# A NOTE ON THIS TRANSLATION

*"Anatomy is destiny"* — Sigmund Freud

Living (or co-existing) in the digital world, I often reflect upon the role of books and what form, if any, a contemporary personal library should assume. Surveying the phalanx of nearly pristine volumes on my shelves, I am struck by two shabby, decaying titles: Clemente's Atlas of Anatomy and the hand anatomy book produced by Dr. Manuel Llusa and his colleagues at the University of Barcelona. The former I purchased at the beginning of medical school, and the latter I plucked from a window display in a Barcelona bookstore. The books now exist in an intricate lattice of large rubber bands, having long since exhausted their bindings. But these books, especially the Llusa volume, have remained singularly, consistently, and remarkably useful.

It is often quipped that a claim of any novel thought or discovery is merely evidence of the author's inability to speak neither French nor German. While a gross exaggeration, it does speak to the extraordinary work done abroad that is not available to English-speaking audiences. A goal of my term as ASSH Education Division Director was to try to facilitate access to important work being done in the non-English speaking world.

Anatomy is the basis of all we do, and the Barcelona text is the finest, most detailed, accurate, and useful anatomy text I have ever seen. While initially configured as the companion guide for the anatomy course at the University of Barcelona, it inspires both as a "read" and a reference. The mastery of the dissections is unmatched, and I truly believe it will help your practice of hand surgery and even increase your fulfillment.

It has been a long-held dream to see this book translated into English so that an even larger audience can enjoy its comprehensive, detailed dissections and descriptions. Finally, this project has reached fruition with the dedication and help of Drs. Llusa and Garcia-Elias and their colleagues. Our speciality owes you a deep debt of gratitude for bringing this translation to fruition.

**Michael R. Hausman, MD**
Lippmann Professor of Orthopedic Surgery
Chief, Upper Extremity Surgery
Mount Sinai Health System
New York City, New York

# CONTENTS


**Dedication** iii

**Acknowledgments** iv

**Contributors** v

**A Note on This Translation** vii
Michael R. Hausman, MD

**Foreword** viii
Marc García-Elías Cos

**Introduction** ix
Manuel Llusá-Pérez

**List of Abbreviations** xii

**Chapter 01**
Volar Region of the Wrist and Hand 3

**Topographic limits and skin incisions** **3**

**Superficial structures** **4**
A. Superficial aponeurosis and anterior annular ligament of the wrist and Guyon's canal; *palmaris brevis (PB)* muscle 4
B. Superficial palmar fascia of the hand (thenar, hypothenar, and palmar fascia) and anatomical components (pretendinous fibers and transverse fibers); interdigital spaces 8

**Subaponeurotic structures** **11**
A. Subaponeurotic structures of the wrist: radial artery and branches, *flexor carpi radialis* (FCR), median nerve and palmar cutaneous branch, *palmaris longus* (PL), *flexor carpi ulnaris* (FCU), ulnar artery and nerve, Guyon's canal, *flexor digitorum superficialis* and *flexor digitorum profundus* (FDS and FDP), *flexor pollicis longus* (FPL) 11

B. Palmar compartments and contents 18
i. Midpalmar compartment: superficial arterial arch, median nerve, ulnar nerve, FDS tendons, FDP tendons and *lumbricales (L) muscles*, FPL tendon 18
ii. Thenar compartment: *abductor pollicis brevis* (APB), *flexor pollicis brevis* (FPB), *opponens pollicis* (OP), and *adductor pollicis* (AdP); tendon FPL and neurovascular relationships 26
iii. Hypothenar compartment: *abductor digiti minimi* (ADM), *flexor digiti minimi* (FDM), *opponens digiti minimi* (ODM); neurovascular relationships 30
iv. Carpal tunnel: content and relationships 33

**Deep structures** **37**
A. Deep wrist plane: *pronator quadratus* (PQ) muscle, anterior interosseous artery and nerve, interosseous membrane 37
B. Deep plane of the hand: deep palmar arterial arch and motor branch of the ulnar nerve; deep palmar aponeurosis; interosseous (IO) muscles 41

**Chapter 02**
Volar Region of the Fingers and Thumb 51

**Topographic limits and skin incisions** **51**

**Palmar digital vessels and nerves; finger compartments; Grayson's and Cleland's ligaments** **53**

**Flexor tendons and fibro-osseous sheaths** **60**

**Vascularization and vincula of the flexor tendons** **76**

**Chapter 03**
Dorsal Region of the Wrist and Hand 85

**Topographic limits and skin incisions** **85**

**Superficial structures** **85**
A. Superficial vessels and superficial cutaneous nerves (radial and ulnar dorsal cutaneous branches); superficial dorsal aponeurosis and extensor retinaculum 85

**Subaponeurotic structures** **94**
A. Subaponeurotic structures of the wrist: compartments of the extensor tendons; anatomical snuffbox and relationships: radial artery, superficial sensory branch of the radial nerve 94
B. Subaponeurotic structures of the hand: extensor tendons of the fingers and *juncturae tendinae*; thumb extensor tendons; extensor tendons of the carpus 98

**Deep structures** **113**
A. Vascularization of the dorsum of the wrist and hand; deep dorsal aponeurosis; dorsal interosseous (IO) muscles 113

**Chapter 04**
Dorsal Region of the Fingers and Thumb 123

**Topographic limits and skin incisions** **123**

**Dorsal digital vessels and nerves** **124**

**Extensor apparatus of the fingers** **127**

**Chapter 05**
Osteoarticular Dissection of the Wrist and Hand 151

**Distal radioulnar joint and ligaments (including the triangular fibrocartilage complex); radiocarpal and midcarpal joints; ligaments** **151**

**Carpometacarpal and intermetacarpal joints and ligaments; carpometacarpal joint of the thumb and ligaments** **184**

**Metacarpophalangeal and interphalangeal joints, ligaments and palmar plate** **195**

**References** **213**

**Index** **217**

CHAPTER

01

# VOLAR REGION OF THE WRIST AND HAND

## TOPOGRAPHIC LIMITS AND SKIN INCISIONS

The proximal boundary of the anterior region of the wrist and hand includes 10–15 cm of the distal area of the forearm to facilitate identification and understanding of the arrangement of the musculotendinous structures and their passage to the wrist and hand. The distal limit is marked by a convex line that passes through the palmar digital crease from the thumb to the little finger. Laterally, this volar region is limited by the tendon of the *brachioradialis* muscle (BR) and the thenar musculature; medially, it is limited by the tendon of the *flexor carpi ulnaris* (FCU) in the wrist and the hypothenar musculature in the hand. In order to facilitate the elevation of skin flaps and dissection of the underlying structures, it is suggested to incise with a midline approach from the proximal limit to the distal wrist flexion crease and transversely extend to the proximal and distal limits. After lifting the flaps corresponding to the distal area of the forearm and wrist, the palmar region of the hand can be exposed with a curved longitudinal incision that follows the longitudinal thenar crease of the hand to the radial edge at the level of the metacarpophalangeal proximal palm crease. Two asymmetric skin flaps are created and anchored in their lateral and medial margins (Fig. 1-1).

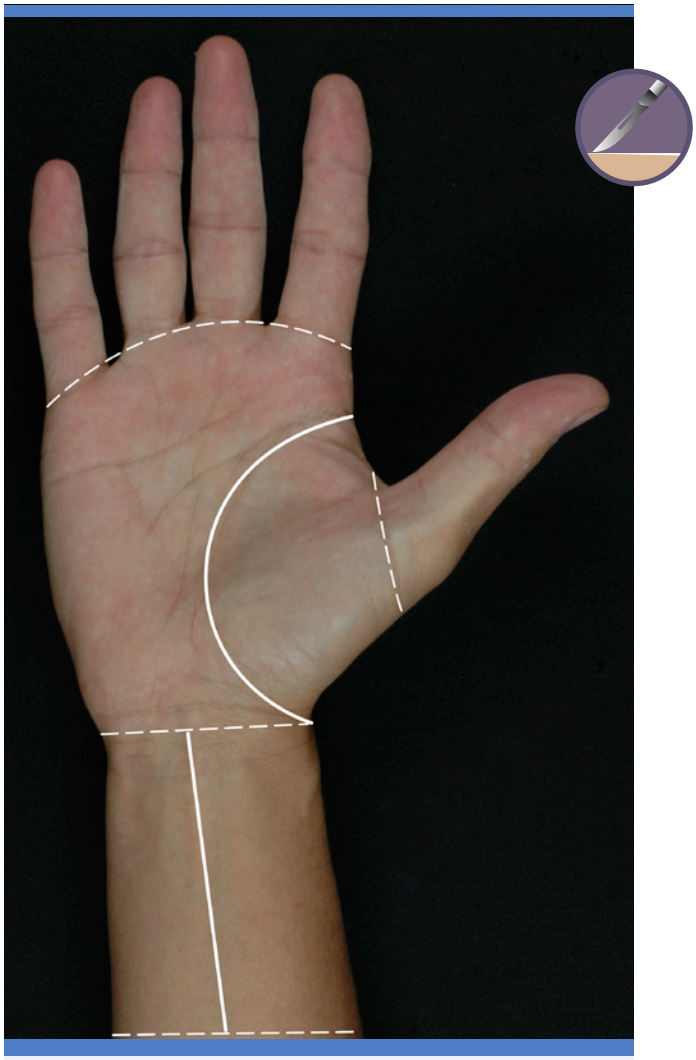

**Figure 1-1.** Anterior region of the wrist and the hand. Topographic limits and cutaneous incisions.

## SUPERFICIAL STRUCTURES

### Superficial aponeurosis and anterior annular ligament of the wrist and Guyon's canal; *palmaris brevis (PB)* muscle

After making the skin incisions and penetrating the subcutaneous adipose tissue, it is recommended to identify the superficial aponeurosis of the forearm in the proximal area. It is important to stay on the fascial plane and not pass through it in order to preserve the underlying tendon and neurovascular structures, which can be visualized through the superficial fascia. Special attention should be paid to the possibility of finding small sensory nerve fibers on the radial side of the lateral antebrachial cutaneous nerve or surface sensory branch of the radial nerve itself, which is evenly divided over the region of the distal wrist. On the ulnar side, small sensory nerve branches from the medial cutaneous antebrachial branch can be found. In the distal area, an attempt should be made to identify the sensory branch (palmar cutaneous branch) of the median nerve. The branch usually crosses the superficial aponeurosis at the junction of the wrist with the base of the hand, lies within adipose tissue and between the tendons of the *flexor carpi radialis* (FCR) and the *palmaris longus* (PL), and is found exactly between the lateral side of the median nerve and the medial side of the FCR tendon.

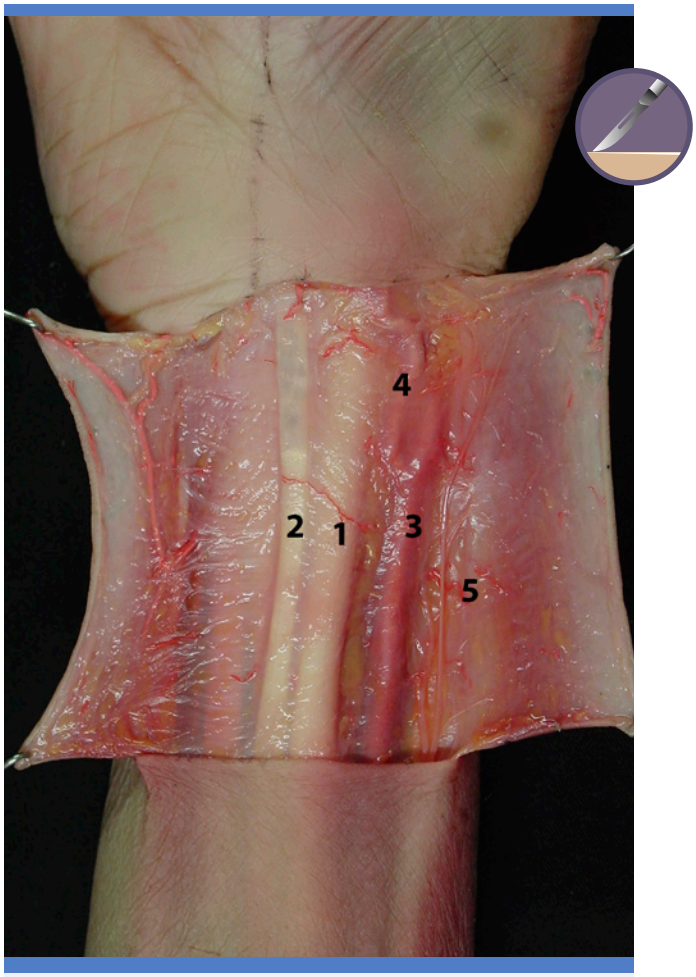


**Figure 1-2.** Cutaneous flaps and superficial aponeurosis. *Flexor carpi radialis* (1), *palmaris longus* (2), radial artery (3), palmar branch of the radial artery (4), and sensory superficial nerves (5).

The superficial palmar fascia at the distal level of the forearm is quite thin, allowing identification of the superficial tendon and neurovascular structures, which include from lateral to medial: the radial artery and veins in the distal wrist, the FCR tendon, the median nerve, the PL tendon (absent in approximately 10% of individuals), superficial flexor tendons (in a deeper plane), ulnar artery and veins, and the FCU tendon that covers the ulnar nerve and vessels (Fig. 1-2). The surface aponeurosis of the forearm thickens in the vicinity of the wrist with a component of transverse fibers constituting the anterior annular ligament of the wrist (Fig. 1-3A). This ligament, called the palmar carpal ligament by some authors, should not be confused with the flexor retinaculum since it constitutes only the most proximal and superficial portion of the retinaculum. In the ulnar aspect, this annular ligament expands to form a layer of fibers that cover the ulnar neurovascular

bundle, constituting Guyon's canal. Avoid the temptation to deepen the dissection at this time, before exposing the palmar region of the hand in order to maintain the anatomical relationships, especially the carpal tunnel and the Guyon's canal with their contents (Fig. 1-3B).

When exploring the anterior subcutaneous region of the hand, the thenar and palmar aponeurosis can be partially identified, highlighting the uneven distribution of adipose tissue. This tissue is more abundant at the base of the palmar region, in the hypothenar area (covering the *palmaris brevis* muscle and the hypothenar aponeurosis), in the metacarpophalangeal region and in interdigital spaces (Fig. 1-4A). It is recommended to start the dissection in the central part of the palm between the thenar and hypothenar eminences by locating the pearly fibers of the palmar fascia and raising the 2 lateral and medial cutaneous flaps carefully along

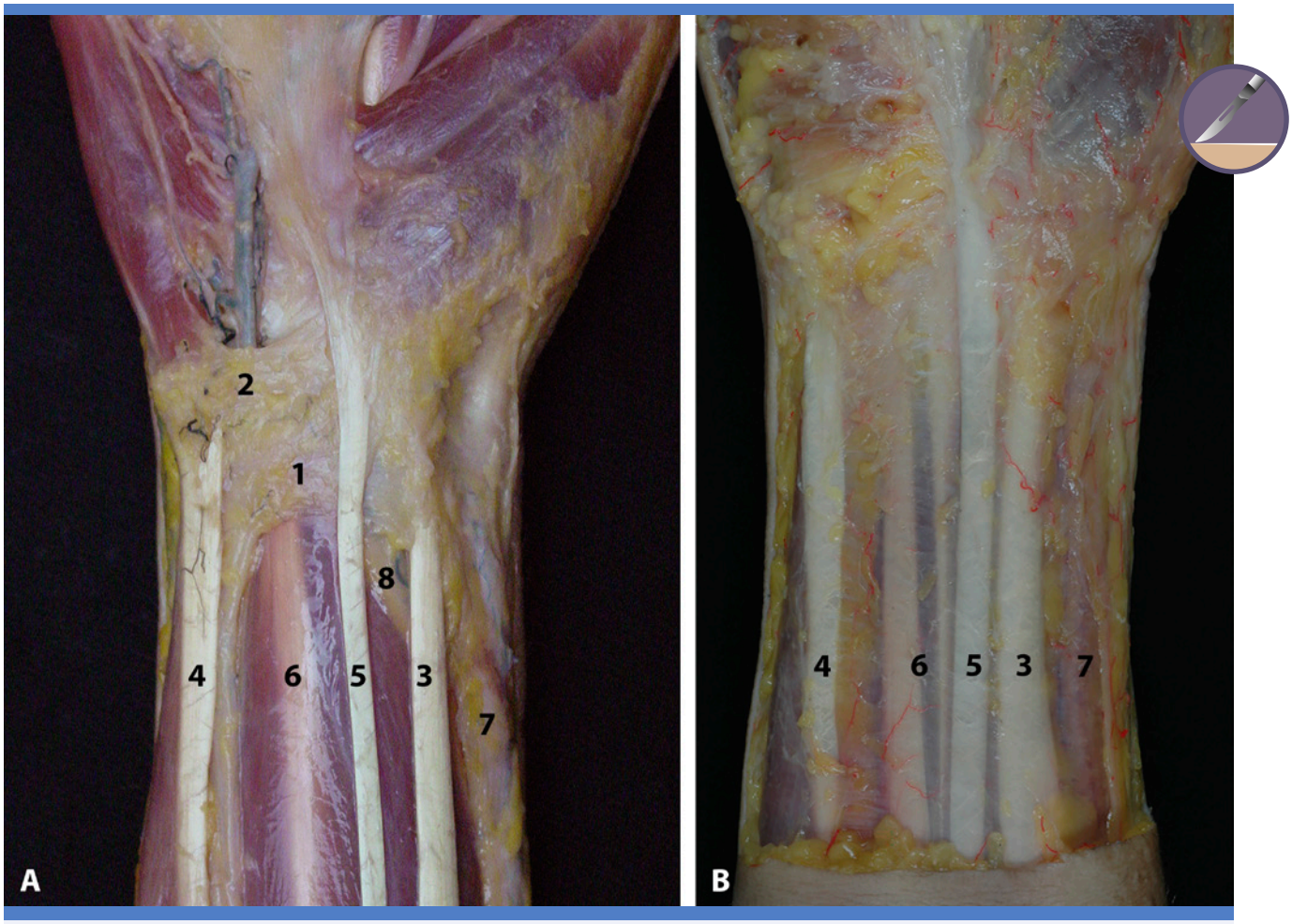


**Figure 1-3.** **A** Prosection showing the anterior annular ligament of the wrist (1), Guyon's canal (2), and the disposition of the tendinomuscular and neurovascular elements of the wrist. **B** Superficial aponeurosis of the hand. Avoid deepening the dissection before exposing the palmar region of the hand. *Flexor carpi radialis* (3), *flexor carpi ulnaris* (4), *palmaris longus* (5), tendons of the *flexor digitorum superficialis* of the index and middle fingers (6), radial artery (7), and median nerve (8).

the aponeurosis. This allows visualization of the neurovascular structures preventing injury. These structures are medially: the ulnar neurovascular bundle and digital branches of the fifth finger, and laterally: the palmar and thenar branch of the median nerve, next to the digital branches of the thumb, and the radial collateral nerve of the index finger at the level of the first commissure. Distally, it is possible to observe the distal division of the common digital vessels and nerves into proper digital nerves in the interdigital spaces, wrapped in rich adipose tissue. This part of the dissection can be done with thin scissors to section the small fibrous tracts that intimately join the aponeurosis with the deep layer of the dermis. At the same time, make the dissection with the tip of the scissors following the longitudinal direction of the neurovascular structures mentioned (Fig. 1-4B). Of course, all surgical incisions addressing this area should take into account the presence of these superficial neurovascular structures. This is a good time to evaluate the different types of surgical approaches to the palm.


**Figure 1-4.** **A** Anterior subcutaneous region of the hand. Heterogeneous distribution of adipose tissue (see text). **B** Adipose pads cover the division of the common palmar digital vessels and nerves at a distal level. Risk of lesion.

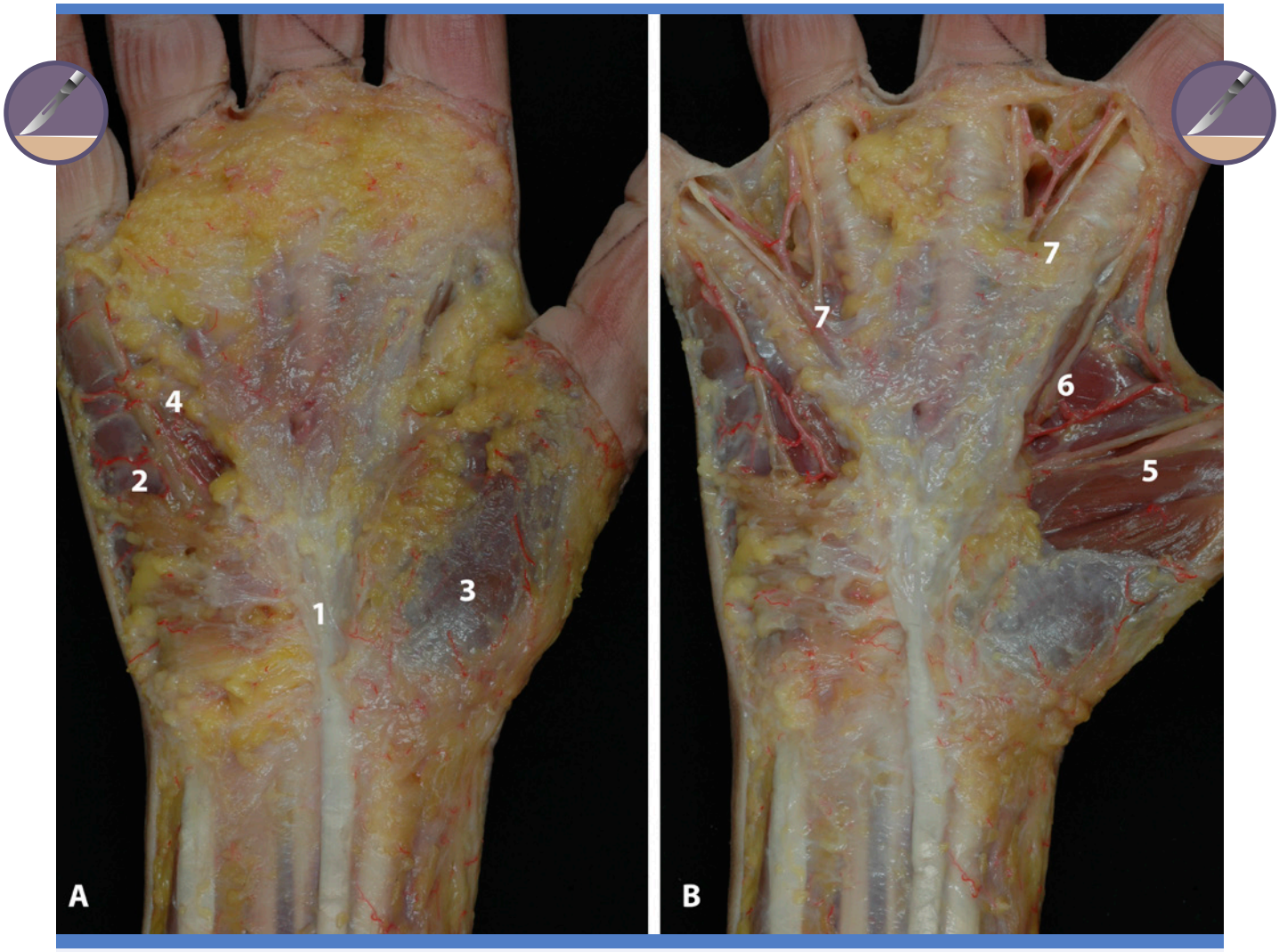


**Figure 1-5.** Superficial plane of the hand. **A** Palmar aponeurosis (1), hypothenar (2), and thenar muscles (3). Identification and dissection of the superficial neurovascular elements, especially the nerve and the palmar digital ulnar artery of the little finger (4). **B** Partial resection of the thenar and hypothenar aponeurosis showing the most exposed superficial neurovascular elements, especially at the level of the first commissure. Proper palmar digital nerves of the thumb (5), radial palmar digital nerve of the index finger (6), divisions of the common palmar digital vessels and nerves into proper digital vessels and nerves in the interdigital spaces (7).

Once all the superficial neurovascular elements have been identified and preserved, the fat tissue around them can be resected to better expose their path and disposition. In the proximomedial area, the *palmaris brevis* muscle can be identified, distal to the Guyon's canal, partially covering the ulnar neurovascular elements and the hypothenar aponeurosis. The *palmaris brevis* muscle originates at the medial edge of the palmar fascia and extends transversely where it inserts into the deep layer of the dermis of the most medial hypothenar area. The Guyon's

canal must be dissected at a more advanced stage of dissection in order to visualize the division in and follow the path of the ulnar vessels and nerve (Fig. 1-5A).

## Superficial palmar fascia of the hand (thenar, hypothenar, and palmar fascia) and anatomical components (pretendinous fibers and transverse fibers); interdigital spaces

At this stage of the dissection, the thenar, hypothenar, and palmar fascia can be fully identified and delimited, with the latter distally showing its pretendinous longitudinal and transverse fibers.

The thenar and hypothenar aponeurosis can be partially removed to expose the muscles contained in each compartment (Fig. 1-5B).

In the thenar region, special attention must be paid to the identification of the recurrent or motor branch of the median nerve (thenar branch) at the intersection of the Kaplan cardinal line (oblique line in the palm of the hand) with the thumb in anatomical position going from the metacarpophalangeal joint of the thumb at the level of the first commissure until the uncinate process of the hamate (*os hamatum*) with a longitudinal line extending proximally from the second digital space (Fig. 1-6). From this point the thenar branch arises laterally to the outer edge of the palmar aponeurosis. Following this outer edge, distally, the thumb's proper digital nerves and the palmar digital nerve of the index finger can be found in the dihedral angle formed between the thenar musculature and the middle palmar fascia (Figs. 1-6, 1-7).

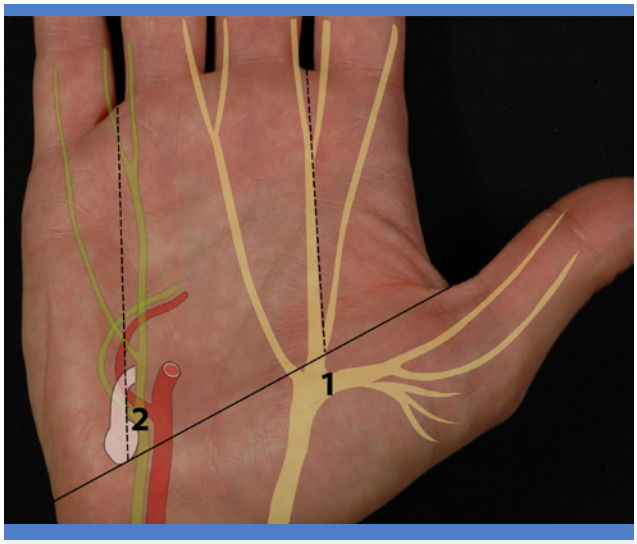


**Figure 1-6.** Kaplan's cardinal line. Localization on the surface of the thenar motor branch of the median nerve (1) and the motor branch of the ulnar nerve (2).

In the hypothenar region, the superficial aponeurosis can be removed while being careful not to injure the ulnar digital vessels and nerves of the little finger that remain inside the edge of the palmar aponeurosis. On the surface, the point of convergence of the line that extends proximally from the fourth commissure with the Kaplan line, located close to the unciform process or hook of hamate, is used as a reference for identification (Fig. 1-6). In the most proximal part, the *palmaris brevis* muscle can be preserved with its insertion in the palmar fascia (Fig. 1-7).

The palmar fascia has a triangular shape extending from the middle area of the hand, as a continuation of the *palmaris longus* tendon, if present, to the base of the fingers where it intertwines with the fibers of the superficial transverse metacarpal ligament (natatory ligament) and continues with the fibrous digital sheath. Pretendinous longitudinal fibers can be seen parallel to the underlying flexor tendons of the index to little fingers and occasionally in the thumb, and deeper transverse fibers can be seen at the level of the middle and distal thirds of the palm, proximal to the metacarpophalangeal joints, which extend from the little finger to the index