CQ HAND + UPPER LIMB
SPECIALIST ORTHOPAEDIC SURGEON

EVIDENCE SUMMARY

Fingertip Repair and Reconstruction

Anatomy & Pathophysiology

GENERAL HAND ARCHITECTURE

- The hand functions as both an organ for obtaining information and an organ of execution [2].
- The hand consists of 19 bones, 17 articulations, and 19 muscles situated entirely within the hand, along with approximately the same number of tendons activated by forearm muscles [2].
- The open hand forms a balanced graceful oval in its longitudinal axis when fingers are extended and in contact [2].
- The dorsal aspect of the hand is convex, while the 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 thumb has a more proximal and lateral position than the four fingers, allowing movement inward and outward from the palm [2].
- The hinges for finger flexion and extension are located at the thenar crease and 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].

OSSEOUS AND LIGAMENTOUS ANATOMY

- The metacarpal arch possesses adaptability due to the mobility of the peripheral metacarpals, which form the sides of the palmar gutter [7].
- The index metacarpal is the most firmly fixed of the metacarpals [7].
- The ring metacarpal has approximately 10 degrees of mobility in flexion and extension [7].
- The fifth metacarpal has a range of flexion–extension of approximately 20 degrees [7].
- The second to fifth metacarpals are bound together by the deep transverse intermetacarpal ligament, also known as the interglenoid ligament [7].
- The interglenoid ligament ties together the anterior glenoid ligaments of the metacarpophalangeal articulations, known as volar plates [7].

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- The metacarpophalangeal joints serve as the keystones of the longitudinal arches of the hand [7].
- The volar plates prevent hyperextension at the metacarpophalangeal joints [7].

INTRINSIC MUSCULATURE

- There are seven interosseous muscles in the hand: four dorsal and three volar [4].
- The dorsal interossei are abductors, while the volar interossei are adductors [4].
- The middle finger has two dorsal interossei and no volar interossei 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: a superficial head and a deep head [4].
- The superficial head of the dorsal interosseous muscles abducts and weakly flexes the proximal phalanx [4].
- The deep head of the dorsal interosseous muscles flexes and weakly abducts the proximal phalanx while extending the middle and distal phalanges [4].
- Transverse fibers arch dorsally from each lateral band to join over the dorsum of the finger, flexing the proximal phalanx [4].
- Oblique or spiral fibers from the lateral bands insert onto the lateral tubercles at the base of the middle phalanx to extend the middle phalanx [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 unite at the distal third of the middle phalanx to form the terminal tendon, which inserts at the base of the distal phalanx to extend it [4].
- The volar interossei have only one muscle head and do not insert onto the proximal phalanx [4].
- The abductor digiti quinti and flexor digiti quinti brevis are structurally and functionally similar to the superficial and deep heads of the dorsal interossei, respectively [4].
- The opponens digiti quinti arises from the pisohamate ligament and the hook of the hamate, inserting onto the ulnar side of the diaphysis of the fifth metacarpal to flex and supinate it [4].

CUTANEOUS ANATOMY AND FUNCTIONAL UNITS

- Functional cutaneous units in the hand are analogous 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 considerable skin excess 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 presence of the nail bed and its matrix [3].
- The palm forms a cutaneous unit extending from the distal transverse crease of the wrist to the transverse crease at the base of the digits [3].

- The oppositional crease of the thumb subdivides the palmar integument into two separate zones [3].
- The skin of the radial portion of the palm covers the thenar eminence and is relatively well vascularized and mobile [3].
- The skin of the ulnar and distal portion of the palm covers the hypothenar eminence and has poor mobility [3].
- The central triangular part of the palm has fixed, poorly vascularized skin that covers the superficial palmar aponeurosis directly [3].
- The integument of the palmar face of the digits is subdivided into phalangeal units separated by digital flexion folds [3].
- When a digit is completely flexed, the integument of adjacent phalanges contacts in the zones of the flexion creases, forming diamond-shaped areas of cutaneous contact [3].
- The sides of the diamond-shaped contact zones do not undergo length variation during flexion and extension movements [3].
- Incisions made along the lines of the diamond-shaped contact zones present a minimal chance of retraction [3].
- The dorsal slope of the web spaces has a gradual incline with supple skin that is not adherent to the subjacent region [3].
- The palmar surface of the web spaces is flat and precipitously interrupted, with skin densely adherent to the commissural skeleton [3].
- The commissural skeleton is formed by the interdigital palmar ligament between fingers and the distal transverse ligament at the thumb web [3].

VASCULAR ANATOMY

- The arteries of the thumb vary in size and number, making surgical reconstruction delicate [8].
- The palmar aspect of the thumb can be schematically divided into three segments defined by the metacarpophalangeal and interphalangeal flexion creases [8].
- In the classical layout, the princeps pollicis artery crosses the first intermetacarpal space and runs along the ulnar side of the first metacarpal bone [8].
- The princeps pollicis artery emerges onto the subcutaneous palmar tissue at the level of the cutaneous flexion crease of the metacarpophalangeal joint [8].
- The princeps pollicis artery divides into two terminal rami, the collateral palmar arteries of the thumb, which run along the digital tunnel symmetrically [8].
- Only 15% of anatomical dissections of the thumb palmar arteries fall into the classical “typical” category [8].
- In the second segment of the thumb, the main artery is typically the ulnar collateral artery [8].
- A subtendinous anastomosis at the level of the neck of the first phalanx acts as a moderator between the two collateral arteries [8].

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- In the pulp segment, the two arteries are of similar size and run through thick fatty subcutaneous padding [8].
- The dorsal arteries of the thumb originate from palmar arteries (princeps, commissural, or superficial arcade anastomoses) at the level of the first metacarpal [8].
- Dorsal thumb arteries are joined by three arcades: one under the extensor tendon at the neck of the first phalanx, the arcade of the nail matrix, and the arcade of the nailbed [8].

NERVE ANATOMY AND PATHOPHYSIOLOGY

- The hand's blood and nerve supplies are continuous with those of the rest of the upper limb [2].
- The recurrent branch (motor) of the median nerve is the most important structure in the thenar area and should be exposed and protected if its location is in doubt [9].
- 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 superficial volar neurovascular arch should be protected when deeper exposure is required in the distal palm [9].
- Structures lying between the metacarpal heads in the distal palm are not protected by the palmar fascia [9].
- The dorsal branch of the superficial radial nerve to the radial side of the thumb must be avoided during midlateral thumb incisions [9].

CLINICAL IMPLICATIONS FOR FINGERTIP DEFECTS

- Fingertip amputation is the most common type of hand amputation [13].
- Approximately 30–50% of patients experience cold intolerance and hypersensitivity following fingertip amputation, regardless of the treatment chosen [13].
- Local flap procedures for fingertip coverage involve incising and advancing uninjured tissue, which extends scarring and damages fine branches of the digital nerves [13].
- Newer studies suggest that the incidence of cold intolerance and hypersensitivity may be lower with secondary healing than with skin grafts or local flaps [13].
- At least a third of the distal phalanx must be left intact to prevent a hook deformity of the nail when bone is removed [13].
- The necessary skin to cover the thumb distal to the metacarpophalangeal joint is approximately 9 cm wide and 8 cm long [6].
- The skin covering each finger is 7 cm by 10 cm on both the palmar and dorsal aspects [6].

Investigations

CLINICAL EXAMINATION

- 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].
- Patients often have difficulty accurately describing their symptoms and may incorrectly attribute pathology to a perceived deficit, whether real or imagined [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].
- A systematic method to approaching the physical examination of the hand is essential due to the number of structures in a small space [1].
- Clinicians may organize their examination by anatomic location or region of the hand, or by organ system or pathology [1].

IMAGING

- 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].
- Doppler imaging is a promising improvement for preoperative identification of structures, but higher resolution imaging technology is needed [11].
- MR assessment of Dupuytren's disease is hindered by the resolution of current equipment, orientation issues due to multiplanar deformities of the fingers, and lack of intraoperative availability [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 has not been investigated yet on a large scale [11].
- Digital vessels are difficult to visualize in Dupuytren's disease, even in 3D MRA reconstruction [11].
- Difficulty orienting the proper imaging direction exists due to multiplanar contractures in Dupuytren's disease [11].

ANATOMY

- The skeleton of the hand and wrist consists of 27 bones, of which 19 are long bones [12].
- The skeleton is divided into five rays, each ray making up a polyarticulated chain comprising the metacarpals and phalanges [12].

- The base of each metacarpal articulates with the distal row of the carpus [12].
- The carpus articulates with the skeleton of the forearm through its proximal row [12].
- The radioulnocarpal articulation has two axes of movement to which is added a third—pronation and supination from the forearm [12].
- The wrist has three axes of movement, permitting the hand to be positioned in any spatial configuration and allowing it to be placed as needed for grasping [12].
- The radial ray or first ray is the shortest and is made up of only three bones—a metacarpal and two phalanges [12].
- The trapezium is clearly angled out in front of the carpal plane so that the first metacarpal makes an angle of about 45 degrees with the second metacarpal in the sagittal plane [12].
- The thumb metacarpal is the shortest and the index metacarpal is by far the longest [12].
- The proximal and middle phalanges of the long and ring fingers are longer than those of the index finger [12].
- The long finger, and usually the ring finger, are longer than the index finger [12].
- The more ulnar the digit, the more obliquely it must deviate as it approaches the palm [12].
- The two ulnar metacarpals, especially the fifth, have slightly more mobility in flexion–rotation, compensating for their lack of length [12].
- The skeleton of the hand presents a longitudinal and transverse concavity, giving it the shape of a cup with a palmar concavity when the thumb is placed next to the index finger [12].
- When the thumb spreads to grasp an object, the cup becomes a gutter whose major oblique axis follows the thumb crease [12].
- The transverse axis of the palm, which corresponds to the metacarpophalangeal articulations, is not perpendicular to the longitudinal axis, represented by the median ray [12].
- The transverse axis is oblique, more distal at the metacarpophalangeal joint of the index finger and more proximal at the fifth metacarpophalangeal joint [12].
- The transverse axis forms an acute angle of approximately 75 degrees with the longitudinal axis [12].
- It is necessary to take the obliquity of the transverse palmar axis into account when applying plaster casts or splints and also in the positioning of crutch and cane handles [12].
- The epiphyseal plates are located at the proximal ends of the phalanges and the first metacarpal [12].
- The epiphyseal plates are located at the distal ends of the other metacarpals [12].

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