CQ HAND + UPPER LIMB
SPECIALIST ORTHOPAEDIC SURGEON

EVIDENCE SUMMARY

Drainage of an Infected Flexor Sheath

Anatomy & Pathophysiology

GENERAL HAND ARCHITECTURE

- The hand is composed of 19 bones, 17 articulations, and 19 muscles situated entirely within the hand [2].
- The hand contains approximately the same number of tendons activated by the forearm muscles as it has intrinsic muscles [2].
- The hand functions as an organ designed to obtain information and an organ of execution [2].
- The hand moves within a large volume of space with the shoulder as the apex, allowing it to reach any part of the body fairly easily due to the mobility of the shoulder, elbow, and wrist [2].
- Distal to the elbow, the wrist and forearm function as a single physiological unit that places the hand in a position for grasping [2].
- The open hand forms a balanced graceful oval in its longitudinal axis when fingers are extended and in contact [2].
- The proximal carpometacarpal half of the hand is flattened, presenting two faces with unique anatomical and functional significance [2].
- The posterior or dorsal aspect of the hand is convex, while the anterior, palmar or volar aspect is concave [2].
- The distal half of the hand is separated into five digits that flex toward the palm [2].
- The digits converge in closing by flexing and adducting, and diverge in opening by extending and abducting [2].
- The thumb has a more proximal and lateral position than the four fingers, allowing movement inward and outward from the palm [2].
- The four fingers are the distal extension of the carpometacarpal part of the hand [2].
- The hinges for finger movement are located at the thenar crease and at the transverse distal palmar crease, not at the bases of the digits [2].
- When fingers are extended and separated, their tips lie on the circumference of a circle whose center is the head of the third metacarpal [2].

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- The web space of the thumb is the largest and deepest among the digital web spaces [2].

CUTANEOUS ANATOMY

- Functional cutaneous units in the hand are similar to those described in the face [3].
- One dorsal cutaneous unit extends from the wrist to the proximal interphalangeal joints of the fingers and the interphalangeal joint of the thumb [3].
- The dorsal covering of the interphalangeal articulations forms a unique cutaneous unit characterized by a considerable excess of skin when digits are in extension [3].
- The fine tight skin of the dorsal aspect of the middle phalanx forms a distinct cutaneous unit [3].
- The dorsal integument of the distal phalanx is distinct due to the nail bed with its matrix [3].
- The palm forms a cutaneous unit extending from the distal transverse crease of the wrist up to the transverse crease at the base of the digits [3].
- The palmar integument is subdivided into two separate zones by the oppositional crease of the thumb, which constitutes the oblique axis of the hand [3].
- The skin of the radial portion of the palm covers the thenar eminence and external part of the palm, is relatively well vascularized, and is the mobile portion [3].
- The skin of the ulnar and distal portion covers the hypothenar eminence where skin has poor mobility [3].
- The distal part of the palm beyond the transverse distal palmar crease acts as a true hinge at the level of the metacarpophalangeal articulations [3].
- The central triangular part of the palm has fixed and poorly vascularized skin that covers almost directly the superficial palmar aponeurosis, which inserts into it [3].
- The integument of the palmar face of the digits is subdivided into phalangeal units separated by digital flexion folds [3].
- There are three digital flexion folds for the fingers and two for the thumb [3].
- When a digit is completely flexed, the integument of adjacent phalanges comes into contact in the zones of the flexion creases, establishing areas of cutaneous contact in the form of a diamond [3].
- The sides of the diamond-shaped cutaneous contact zones do not undergo variations in length during flexion and extension movements [3].
- Incisions made along the lines of the diamond-shaped cutaneous contact zones present a minimal chance of retraction [3].
- The web spaces are formed from the union of two nonsymmetrical cutaneous surfaces [3].
- The dorsal slope of the web space has a gradual incline and its supple skin is not adherent to the subjacent region [3].
- The palmar surface of the web space is flat and precipitously interrupted, with skin densely adherent to the commissural skeleton [3].
- The commissural skeleton is formed by the interdigital palmar (natatory) ligament between the fingers and by the distal transverse ligament at the level of the thumb web [3].

- The distal transverse ligament at the level of the thumb web is by far the deepest and the most mobile [3].

INTRINSIC MUSCULATURE

- There are seven interosseous muscles in the hand, consisting of four dorsal and three volar muscles [4].
- The dorsal interossei are abductors [4].
- The anatomic axis of the hand coincides with the axis of the third metacarpal [4].
- The dorsal interossei lie to the radial side of the index and middle fingers and the ulnar side of the middle and ring fingers [4].
- The little finger is abducted by the abductor digiti quinti [4].
- The volar interossei are adductors [4].
- The volar interossei lie to the ulnar side of the index finger and the radial side of the ring and little fingers [4].
- The middle finger has two dorsal interossei (abductors) and no volar interossei (adductors) because the central axis of the hand lies within it [4].
- Each dorsal interosseous muscle, with the exception of the third, has two muscle heads [4].
- The superficial head of the dorsal interosseous muscles arises most dorsally from the shaft of the contiguous metacarpals [4].
- The superficial head is inserted deeply by a medial tendon onto the lateral tubercle of the base of the proximal phalanx [4].
- The superficial head abducts and weakly flexes the proximal phalanx [4].
- The superficial head has no direct effect on the middle or distal phalanges [4].
- The deep head of each dorsal interosseous muscle forms a lateral tendon, or lateral band, at the level of the MP joint [4].
- The deep head flexes and weakly abducts the proximal phalanx while extending the middle and distal phalanges [4].
- At the level of the middle of the proximal phalanx, transverse fibers arch dorsally from each lateral band to join each other over the dorsum of the finger [4].
- These transverse fibers flex the proximal phalanx [4].
- More distally, oblique fibers (spiral fibers) from the lateral bands sweep over the distal third of the proximal phalanx to insert onto the lateral tubercles at the base of the middle phalanx [4].
- The oblique fibers extend the middle phalanx at the PIP joint [4].
- The lateral bands are joined by the lateral slips of the extensor tendon to form the conjoined lateral band [4].
- The two conjoined lateral bands to each finger unite at the distal third of the middle phalanx to form the terminal tendon [4].
- The terminal tendon inserts at the base of the distal phalanx to extend it [4].

- The flexor digiti quinti brevis is structurally and functionally similar to the deep head of the dorsal interossei [4].
- The flexor digiti quinti brevis forms the ulnar lateral band of the little finger [4].
- The three volar interossei arise from adjacent surfaces of contiguous metacarpal shafts [4].
- Each volar interosseous muscle has only one muscle head [4].
- None of the volar interossei insert onto the proximal phalanx [4].
- The volar interossei form the ulnar lateral band of the index finger and the radial lateral band of the ring and little fingers [4].
- The volar interossei send oblique or spiral fibers that insert onto the base of the middle phalanx at its lateral tubercle [4].
- The abductor digiti quinti and flexor digiti quinti brevis are similar in both structure and function to the superficial and deep heads of the dorsal interossei, respectively [4].
- The abductor digiti quinti and flexor digiti quinti brevis arise from the fifth metacarpal [4].
- The abductor digiti quinti inserts onto the ulnar lateral tubercle at the base of the proximal phalanx of the little finger [4].
- The flexor digiti quinti forms the ulnar lateral band [4].
- The opponens digiti quinti lies deepest among the hypothenar muscles [4].
- The opponens digiti quinti arises from the pisohamate ligament and the hook of the hamate [4].
- The opponens digiti quinti inserts onto the ulnar side of the diaphysis of the fifth metacarpal [4].
- The opponens digiti quinti flexes and supinates the fifth metacarpal [4].

METACARPAL AND ARCH ANATOMY

- The metacarpal arch is endowed with a great deal of adaptability because of the mobility of the peripheral metacarpals [7].
- The peripheral metacarpals form the sides of the cup or the palmar gutter and can deepen the concavity as they approach each other [7].
- The peripheral metacarpals are attached to the fixed element, which is the middle metacarpals [7].
- The thumb metacarpal is independent and articulates with the trapezium [7].
- The middle metacarpals are united to the carpus by the intrinsic interlocking encasement of the bones themselves [7].
- The index metacarpal is the most firmly fixed [7].
- The ring metacarpal is a transitional element to the fifth metacarpal and has about 10 degrees of mobility in flexion and extension [7].
- The fifth metacarpal is semi-independent and articulates with the hamate [7].
- The fifth metacarpal is restrained on its radial side by its articulation with the base of the fourth metacarpal [7].

- The fifth metacarpal has a range of flexion–extension of approximately 20 degrees [7].
- The second to fifth metacarpals are all bound together by various fibrous structures [7].
- The most distal fibrous structure binding the second to fifth metacarpals is the deep transverse intermetacarpal ligament [7].
- The deep transverse intermetacarpal ligament is better named the interglenoid ligament [7].
- The interglenoid ligament ties together the anterior "glenoid ligaments" of the metacarpophalangeal articulations, known as the "volar plates" [7].
- The longitudinal arches are composed of a fixed portion, the carpometacarpal, and a mobile portion, the digits [7].
- There is a longitudinal arch for every ray [7].
- The longitudinal arches diverge distally according to their different obliquities, with the thumb ray being the most divergent [7].
- The keystones of the longitudinal arches are the metacarpophalangeal articulations [7].
- The thick anterior glenoid capsules, known as volar plates, prevent hyperextension at the metacarpophalangeal articulations [7].
- The volar plates are interconnected by the transverse interglenoid ligament [7].
- The stability of the metacarpophalangeal joints is essential to the support of the longitudinal arch as well as of the transverse metacarpal arch [7].
- The thumb ray has considerable mobility and independence [7].
- The fifth ray has much less mobility and independence than the thumb [7].
- The index ray has a certain degree of independence at the phalangeal level, owing to the arrangement of its flexor and extensor muscles, but not at the metacarpal level [7].

VASCULAR ANATOMY

- The arteries of the thumb vary in both size and number [8].
- The layout of the thumb arteries is the result of innumerable variations regarding origin, transit, connections, and size [8].
- The most common variations of the palmar arteries can be schematized by dividing the thumb into three segments defined by the metacarpophalangeal and interphalangeal flexion creases [8].
- In the classical layout, the "princeps pollicis" artery, the terminal branch of the radial artery, crosses the first intermetacarpal space [8].
- The "princeps pollicis" artery runs along the ulnar side of the first metacarpal bone and along the volar surface of the adductor muscle [8].
- The "princeps pollicis" artery emerges onto the subcutaneous palmar tissue at the level of the cutaneous flexion crease of the metacarpophalangeal joint [8].
- At the metacarpophalangeal joint level, the "princeps pollicis" artery divides into two terminal rami, namely the collateral palmar arteries of the thumb [8].

- The collateral palmar arteries of the thumb run along the digital tunnel symmetrically and are of equal caliber [8].
- The collateral palmar arteries head distally to finally unite in the pulp arcade [8].
- During their transit in the digital tunnel, the collateral palmar arteries break off into numerous collateral branches, either cutaneous, articular, or osseous [8].
- An arcade located deep in the flexor tendon joins together the two arteries at the level of the distal metaphysis of the first phalanx [8].
- Vessels originating from the subtendinous arcade enter the "vincula" and irrigate the flexor tendon [8].
- Only 15% of anatomical dissections fall into the category of the classical description of the palmar arteries of the thumb [8].
- In the first segment of the thumb (between the opposition crease and the metacarpophalangeal flexion crease), it is rare to find arteries of surgical interest on the volar surface [8].
- The artery in the first segment of the thumb is located deeply and is more easily accessible from the dorsal surface [8].
- In the second segment of the thumb, the two arteries run alongside the flexor tendon and behind the collateral nerves [8].
- In the second segment of the thumb, the main artery is the ulnar collateral artery [8].
- The subtendinous anastomosis situated at the level of the neck of the first phalanx acts as a "moderator" between the two arteries in the second segment [8].
- In cases where the palmar ulnar collateral artery is absent, the dorsal artery takes its place by means of a branch through the subtendinous arcade [8].
- In the third segment (pulp segment) of the thumb, the two arteries are of similar size and run through the thick fatty subcutaneous padding [8].
- In the pulp segment, the arteries cross over and convert into the ends of the digital nerves at the level of the median axis [8].
- The posterior area of the thumb is vascularized by two arteries which originate from the palmar arteries (princeps, commissural, or anastomoses of the superficial arcade) at the level of the first metacarpal [8].
- These dorsal arteries run laterally along the metacarpophalangeal joint and continue obliquely from volar to dorsal [8].
- The dorsal arteries head in a distal direction remaining on the side of the two distal phalanges [8].
- At the level of the neck of the first phalanx, an anastomosis can be found which originates from the palmar arteries for the dorsal supply [8].
- The ulnar dorso-collateral artery generally stems from the "princeps pollicis" onto the medial border of the neck of the first metacarpal [8].
- The ulnar dorso-collateral artery heads distally remaining on the lateral surface of the finger [8].

SURGICAL APPROACH CONSIDERATIONS

- Distal palmar incisions are transverse as a rule [9].
- In the proximal palm, incisions tend to be more longitudinal, with the distal end curving radially and paralleling the closest major skin crease [9].
- An incision of any desired length can be made across the palm, provided that the underlying digital nerves and other vital structures are protected [9].
- After the skin and underlying fat have been incised, the fat is dissected from the palmar fascia and is carried with the skin flaps [9].
- Most of the vital structures in the palm are deep to the palmar fascia [9].
- In the distal palm, structures lying between the metacarpal heads are not protected by the palmar fascia [9].
- The superficial volar neurovascular arch should be protected when deeper exposure is required [9].
- Incisions in the more proximal palm should parallel the thenar crease [9].
- When extended proximal to the wrist, incisions should not cross the flexor wrist creases at a right angle [9].
- The most important structure in the thenar area is the recurrent branch (motor) of the median nerve [9].
- Anatomic studies have shown that there is no single longitudinal incision in the proximal palm that completely avoids the palmar cutaneous branches of the median and ulnar nerves [9].
- The volar

Investigations

- Clinical evaluation of the injured or dysfunctional hand and wrist requires combining patient history with a careful physical examination to pinpoint or narrow the scope of possible pathologic processes [1].
- Diagnostic tests such as imaging and serum laboratory studies are useful in determining pathology but can be expensive, time consuming, and often nonspecific [1].
- A careful physical examination is essential to direct care and future testing if indicated [1].
- An 8-MHz Doppler tone assessment may be used to identify superficially displaced neurovascular bundles when Dupuytren cords lie beneath soft fleshy prominences [11].
- False-negatives are possible with 8-MHz Doppler tone assessment for identifying neurovascular bundles [11].
- MRI is probably most useful in identifying additional pathology such as flexor tendon bowstringing [11].
- MRI may be helpful in providing a quantitative noninvasive measure of cellularity of affected areas, which is an index of biologic activity [11].
- The potential of MRI as a staging tool based on cellularity measurement has not been investigated yet on a large scale [11].

References

[1] Orthopaedic Knowledge Update 13 Ebook Without Multimedia. Anatomy, Evaluation, Clinical Examination, and Imaging > Evaluation and Clinical Examination: Current Concepts.

[2] Exam Of The Hand Wrist 2Ed. INTRODUCTION.

[3] Exam Of The Hand Wrist 2Ed. Functional cutaneous units.

[4] Green S Operative Hand Surgery. Interosseous and Hypothenar Muscles.

[7] Exam Of The Hand Wrist 2Ed. The arches of the hand > *The metacarpal arch*.

[8] Exam Of The Hand Wrist 2Ed. Techniques of investigation of the arterial supply by J P Melki > Vascularization of the thumb > Palmar aspect.

[9] Campbell S Operative Orthopaedics 4 Volume Set. RESULTS OF SUTURE OF THE SCIATIC NERVE > PALMAR INCISIONS.

[11] Dupuytren S Disease And Related Hyperproliferative Disorders. 54. The Future of Dupuytren's Research and Treatment > 54.4 Mechanical Measurements and Procedures > 54.4.4 Imaging.

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