

FACULTY DISCUSSION & STUDY GUIDE

In addition to the review of the ASPS EdNet course modular material, this guide is provided as a tool for faculty use in preparation for a weekly conference. By following and addressing the points below, any plastic surgeon should be able to step in to teach the curriculum in a consistent and complete manner.

VIII.D Hand, Upper Extremity: Fractures 1, 2, 3

2 - Dislocations and ligament injuries

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Financed with a grant from The Hoopes Foundation.

A. Clinical Exam, Sprains

1. Outline the clinical examination of a patient with a suspected digital PIP joint sprain. (The three elements of the clinical exam include test of active motion, lateral stress test, and the status of reduced dislocations.

First, the patient should be encouraged to perform full active flexion and extension of all joints. If pain prevents full active motion a digital block can be accomplished. At that point the active ROM test is repeated. The next step is a lateral stress test with the digit in extension. If more than 10 degrees of lateral motion should be present, then instability is reflected by an abnormal deviation of the joint. Thirdly, the joint is observed during full extension. Unstable dislocations will dislocate in the last 20 degrees of active extension. Of course, the digit should be compared to the opposite side. Mallet fingers are covered under extensor tendons.)

2. What is the treatment for PIP joint sprains? (Splinting can be accomplished with the joint in full extension and allowing MP joint flexion only for 10 days followed by “buddy-taping” to the adjacent finger.)

B. The Digital Interphalangeal Joints

Comment; DIP joint injuries are included in the fracture modules VIII D1 and extensor tendon module VIII H.

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1. What are the bony anatomical aspects of the PIP joints that contribute to lateral stability? Describe both in lateral and AP aspect. (The bicondylar head of the proximal phalanx sits firmly into the shallow concavities of the base of the middle phalanx. The base of the middle phalanx has a dorsal-volar midline bony tongue that sits firmly into the corresponding groove of the head of the proximal phalanx formed by the two lateral condyles; the middle phalanx fits also firmly into the retrocondylar recess of the head of the proximal phalanx in full flexion; width of the base of the middle phalanx is about 10% greater than the condylar diameter which aids in a further divergence of the collateral ligaments from proximal to distal; and finally, the transverse diameter of the base of the middle phalanx and to a lesser degree head of the proximal phalanx is nearly twice that of the vertical height.)
2. Describe the physical attributes of the collateral ligament that contribute to PIP joint stability. (The PIP joint is thought of as a box with the collateral and accessory collateral ligaments on the radial and ulnar side inserting into the volar base of the middle phalanx and the lateral aspect of the volar plate with respect to the accessory component. The tough fibrous quadrangular collateral ligament arises from the retrocondylar recess and inserts primarily into the volar plate and the distal volar base of the middle phalanx. The triangular collateral ligament inserts entirely on the proximal volar plate. The volar plate is the bottom of the box, and the extensor mechanism and joint capsule is the top of the box. The volar plate of the PIP joint has a thickening on each lateral aspect termed the lateral check-rein ligaments which also provides substantial stability to the joint and prevents little in the way of lateral motion. For instability to occur in disruption of at least two sides of the box, usually the collateral ligament system and volar plate, are necessary.)

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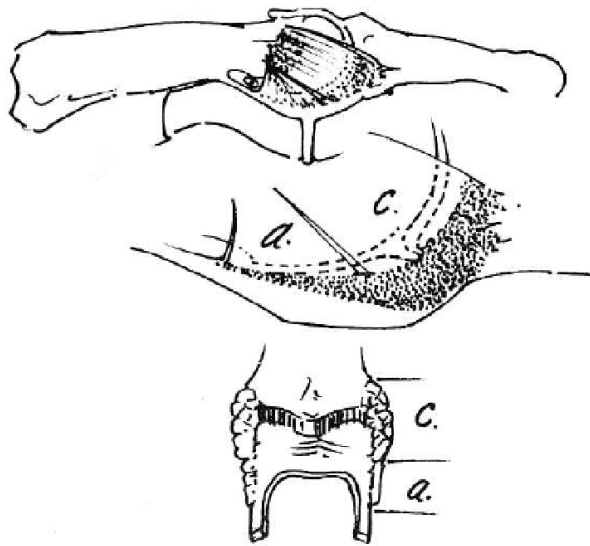


FIGURE 4. Drawing of the proximal interphalangeal joint and its ligament support. The quadrangular collateral ligament (c) by its insertion on the phalanx and volar plate, overlaps and reinforces the volar plate insertion into the middle phalanx. The accessory ligament (a) represents a proximal thinning of the collateral ligament. The central volar plate also becomes membranous proximally, permitting this portion of the capsule to fold upon itself in full flexion.

Eaton MD, R. G., Chapter 2: "The Digital Interphalangeal Joints." Joint Injuries of the Hand, Charles C. Thomas, (1971), pp 12.

3. Compare and contrast the quadrangular collateral ligaments structural changes in extension and flexion to that of the MP joint. (As described later the MP joint collateral ligaments become increasingly taut and stretched as the joint moves from extension to flexion. In the PIP joint little change occurs except that the dorsal aspect of the collateral ligament becomes somewhat more lax in extension. Also, the collateral ligament origin and insertion is more eccentric dorsal proximally and volar distally in the MP joint and more concentric or central in the PIP joint, although still slightly eccentric.)
 - a. What are the characteristics of the accessory collateral ligament in the PIP joint? (The accessory is more proximal, more membranous and more volar, and inserts solely on the volar plate in the lateral aspect. The accessory collateral ligament suspends the volar plate and flexor tendon sheath as the collateral ligament proper suspends the middle phalanx. The accessory ligament perhaps becomes somewhat more lax in full flexion.)

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4. How does the PIP joint volar plate differ from that of the MP joint? (Presence of thicker checkrein ligaments in the lateral aspect of the PIP joint volar plate and the presence of apertures for the nutrient branches of the digital artery and a more membranous nature to the proximal and central portion of the volar plate of the MP joint.)
 - a. What are the checkrein ligaments and what is the contribution of the checkrein ligaments to the PIP joint? (The checkrein ligaments are thickening of the lateral aspect of the volar plate that run longitudinally from the most proximal to the most distal position of the plate. The purpose of the checkrein ligaments is to prevent hyperextension of the PIP joint, and yet they are sufficiently flexible to allow flexion.)
 - b. Why is the position of function for the PIP joint one of extension? (The check ligaments in flexion are completely relaxed and would rapidly become contracted once in that position.)
5. Explain the key to proximal interphalangeal joint stability. (The key is the anatomical interface of the volar plate with the base of the middle phalanx and the collateral-accessory collateral ligament system. As discussed above in this sense it resembles a box, the top of which is the dorsal capsule and central slip of the extensor tendon. For instability to occur a disruption of at least two sides of the box, usually the collateral ligament system and volar plate, are necessary.)

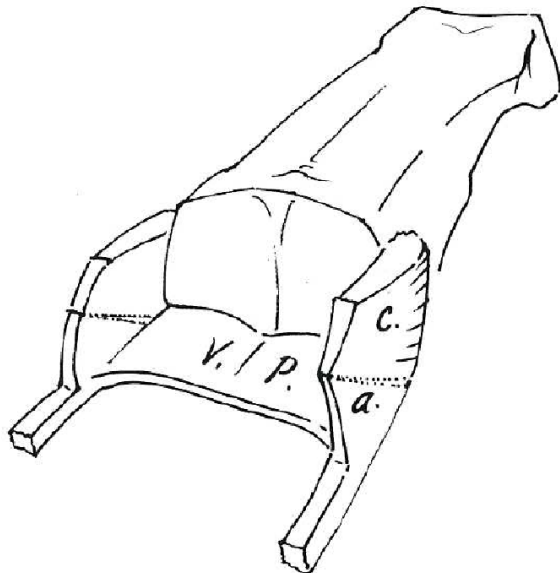


FIGURE 9. Schematic drawing of the ligament seat or box configuration which supports the interphalangeal joints. The thickest portion of the collateral ligament overlaps and reinforces the insertion of the volar plate into the base of the middle phalanx. The two ligaments firmly inserted around the vertical base of the middle phalanx create a support system of great strength. Displacement of the middle phalanx cannot occur unless two of these insertions are disrupted. The proximal convergence of the volar plate and accessory ligament to form the check ligament can be seen.

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Eaton MD, R. G., Chapter 2: "The Digital Interphalangeal Joints." Joint Injuries of the Hand, Charles C. Thomas, (1971), pp 17.

6. What additional protection against lateral stress is provided in full extension vs. flexion? (A taut volar plate.)
7. Discuss the exam of the "dislocated" PIP joint that occurred during a basketball game reduced by the coach and how your findings will guide treatment. (Perform a digital block and do active flexion and extension – does the joint redislocate in the last 15-20 degrees of extension? Perform a lateral stress test for instability. Redislocation and a markedly abnormal stress test indicate operative intervention. The readings would indicate a grey zone of ambiguity of splinting vs. operative intervention. Certainly, an articular fracture of any magnitude in the presence of a positive lateral stress test and/or re-dislocation on active extension would be an impetus for operative intervention. If both tests are negative, splint with the PIP joint in 10 or 15 degrees of flexion only for 2-4 weeks and then buddy tape to the adjacent finger additional two weeks.)
 - a. How might the x-rays guide you in selection of a treatment plan? (The volar plate when torn from the distal insertion on the base of the middle phalanx may avulse a fragment of bone. The location of that bone and the fragment size can be helpful, for example, if the fragment is larger than one-fourth of the articular surface, then reconstitution of the articular surface is unlikely with closed methods *and* the "box" of the supporting structures of the PIP joint have been sufficiently avulsed, the volar plate as well as probably the collateral ligament. Without operative reduction and fixation, an unstable joint is the probable outcome. Stress x-rays are probably of little value.)
 - b. Explain the pathologic anatomy of the patient who redislocates during the final 20 degrees of extension (What has occurred is a significant tear of not just the lateral portion of the box, namely the accessory and collateral ligaments, but also a significant tear-dehiscence of the volar plate or injury to two sides of the joint box. As a result the structures are unable to hold the middle phalanx in proper position as the finger is extended and the base of the middle phalanx redislocates dorsally.)

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8. You sustain a transverse laceration on the radial aspect of your index PIP joint, from an inept junior resident, that transects your collateral and accessory collateral ligaments. What are the physical findings? Explain. (A transection only of the collateral ligaments will lead to some minor degree of lateral instability but not dislocation of the joint. Tape up and move on.)
9. You receive a phone call from this same resident about an “unstable” PIP joint dislocation in the ER. What may explain unstable dislocations? (As represented in the drawing below diagram B, a stable dorsal dislocation allows the base of the middle phalanx to ride dorsally onto the head of the proximal phalanx yet enough of the collateral ligament is retained that once reduced the joint will be stable. An unstable dislocation is the result of avulsion of sufficient structures of the box, volar plate and collateral ligaments and a volar plate is frequently interposed between middle and proximal phalanx. Dependent on severity, the joint may be unstable throughout attempted extension, or conversely dislocates in the final 20° of extension. A reducible but unstable dislocation is represented in the following diagram.)

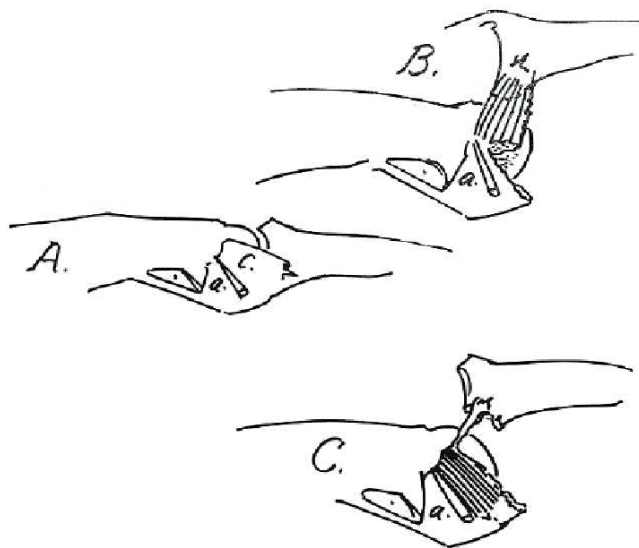


FIGURE 12. Schema of proximal interphalangeal dorsal dislocation. A. The division of the lateral capsule into collateral (c) and accessory (a) ligaments is hypothetical, no actual separation exists. The tough check ligaments are firmly anchored to the distal portion of the proximal phalanx, bridging the retrocondylar space through which pass the nutrient vessels to the flexor tendons and joint synovium. B. Stable dorsal dislocation. The volar plate insertion has been ruptured yet the collateral-accessory ligament attachment to the volar plate retains the normal condyle-volar plate relationship. Closed reduction will reapproximate all structures so that capsular restitution will be satisfactory. C. Unstable dorsal dislocation. The middle phalanx has dislocated dorsally, leaving a large volar fragment still attached to the volar plate and the major portion of the collateral ligaments. Should a few fibers of the ligament remain attached to the phalanx to facilitate complete reduction, structural restitution may be satisfactory; however, if these ligamentous fibers have been completely torn or are subsequently ruptured, a satisfactory reduction is unlikely.

Eaton MD, R. G., Chapter 2: “The Digital Interphalangeal Joints.” Joint Injuries of the Hand, Charles C. Thomas, (1971), pp 23.

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- a. At what anatomical point is the volar plate avulsed? (Because of the firm periosteal attachment of the check rein ligaments and the volar plate to the periosteum of the base of the middle phalanx and the more flexible accordion like configuration proximal, the most common disruption is distally.)
 - b. What is the position of the PIP joint in an *irreducible* dislocation? (Positioning of the base of the middle phalanx volar to the head of the proximal phalanx, a dislocation known as a volar dislocation as opposed to a much more common dorsal dislocation. The head or a condyle of the proximal phalanx may become entrapped within the dorsal joint structures such as between the central slip and a lateral band in contrast to the more common dorsal dislocation.
10. Describe the operative management of an acute PIP joint dislocation with a sizeable volar distal bone fragment. (Zigzag palmar incision for exposure, identification of the distal end of the volar plate, excision of the bone fragment, repair to the base of the middle phalanx by drill holes, a pullout suture tied over a button on the dorsal aspect of the proximal portion of the middle phalanx, direct suture repair of collateral ligament, postoperative management is with a dorsal blocking splint in 15-20° of flexion for three weeks and then physical therapy.)
11. The three complications are a stiff joint, boutonniere, and a recurvatum deformity. Explain how each might occur. (A boutonniere deformity might occur because of failure to recognize an injury to the transverse retinacular ligament on one side and subluxation of the lateral bands, as well as adhesions of the volar plate and inability to fully extend the finger. A recurvatum deformity occurs because excessive laxity of the volar plate as a result of perhaps a dehiscence of the volar plate repair. An injury to both transverse retinacular ligaments may also be present. A stiff joint is self-explanatory)
12. A patient in the ER has sustained a “dislocated” DIP joint. On exam a transverse laceration on the palmar aspect of the joint is present and the distal phalanx is dislocated dorsally on the head of the middle phalanx. Treatment? (Wash out the joint with a digital block, reduce the dislocation and close the skin, obtain an x-ray, splint +/- K-wire at about 10° of flexion for six weeks, unless the joint is grossly unstable as discussed in a prior question.)

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- a. Why are closed dislocations of the DIP joint uncommon? (The tight adherence of the skin and the immediate insertion of both the extensor and flexor mechanism provide adherent stability. Only an open joint with transection of one of those two structures will produce a dislocation of the DIP joint.)
13. Explain why a dislocated DIP joint, once reduced, is inherently stable. (The joint is encased dorsally and palmward by the insertions of the flexor and extensor tendon.)

C. Digital Metacarpophalangeal Joints

1. The digital metacarpal joints are more lax and allow some lateral movement in extension and tight in flexion, why? (Mostly the increased tautness of the collateral ligaments – the ligaments arise more dorsally on the head of the metacarpal and course volarward over the volar bulge of the condylar head and so have an eccentric course and are taut in flexion; the head is shaped triangular or ovoid and broader on the palmar aspect which also helps lock in place the base of the proximal phalanx in flexion.)
 - a. What is the linking structure of the metacarpals? (Transverse volar intermetacarpal ligament.)
 - b. Describe the difference in the distal insertion between the collateral ligament and the accessory collateral ligament. (The collateral ligament inserts on the base of the proximal phalanx and some on the distal volar plate and flexor tendon sheath; the accessory collateral ligament inserts solely on the volar plate and the tendon sheath.)
 - c. From a bony perspective only, the MP joints would appear to permit a significant amount of lateral movement. Yet, such is not the case. What is the anatomic explanation? (A strong lateral support from the adjacent interosseous muscles and the tight, fibrous transverse volar metacarpal ligament.)
2. Describe the configuration of the MP joint volar plate. (Loose membranous proximal portion, tight distal attachment to the periosteum of the base of the proximal phalanx; the more membranous central portion, attached transversely by the volar metacarpal ligaments on each side of the digit with exception of the radial index and ulnar little and finally a near absence of the check ligaments in contrast to the PIP joint.)

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3. You are called by an experienced ER doctor who relates he wants you to see a dislocated index MP joint that can not be reduced. Predict the dislocation, clinical findings, and x-ray appearance. (Almost always a dorsal dislocation of the proximal phalanx onto the metacarpal head. The clinical findings are the absence of a MP “knuckle”, slight ulnar deviation, and shortening of the digit. The MP joint will be in extension and the PIP joint in slight flexion. The x-rays will demonstrate a “bayonet” deformity with dorsal displacement of the base of the proximal phalanx onto the head of the metacarpal.)
 - a. What is the pathologic anatomy? Why is this location usually irreducible? (The membranous portion of the volar plate has been torn with subluxation of the head of metacarpal through the volar plate. The head of the metacarpal is entrapped by the flexor tendons on the ulnar side and the lumbrical muscle on the radial side of the neck. Finally, the volar plate, which is still attached distally, is interposed in the joint space, also preventing reduction. Any attempt at reduction by traction on the proximal phalanx simply tightens the above structures.)
 - b. Differentiate dislocation from subluxation anatomically and in treatment. (Subluxation is usually a torn collateral ligament but the volar plate is not dehisced and the joint surfaces are still in contact. Clinically, a subluxation can be reduced by simple flexion with traction.)
4. Which digit is more likely to sustain MP joint dislocation? Why? (The index finger as a border digit. The other digits have the protection of the transverse volar metacarpal ligament and the little finger is usually not involved in the action.)
5. You should have noted by now that a PIP joint dorsal dislocation avulses the *distal* portion of the volar plate, while a MP joint dorsal dislocation results in a tear of the membranous or *proximal* portion of the volar plate. Explain. (All the structures of the PIP joint including the collateral ligaments are tight in full extension and prevent hyperextension of the joint. Ultimately, hyperextension forces tear the volar plate from its periosteal insertion. The MP joints are structured such that hyperextension is possible even normally with the collateral ligaments *lax* in full extension. With a hyperextension force driving the digit and the proximal phalanx even further dorsally, the metacarpal head is forced through the proximal or membranous portion of the volar plate.)

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- a. Compare the frequency of PIP vs. MP joint dislocations. (PIP joint dislocations are much more common than MP joint for two reasons: one, a hyperextension force will be directed toward the PIP before the MP joint; second, the transverse volar metacarpal ligament lends adherence stability to the MP joint. The end result is the border digit, most commonly the index, that sustains a MP joint dorsal dislocation.)
6. With a zigzag incision for repair of the MP joint dislocation, you must be careful to avoid what structure? (The neurovascular bundle, usually radial, displaced into a subcutaneous location taut over the volar aspect of the metacarpal head.)
 - a. You are not able to reduce the metacarpal into proper position, what next? (Release the superficial fascia overlapping the metacarpal head, release the flexor tendon sheath distally. Most radically, divide the lumbrical on the radial aspect.)
 - b. Further operative management and postoperative care? (The volar plate must be repaired with a suture or two and the joint splinted in 30 or 35 degrees of flexion for three weeks followed by physical therapy.)
7. Once a irreducible dislocation is managed with open reduction, how does the subsequent operative management differ for the MP joint vs. the PIP joint? (The MP joint dislocation occurs because of the head of the metacarpal perforating the proximal membranous portion of the volar plate and yet the remaining structures of the “box”, the collateral ligaments are usually intact and therefore other than a couple pro forma stitches in the volar plate the subsequent management is postoperative splinting and then therapy. The PIP joint in contrast is irreducible because of loss of congruity of three sides of the box and as such repair with internal fixation is usually necessary.)

D. Dislocations and Fracture Dislocations of the Metacarpophalangeal Joint of the Thumb

1. How does the volar plate of the metacarpal joint of the thumb differ and similar to that of the digital PIP joint volar plate? (Both the MP joint of the thumb and the PIP joint of the digits are similar in the structure of the two elements of the collateral ligaments, quadrangular and accessory. Both have a tight periosteal adherence to the base of the more distal phalanx, the proximal in the thumb and the middle in the digits. What is different is the absence of the lateral check ligaments in the thumb metacarpal volar plate and the similarity of the proximal volar plate to that of the digits.)

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2. What structures insert on the sesmoids? (Intrinsic thenar muscles *except* opponens, so slips of the short thumb abductor and flexor pollicis brevis on the radial sesmoid, as well as the transverse head of the adductor on the ulnar sesmoid.)
 - a. Explain how the intrinsic muscles can both flex the MP joint and assist in the extension of the IP joint. (That capacity is because of the triradiate insertions, that is best exemplified by the adductor which inserts not only into the sesmoid but also the proximal, volar, and ulnar aspect of the proximal phalanx and then finally into the dorsal extensor aponeurosis, the last of which enables and assists in weak extension of the IP joint.)
3. What are the pathomechanics of injury to the ulnar collateral ligament of the thumb MP joint? (Essentially, the injury is one of hyperabduction or radial abduction usually with some hyperextension that results in tearing of the ulnar collateral ligament.)
 - a. What is a Stener's lesion? (See attached diagram, the lesion is that of a complete tear of the ulnar collateral ligament, which is torn off the distal insertion at the base of the proximal phalanx. The fragment of collateral ligament then becomes superficial or outside the adductor extensor aponeurosis preventing healing in the normal anatomic location.)

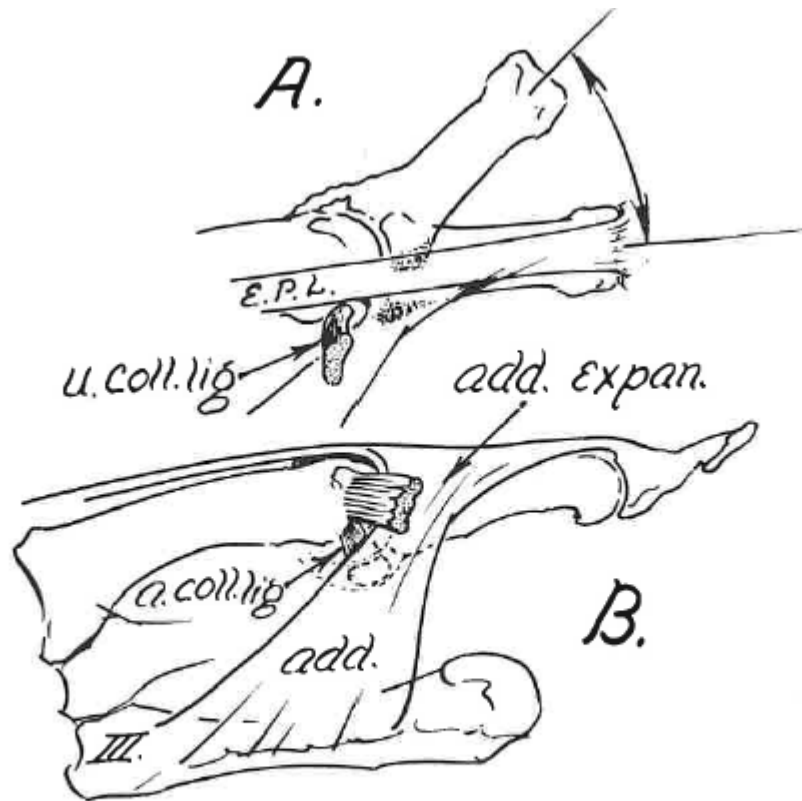


FIGURE 37. The mechanism of displacement of the ulnar collateral ligament. A. Forceful abduction tears the ulnar collateral ligament distally and draws the adductor aponeurosis tightly across the site of rupture. With realignment, the ligament is swept proximally by the edge of the extensor mechanism. B. The torn end of the ligament is prevented from healing in its normal position by interposition of the aponeurosis.

Eaton MD, R. G., Chapter 2: "The Digital Interphalangeal Joints." Joint Injuries of the Hand, Charles C. Thomas, (1971), pp 64.

4. Discuss the performance of the thumb MP joint stress test. (Under digital block, lateral or radial stress is placed on the thumb MP joint while in extension or 15° of flexion. Relatively little lateral movement should be possible beyond 10 or 15 degrees. Always compare to the opposite uninjured hand.)
 - a. What type of anesthesia? (The readings describe performance of a radial and median block at the wrist but probably a thumb block would suffice.)
5. What is the role of x-rays? (Identification of a fracture fragment from the base of the proximal phalanx, the size of the fragment that may be helpful, greater than 10% of the articular surface, as well as a degree of displacement of the fractured fragment. More modern techniques have used an MRI with a finger coil to examine this injury.)

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6. What are the indications for operative repair. (Positive lateral stress test of $>35^\circ$, periarticular fracture fragment $>10\%$ of the joint surface.)
7. Describe repair of the acute injury and postoperative care. (Operative repair consists of direct suture of the accessory and body portion of the collateral ligament as well as repair of the aponeurosis. The readings discuss a pull out suture technique. Postoperative care consists of a thumb spica +/- a K-wire across the joint plus a plaster thumb spica for four weeks then splinting and physical therapy for an additional four weeks.)
8. You are called by the intern from the ER who says he has a patient with a “dislocated MP joint” of the thumb that he is unable to reduce. What kind of dislocation, in all likelihood, is it? (Hyperextension or dorsal dislocation with entrapment of the metacarpal head volarly and the volar plate interposed between the metacarpal head and the base of the proximal phalanx similar to the digital MP joints.)
 - a. Why can he not reduce? (Probably can. The dislocations differs from the fingers in the absence of the lumbrical. The proper positioning of a closed reduction of a dorsal dislocation of the MP joint of the thumb is one of adduction to relax the adductor, modest flexion of the joint to relax the short abductor and flexor, and flexion of the thumb posture to relax the long thumb flexor. Distal traction and dorsal pressure on the base of the proximal phalanx should bring the joint into reduction. Failure to do so probably indicates a volar plate malposition within the joint space.)

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