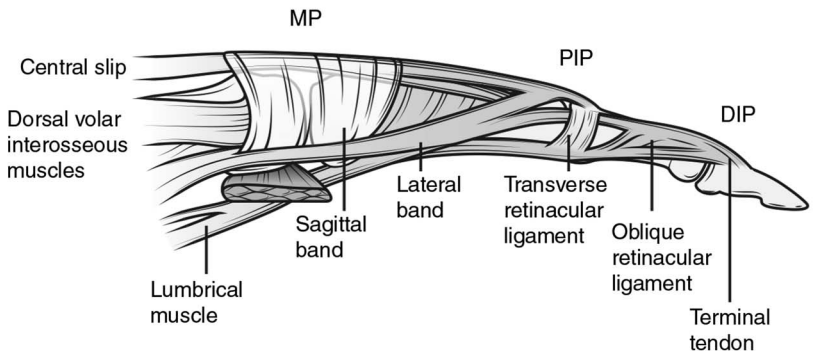


Illustration of the lateral view of the anatomy of the extensor mechanism at the metacarpophalangeal joint. The sagittal band arises from the volar plate and intermetacarpal ligament and stabilizes the extensor tendon. DIP = distal interphalangeal, MP = metacarpophalangeal, PIP = proximal interphalangeal

Figure 2

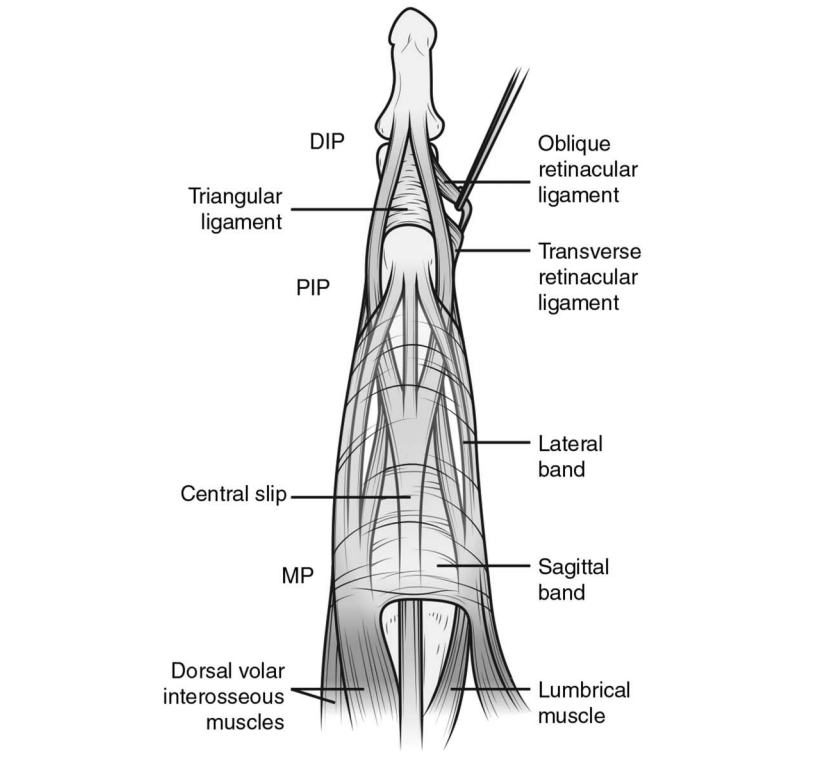


Illustration of the dorsal view of the anatomy of the extensor mechanism at the metacarpophalangeal joint. DIP = distal interphalangeal, MP = metacarpophalangeal, PIP = proximal interphalangeal

tendons, with the transverse bands stabilizing the extensor tendon overlying the distal MP joint and proximal phalanx. The oblique bands serve a similar role at the proximal interphalangeal joint.

Figure 3

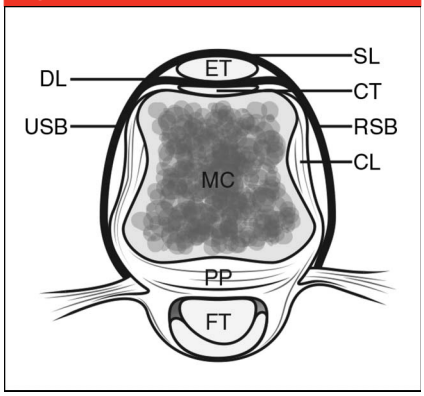


Illustration of the axial view of the extensor mechanism at the metacarpophalangeal joint. CL = collateral ligament, CT = connective tissue, DL = deep layer of the dorsal hood, ET = extensor tendon, FT = flexor tendon, MC = metacarpal bone, PP = palmar plate, SL = superficial layer of the dorsal hood, USB = ulnar sagittal band, RSB = radial sagittal band

The sagittal bands run perpendicular to the EDC tendon, attaching to the palmar plate and the deep transverse metacarpal ligament. The sagittal band consists of two layers, a thin superficial layer and a thicker deep layer (Figure 3). The deep layer contains a tunnel through which the EDC travels.[3] The radial and ulnar sagittal bands prevent subluxation of the EDC overlying the MP.

The thickness of the sagittal bands has been found to vary significantly in ultrasonography studies of healthy volunteers.[4] In men, the mean thickness ranged from 0.51 to 0.72 mm, whereas the mean thickness ranged from 0.42 to 0.53 mm in women. No significant difference in thickness was found between ulnar and radial sagittal bands, dominant and nondominant hands, or the index finger and all remaining fingers.

Biomechanical studies have shown the relative importance of the radial sagittal band. Young and Rayan[5]

showed that complete sectioning of the ulnar sagittal band did not cause extensor instability at any point throughout MP flexion or extension, with the wrist in any position. Because the MP joints rest in a slightly ulnar deviated position and the junctura tendinae provide a tethering effect, radial dislocation of the EDC is believed to be relatively rare.[6] In contrast, partial sectioning of the proximal 50% of the radial sagittal band was sufficient to cause extensor subluxation. This instability worsened with progressive wrist and MP flexion. Sectioning of the distal 50% of the band did not cause instability. Interestingly, complete sectioning of the radial sagittal band produced dislocation in all fingers except the small fingers, only 20% of which experienced dislocation. The inherent stability was attributed to the junctura tendinum. Congenital absence of the juncturae has also been noted in an apparently idiopathic case of extensor tendon dislocation.[7]

Radial dislocation of the EDC has been rarely reported in the literature and could only be reproduced in a laboratory setting with complete transection of both the ulnar sagittal band and the intertendinous fascia followed by flexion of the MP, with resistance in all extensor tendons.[8]

Clinical History

The association between sagittal band injury and boxing has been well documented. Since Gladden's original description,[2] several case series consisting of boxers and martial artists have been presented.[9,10] Stracher and Posner[11] believed that such injuries occur when the fighter strikes his opponent with the relatively narrow dorsal edge of the index or long finger metacarpal rather than with the relatively broad area of the proximal phalanges. Boyes[12] believed that any mechanism that reproduced forced digital flexion in the setting of a flexed and ulnarly deviated wrist could produce this injury. Dislocation of the extensor tendon has even been reported in the setting of focal myoclonic epilepsy.[13]

Although the exact mechanism remains elusive, it is clear that sagittal band injuries can occur under a variety of conditions. Compressive trauma to the MP joint in the form of a fall or a direct blow can cause sagittal band injury and has been called a "closed crush injury of the metacarpophalangeal joint" by at least one author.[14] Additionally, several series have shown a preponderance of sagittal band injuries occurring in the setting of so-called low-energy trauma.

Ishizuki[15] sought to define the differences between traumatic and so-called spontaneous ruptures and described spontaneous dislocations resulting from snapping, crossing a finger, or crumpling paper. Spontaneous ruptures involved only the superficial layer of the sagittal band and originated from its insertion point on the radial aspect of the EDC. In contrast, traumatic ruptures involved both the superficial and deep layers of the sagittal band. Traumatic ruptures also originated several millimeters radial to the extensor tendon.

Congenital factors have also been documented in patients with nontraumatic dislocations. Inoue and Tamura[16] and Ozcanli et al[17] reported on two case series of patients with congenital dislocations of the EDC. In each patient, dislocation or subluxation was noted before age 10 years and there was no history of trauma. The radial sagittal band was either thin or absent in all patients. Additionally, three of four patients with congenital EDC dislocations exhibited ligamentous hypermobility in other joints.[16] Kim et al[18] described a patient with generalized ligamentous laxity based on the Beighton and Horan criteria. These criteria were developed to measure benign joint hypermobility by examining hyperextension at various joints and other systemic manifestations of ligamentous laxity. The patient presented with simultaneous subluxation of the extensor carpi ulnaris and the long finger EDC after a fall from standing height. Congenital absence of the juncturae tendini has also been reported in a patient with extensor tendon dislocations following a low-energy fall.[7] Spontaneous ulnar subluxation of the EDC has been observed in elderly patients with osteoarthritis in two separate series.[19,20] Subluxation was attributed to a combination of generalized laxity and attritional rupture of the sagittal band.

Patients typically present with a painful and occasionally swollen MP joint. The long finger is believed to be the most commonly affected digit.[7] Slight ulnar subluxation of the MP joint may also be present. Initiating MP extension from a flexed position is uncomfortable and, if the extensor tendon is dislocated, extension from this position is often impossible to perform. This dislocation is often dynamic and a careful observer can often visualize the tendon falling into the intermetacarpal recess with MP flexion. However, subluxation of the EDC can be idiopathic and asymptomatic, which makes careful examination of the asymptomatic, uninvolved side essential.

Crepitus may occur with subluxation, creating a pseudo-trigger finger. Sagittal band injuries are often mistakenly diagnosed as trigger finger, leading to a delay in diagnosis. The differential diagnosis when evaluating a presumed sagittal band injury should include MP arthritis, juncturae tendon rupture, and MP collateral ligament injury.

Table 1

Boxer's Knuckle Classification[2]

Type	Description
I	Thickening of extensor tendon and/or capsule without evidence of tear
II	Thickening of extensor tendon and/or capsule with superficial tear
III	Thickening of extensor tendon and/or capsule with tear extending into tendon/capsule
IV	Thickening of extensor tendon and/or capsule with tear extending into joint space

Classification

Gladden[2] initially proposed a classification system for boxer's knuckle injuries (Table 1). Type I injuries consisted of "thickening of the tendon and capsule" without evidence of tearing of the extensor tendon, whereas type II included tearing of the "superficial portion of the soft tissue." Types III and IV exhibited tearing of the tendon and joint capsules. No mention was made of extensor tendon subluxation or dislocation.

Rayan and Murray[21] described another classification system based on clinical presentation. After examining 28 patients, three types of sagittal band injuries were identified. Type I injury was defined as a simple contusion of the retinacular tissue without a tear. Patients with this injury typically present with tenderness of the sagittal band and no evidence of extensor tendon instability. Type II injuries were associated with extensor tendon subluxation, and type III injuries were associated with extensor tendon dislocation (Figure 4).

Imaging

PA, lateral, and oblique radiographic views of the hand should be obtained to rule out associated fracture or dislocation of the affected finger. A Brewerton view, which is an AP view obtained with the MP flexed 65° and the x-ray beam directed 15° ulnar to radial, can be helpful for evaluating concomitant osteochondral injuries or occult fractures of the metacarpal head.

MRI has proven reliable for diagnosing simulated injuries to the sagittal band in cadaver studies, with disruption of the sagittal bands and edema of the surrounding soft-tissue noted on T2-weighted imaging. Cadaver studies have also shown that MRI and magnetic resonance (MR) arthrography have equivocal accuracy in the diagnosis of injuries to the sagittal band.[22] Arai et al[23] recommended obtaining an MR arthrogram to determine if the MP joint capsule was ruptured because this was thought to portend a poor response to nonsurgical treatment (Figure 5).

Although rare, concomitant MP collateral ligament rupture has been reported in the setting of sagittal band injury.[24] The small finger was most frequently injured, and a Stener-like lesion was caused by interposition of the collateral ligament within the partially ruptured sagittal band. Ishizuki et al[24] recommend the use of MR arthrography to diagnose this Stener-like lesion (Figure 6).

The use of ultrasonography as a diagnostic modality for sagittal band injury has also been examined.[25] The sagittal bands are most easily visualized with the MP in 30° of flexion[3] and are seen as hypoechoic masses that border the extensor tendon.[26] Ultrasonography also provides the unique benefit of providing a dynamic assessment of extensor tendon function. With injury to the index finger, increased subluxation between the EDC and extensor indicis proprius was noted during digital flexion.[4]

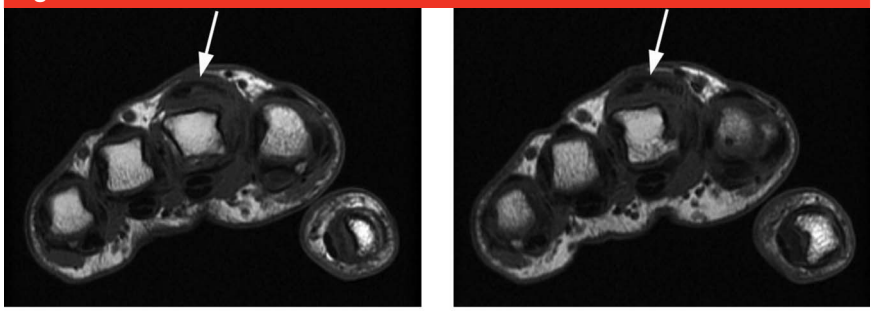
Figure 4

Photograph of the hand demonstrating ulnar dislocation of the extensor digitorum communis tendon with digital flexion in a 41-year-old woman with a low-energy sagittal band rupture of the left long finger.

Nonsurgical Treatment

Several series have focused on surgical management of sagittal band injuries, and some consider surgical management the treatment of choice for all of these injuries.[10] However, most acute injuries can be managed nonsurgically, with surgery reserved for chronic injuries.[8,16,21] Successful nonsurgical treatment of acute sagittal band injuries has been reported. In two patients with sagittal band injuries, Ritts et al[27] used dorsal splinting for 4 to 7 weeks, with good results. Catalano et al[28] treated 10 patients with 11 acute

Figure 5



A B

A and **B,** Consecutive axial T1-weighted magnetic resonance images demonstrating a torn radial sagittal band (arrows) in a 52-year-old woman.

Figure 6

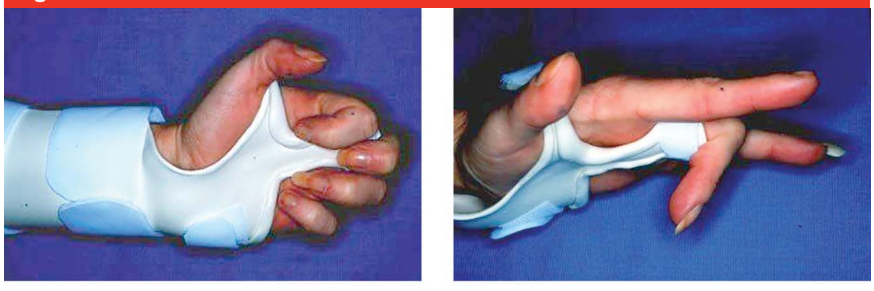
Magnetic resonance arthrogram of the metacarpophalangeal joint demonstrating the presence of a Stener-like lesion, with visible leakage and pooling of the dye. (Reproduced with permission from Ishizuki M, Sugihara T, Wakabayashi Y, Shirasaka R: Stener-like lesions of collateral ligament ruptures of the metacarpophalangeal joint of the finger. *J Orthop Sci* 2009;14[2]:150-154.)

Figure 7

A B

A, Photograph of a sagittal band bridge. **B,** Photograph of the hand demonstrating the placement of a sagittal band bridge, which maintains extension of the affected metacarpophalangeal joint.

Figure 8



A B

Photographs of the forearm (**A**) and hand (**B**) demonstrating placement of a P1 blocking splint used for nonsurgical treatment of an acute sagittal band rupture.

sagittal band injuries using a custom digital extension orthosis referred to as a sagittal band bridge (Figure 7). All patients had Rayan and Murray type III injuries. Active interphalangeal range-of-motion exercises were begun immediately. At 14 months, 3 of the 10 patients had moderate residual subluxation of the extensor tendon, with 1 patient electing to undergo surgical treatment. In patients with type II or type III injuries, we typically use a forearm-based P1 blocking splint for 3 weeks (Figure 8).

Surgical Treatment

A wide range of surgical procedures has been used to manage sagittal band injuries. Simple repair of the torn sagittal band fibers combined

Figure 9

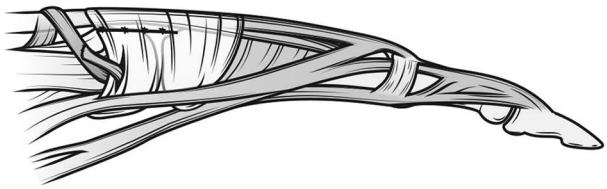


Illustration of the lateral aspect of the finger demonstrating the transfer of the ulnar-sided juncturae through the repaired radial sagittal band. This will prevent ulnar subluxation of the extensor tendon.

Figure 10

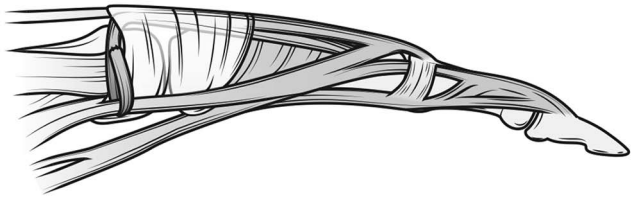
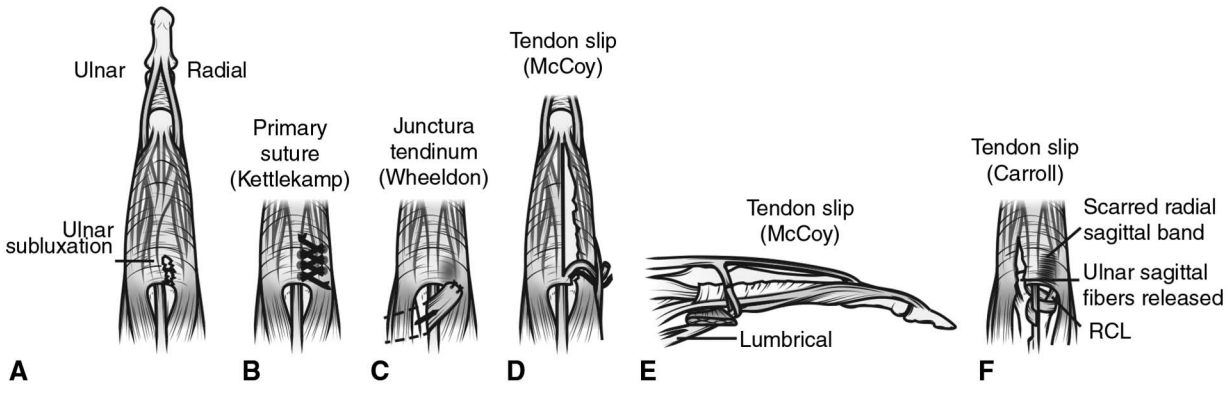


Illustration of the lateral aspect of the finger demonstrating the transfer of a portion of the extensor tendon around the intrinsic tendon to prevent ulnar subluxation of the extensor tendon.

with realignment of the extensor tendon is the classic technique used,[29] and it remains effective in cases of both traumatic and spontaneous ruptures. Disparate opinion exists on the proper management of capsular injury. In a series of six boxers with dorsal capsular rupture of the MP joint, Posner and Ambrose[30] recommended closure of the injured joint capsule and postoperative immobilization in a position of MP flexion. All patients were able to return to competition and regained full motion. In a series of eight professional athletes with boxer's knuckle, Hame and Melone[10] recommended simple débridement of the capsule because excessively tight soft-tissue closure could potentially limit MP flexion. All patients regained full digital range of motion and returned to sport by 5 months. In a series of five professional boxers, Nagaoka et al[31] grafted irreparable capsular ruptures with a segment of extensor retinaculum graft, and all patients returned to competition within 9 months of surgery. Although the

Figure 11



A, Illustration of ulnar subluxation of the extensor digitorum communis (EDC) tendon caused by a torn radial sagittal band. **B** through **F,** Illustrations of several methods of sagittal band reconstruction. **B,** Primary suture of the radial sagittal band to center the EDC tendon. **C,** The ulnar junctura tendium is released from the adjacent tendon and sutured to the palmar radial sagittal band remnant of the deep intermetacarpal ligament. **D** and **E,** The distal tendon is splinted on the radial side and wrapped around the lumbrical muscle. **F,** The ulnar, distally based slip of EDC is looped around the radial collateral ligament (RCL).

Table 2

Outcomes of Surgical Reconstruction Techniques for Closed Sagittal Band Injury

Study	No. of Patients	Surgical Technique	Minimum Follow-up	Outcome
Kang and Smith[7]	6	Palmaris autograft reconstruction	3 mo	>80° MP flexion, full extension, resolution of subluxation
Hame and Melone[10]	8	Direct repair	Average 5 mo	All patients had full range of motion and returned to professional sports.
Rayan and Murray[21]	10	Either imbrication of radial sagittal band or rerouting of extensor tendon to radial aspect of proximal phalanx base	Average 26 mo	One patient had painless recurrent EDC instability. The remaining patients had full painless range of motion and no instability.
Arai et al[23]	8	Closure of torn capsule	32 wk	No persistent pain or instability, "normal range of motion"
Ishizuki et al[24]	13	Direct repair	Minimum 1 yr	No instability
Kettelkamp et al[29]	5	Direct repair	5 yr	Full range of motion, no instability
Posner and Ambrose[30]	6	Direct repair	NR	Full range of motion
Nagaoka et al[31]	5	Extensor tendon retinaculum graft	Average 19 mo	No recurrent instability, all patients returned to sport
Watson et al[35]	16	Distally based EDC routed around transverse metacarpal ligament	Average 16.3 mo	Mean flexion of 89.1°, pain and instability eliminated in all patients
Carroll et al[37]	3	Distally based EDC routed around radial collateral ligament	6–36 mo	No recurrence, minimum MP joint flexion of 90°

EDC = extensor digitorum communis, MP = metacarpophalangeal, NR = not reported

ideal management of a capsular tear remains unknown, Melone et al[9] noted an association between capsular and osteochondral injury in a series of 47 professional boxers. This injury was typically noted in the dorsal central area of the metacarpal articular head.

Numerous adjunctive techniques for preventing subluxation of the extensor tendon or augmenting the sagittal band repair have been described. Wheeldon[32] recommended transferring the ulnar-sided juncturae to the torn radial sagittal band (Figure 9). Most reconstructive techniques have used a proximally or distally based strip of the EDC to reconstruct the radial sagittal band. This segment of the EDC can be sutured to the intact EDC or the radial MP capsule. The principle difference between these reconstructive techniques is the structure around which the tendon strip is routed. Options include the volar interosseous muscle,[33] the deep transverse metacarpal ligament,[34,35] the radial collateral ligament,[36,37] and the lumbrical tendon[38] (Figures 10 and 11).

Anomalous extensor tendons (extensor digitorum brevis manus or extensor indicis et medii communis) have also been used to augment radial sagittal band repair.[39] Segalman[40] recommended transferring the radial lumbrical through a longitudinal split within the EDC and suturing it upon itself to create a dynamic reconstruction. Kang and Carlson[41] described a reconstruction technique that used palmaris longus autograft. A bone tunnel is created through the metacarpal head and the autograft is passed through it and sutured to itself after passing dorsal to the EDC, stabilizing the EDC.

Despite the variation in surgical reconstruction techniques, most authors have used similar postoperative rehabilitation protocols. The involved MP joint is typically immobilized in extension for 3 to 4 weeks. However, some have used dynamic splinting in the immediate postoperative period.[14] Active and passive range of motion is then begun. Although the case series have been small, the reported outcomes have been generally favorable[7,10,21,23,24,29-31,35,37] (Table 2).

Senior Author's Preferred Treatment

We believe that most acute injuries can be treated nonsurgically. Acute surgical management is reserved for high-level athletes. Ideally, treatment is initiated within 1 week of injury, but

it can be initiated up to 3 weeks after injury. We typically place type II and type III injuries in a forearm-based P1 blocking splint for 3 weeks, followed by a finger-based sagittal band bridge for an additional 3 weeks. If subluxation or dislocation of the EDC is not seen but the sagittal band is painful (type I injury), we buddy tape the injured finger for a period of 4 weeks and warn patients that MP tenderness may persist for up to 1 year.[21]

Surgery is typically reserved for patients with chronic injuries or those who have failed a course of nonsurgical treatment. We first attempt to repair the sagittal band and leave the MP capsule open to prevent postoperative stiffness. If repair is not possible, a reconstructive procedure is performed. We have successfully used the technique described by Kilgore et al[36] in which a distally based portion of the EDC is routed around the radial collateral ligament and sutured to itself.

Summary

Sagittal band injuries are uncommon in nonrheumatoid patients. Most injuries occur from a direct blow to the dorsum of the MP, with the long finger most often affected. Seemingly spontaneous injuries also occur. Although helpful for diagnosing associated injuries, advanced imaging studies are rarely necessary when evaluating sagittal band injuries. Nonsurgical management can be effective for most type I and type II injuries and many type III injuries. Patients who present with subacute or chronic injuries may benefit from surgery. Repair or reconstruction of the sagittal band is effective in improving a symptomatic MP joint with an unstable extensor tendon.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, references 2-6, 8-10, 14-16, 19-30, 35, and 37 are level IV studies. References 7, 11, 13, 17, 18, 31, 32, 34, 36, and 38-41 are level V expert opinion.

References printed in **bold type** are those published within the past 5 years.

1. Legouest: *Societe Imperiale de Chirurgie de Hopitaux*. 183, 1868.
2. Gladden JR: Boxer's knuckle: A preliminary report. *Am J Surg* 1957;93(3):388-397.
3. Kichouh M, Vanhoenacker F, Jager T, et al: Functional anatomy of the dorsal hood or the hand: Correlation of ultrasound and MR findings with cadaveric dissection. *Eur Radiol* 2009;19(8):1849-1856.
4. **Kichouh M, De Maeseneer M, Jager T, Marcelis S, Van Hedent E, De Mey J: The thickness of the sagittal bands in volunteers: High resolution ultrasound of the fingers. *Surg Radiol Anat* 2011;33(1):65-70.**
5. Young CM, Rayan GM: The sagittal band: Anatomic and biomechanical study. *J Hand Surg Am* 2000;25(6):1107-1113.
6. Koniuch MP, Peimer CA, VanGorder T, Moncada A: Closed crush injury of the metacarpophalangeal joint. *J Hand Surg Am* 1987;12(5):750-757.
7. Kang N, Smith P: Congenital absence of the juncturae tendini contributing to dislocation of the extensor tendons. *J Hand Surg Am* 2001;26(3):501-505.
8. Araki S, Ohtani T, Tanaka T: Acute dislocation of the extensor digitorum communis tendon at the metacarpophalangeal joint: A report of five cases. *J Bone Joint Surg Am* 1987;69(4):616-619.
9. Melone CP Jr, Polatsch DB, Beldner S: Disabling hand injuries in boxing: Boxer's knuckle and traumatic carpal boss. *Clin Sports Med* 2009;28(4):609-621, vii.
10. Hame SL, Melone CP Jr: Boxer's knuckle in the professional athlete. *Am J Sports Med* 2000;28(6):879-882.
11. Stracher M, Posner MA: Boxer's knuckle. *Tech Hand Up Extrem Surg* 2002;6(4):196-199.
12. Boyes JH: *Bunnell's Surgery of the Hand*. 4th ed. Philadelphia, PA, JB Lippincott, 1964:343-346, 470-471.
13. Ovesen OC, Jensen EK, Bertheussen KJ: Dislocation of extensor tendons of the hand caused by focal myoclonic epilepsy. *J Hand Surg Br* 1987;12(1):131-132.
14. Koniuch MP, Peimer CA, VanGorder T, Moncada A: Closed crush injury of the metacarpophalangeal joint. *J Hand Surg Am* 1987;12(5 pt 1):750-757.
15. Ishizuki M: Traumatic and spontaneous dislocation of extensor tendon of the long finger. *J Hand Surg Am* 1990;15(6):967-972.
16. Inoue G, Tamura Y: Dislocation of the extensor tendons over the metacarpophalangeal joints. *J Hand Surg Am* 1996;21(3):464-469.
17. **Ozcanli H, Ozenci AM, Ozdemir H: Congenital dislocation of the extensor tendon of the hand. *J Plast Surg Hand Surg* 2012;46(6):447-449.**
18. **Kim BS, Yoon HG, Kim HT, Park KH, Kim CG, Song HS: Subluxation of the extensor carpi ulnaris tendon associated with the extensor digitorum tendon subluxation of the long finger. *Clin Orthop Surg* 2013;5(1):82-86.**
19. Love GJ, MacLean JG: Ulnar subluxation of the extensor tendons in elderly osteoarthritic females: A neglected diagnosis. *J Hand Surg Eur Vol* 2007;32(1):45-49.
20. Harvey FJ, Hume KF: Spontaneous recurrent ulnar dislocation of the long extensor tendons of the fingers. *J Hand Surg Am* 1980;5(5):492-494.
21. Rayan GM, Murray D: Classification and treatment of closed sagittal band injuries. *J Hand Surg Am* 1994;19(4):590-594.
22. Pfirrmann CW, Theumann NH, Botte MJ, Drapé JL, Trudell DJ, Resnick D: MR imaging of the metacarpophalangeal joints of the fingers: Part II. Detection of simulated injuries in cadavers. *Radiology* 2002;222(2):447-452.
23. Arai K, Toh S, Nakahara K, Nishikawa S, Harata S: Treatment of soft tissue injuries to the dorsum of the metacarpophalangeal joint (Boxer's knuckle). *J Hand Surg Br* 2002;27(1):90-95.
24. Ishizuki M, Sugihara T, Wakabayashi Y, Shirasaka R, Aoyama H: Stener-like lesions of collateral ligament ruptures of the metacarpophalangeal joint of the finger. *J Orthop Sci* 2009;14(2):150-154.
25. Lopez-Ben R, Lee DH, Nicolodi DJ: Boxer knuckle (injury of the extensor hood with extensor tendon subluxation): Diagnosis with dynamic US. Report of three cases.*Radiology* 2003;228(3):642-646.
26. **Kichouh M, De Maeseneer M, Jager T, et al: Ultrasound findings in injuries of dorsal extensor hood: Correlation with MR and follow-up findings. *Eur J Radiol* 2011;77(2):249-253.**
27. Ritts GD, Wood MB, Engber WD: Nonoperative treatment of traumatic dislocations of the extensor digitorum tendons in patients without rheumatoid disorders. *J Hand Surg Am* 1985;10(5):714-716.
28. Catalano LW III, Gupta S, Ragland R III, Glickel SZ, Johnson C, Barron OA: Closed treatment of nonrheumatoid extensor

tendon dislocations at the metacarpophalangeal joint. *J Hand Surg Am* 2006;31(2):242-245.

29. Kettelkamp DB, Flatt AE, Moulds R: Traumatic dislocation of the long-finger extensor tendon: A clinical, anatomical, and biomechanical study. *J Bone Joint Surg Am* 1971;53(2):229-240.

30. Posner MA, Ambrose L: Boxer's knuckle: Dorsal capsular rupture of the metacarpophalangeal joint of a finger. *J Hand Surg Am* 1989;14(2 pt 1):229-236.

31. Nagaoka M, Satoh T, Nagao S, Matsuzaki H: Extensor retinaculum graft for chronic boxer's knuckle. *J Hand Surg Am* 2006;31(6):947-951.

32. Wheeldon FT: Recurrent dislocation of extensor tendons in the hand. *J Bone Joint Surg Br* 1954;36(4):612-617.

33. Michon J, Vicard P: Lateral luxations of the extensor tendons with regard to the metacarpophalangeal articulation [French]. *Rev Med Nancy* 1961;86: 595-601.

34. Elson RA: Dislocation of the extensor tendons of the hand: Report of a case. *J Bone Joint Surg Br* 1967;49(2): 324-326.

35. Watson HK, Weinzweig J, Guidera PM: Sagittal band reconstruction. *J Hand Surg Am* 1997;22(3):452-456.

36. Kilgore ES, Graham WP, Newmeyer WL, Brown LG: Correction of ulnar subluxation of the extensor communis. *Hand* 1975;7(3): 272-274.

37. Carroll C IV, Moore JR, Weiland AJ: Posttraumatic ulnar subluxation of the extensor tendons: A reconstructive technique. *J Hand Surg Am* 1987;12(2): 227-231.

38. McCoy FJ, Winsky AJ: Lumbrical loop operation for luxation of the extensor tendons of the hand. *Plast Reconstr Surg* 1969;44(2):142-146.

39. Beck JD, Riehl JT, Klena JC: Anomalous tendon to the middle finger for sagittal band reconstruction: Report of 2 cases. *J Hand Surg Am* 2012;37(8): 1646-1649.

40. Segalman KA: Dynamic lumbrical muscle transfer for correction of posttraumatic extensor tendon subluxation. *Tech Hand Up Extrem Surg* 2006;10(2):107-113.

41. Kang L, Carlson MG: Extensor tendon centralization at the metacarpophalangeal joint: Surgical technique. *J Hand Surg Am* 2010;35(7):1194-1197.