Palpation of the lateral bands of the extensor apparatus of the fingers. Anatomy of a neglected clinical finding

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Abstract

This study aimed to determine by ultrasonography, and cadaveric dissection, whether the firm cords felt by palpation at the sides of the proximal phalanx (PP), actively flexing and extending the proximal interphalangeal (PIP) joint while keeping the metacarpophalangeal (MCP) joint extended, are the lateral bands (LBs) of the extensor apparatus. If so, palpation of the LBs could help evaluate hand conditions that impact the digits' intrinsic muscles. To this end, the PP of the middle and ring fingers of the dominant hand of seven subjects were studied by palpation on both sides. Ultrasonography (US) was performed with a hockey-stick transducer placed on the ulnar side. Five cadaveric hands were dissected, exposing the dorsal extensor apparatus. On palpation, a firm cord was consistently felt at the PP's sides in all subjects. These cords moved widely forward on PIP flexion and dorsally with PIP extension. By US scanning, the cords corresponded to the LBs. However, the forward movement had only a median of 1.8mm (range 0.7-3mm) in the middle finger and a median of 1.1mm (range 0.3-2.7mm) in the ring finger compared with an estimated 5-10mm upon palpation. Cadaveric dissection confirmed the forward movement of the LBs in PIP flexion. We concluded that the firm cords felt at the PP sides are the LBs of the extensor apparatus. We confirmed their movement with the active flexion/extension of the PIP joint. Comparing the wide palpatory and the meager US motion, a haptic illusion of motion may be present.

Keywords

Extensor apparatus, lateral bands, dorsal aponeurosis, metacarpophalangeal joint, proximal interphalangeal joint, physical examination

1. INTRODUCTION

A dorsal view of the extensor apparatus, or extensor hood, of the digits was accurately depicted by Albinus (Albini 1734). More pertinent to the present study, a side view by Weitbrecht (1742) ingeniously showed the dorsal interosseous (DI) of the right ring finger, from proximal to distal, as it approached the proximal phalanx (PP) and the dorsal aponeurosis (DA). Poirier and Charpy (1911a and b) and Landsmeer (1949) accurately depicted both views. Because the extensor apparatus on the PP is laminar and convex, its complexity shows better if drawn on a plane or removed and spread on a surface (Poirier and Charpy 1911a, Landsmeer 1949, Clavero et al., 2003). When viewed flat on a surface, the proximal extensor apparatus forms an isosceles triangle bisected by the extensor digitorum (ED) with a proximal short edge and two long lateral edges. An interosseous tendon -dorsal (DI) or palmar (PI) depending on the digit- runs at either edge and in the radial side is joined by a lumbrical (L) (Eladoumikdachi et al., 2002a and b). Hunter, anatomically, and Duchenne de Boulogne, based on clinical and electrical analysis of nerve palsies, correctly attributed to the oblique course of the DI, PI, and L tendons on the PP, a flexor action on the MCP joint, and an extensor action on the proximal (PIP) and distal (DIP) interphalangeal joints (Hunter, 1797; Duchenne de Boulogne, 1861). These oblique tendinous formations at the PP sides are the lateral bands (LBs) (Wang et al., 2014; Standring and Gray, 2016). Lockhart showed the subcutaneous edge of the left middle finger's radial DI (Lockhart, 1948).

On self-examination (Canoso et al., 2020), keeping the digit extended, the LBs are inconspicuous. However, by actively flexing and extending the PIP joint while the MCP joint is in extension, two striking cords, one radial and one ulnar, become apparent and move forward with PIP flexion and dorsally in extension at each side of the PP. These cords were assumed to be the LBs (Vargas et al., 2012; Canoso et al., 2020). However, proof of their anatomical identity was lacking. Recently, ultrasound (US) provided additional information on the extensor apparatus's anatomy (De Maeseneer et al., 2020). The purpose of the current investigation was

to determine, based on clinical examination, US, and dissection, whether these firm, shifting structures at the sides of the PPs indeed correspond to the LBs. Their study might yield useful clinical information in congenital, orthopedic, rheumatologic, and neurologic diseases affecting the hand.

2. METHODS

2.1 The studied hands

The Committee on Ethics in Research, Fundación Jiménez Díaz, approved the clinical and US studies on February 6, 2020, PICO20-20_FJD_ESP. The seven participants provided written informed consent. The anatomical study was performed in accordance with the Declaration of Helsinki. The corps belonged to the Center of Donation of Corps of the Complutense University of Madrid and were obtained following the donation's legal procedures. We studied the dominant hand -six right and one left- of seven participants without a history of hand trauma, arthritis, or neurologic disease. The study subjects included five women and two men, in the 23 to 55 age range, and body mass index ranging from 18.0 to 23.1. Criteria for hand normality included an expected appearance on inspection and the ability to perform exercises demonstrated by one of us with 46 years of experience (JJC) and repeated by the volunteers. The examiner assessed the subjects' extensor and flexor tendons by asking them to open the hand fully and then making a fist. The dorsal and palmar interossei, lumbricals, thenar, and hypothenar muscles were evaluated by (a) opening the hand fully, spreading the fingers apart and then bringing them together, (b) flexing de digits (index to little fingers) 90º at the MCP while keeping the PIP and DIP in extension, and (c) touching with the tip of the thumb each of the fingertips opening the hand fully before moving to the next finger. This assessment took less than two minutes.

2.2 Finger palpation

The examiner placed his thumb and index finger at the midpoint of the sides of the PP of the middle and ring fingers. Keeping the MCP joint extended (0^o flexion), the subject was asked to flex and extend the PIP joint actively

2.3 Ultrasound scanning

Two experts, with 25 and 5 years of experience (EN, LM-E) performed the ultrasound (US) scanning with a real-time scanner (LOGIQ E9, GE Medical Systems Ultrasound and Primary Care Diagnostics, LLC, Wauwatosa, WI, USA) equipped with a multifrequency linear hockey-stick transducer (L8–18 MHz). B-mode settings were standardized for the whole study: B-mode: frequency 18 MHz; B-mode gain 50 dB, and dynamic range 63 dB. The subjects were seated in front of the examiner with the dominant hand pronated, the forearm resting on a small table, and the MCPs extended at 0^o.

The examiners placed the probe transversely to the midpoint of the ulnar side of the PP of the ring and middle fingers of each subject (Fig 1A and B). The PIP joint was actively flexed and extended to identify the LB, which was a flat, ellipse-shaped fibrillar hyperechoic structure on the ulnar aspect of the PP (Fig 2A and B). The distance between the midpoint of the deep aspect of the lateral band and the midpoint of the bone profile of the PP's ulnar aspect was measured using a distance measurement software of the US machine (Fig 2A and B) for both fingers of each individual.

2.4 Cadaveric dissection

The embalmed cadaveric hands included in this investigation (three rights and two left, from two males and one female, aged between 60 and 85 years) were free from conspicuous musculoskeletal disease. The hands were dissected to identify the extensor apparatus of the fingers. The middle finger was splinted with the MCP extended (0^o flexion), and the ring and little fingers were flexed by traction (Fig. 3A). The middle finger's ulnar side was photographed with the PIP extended and then flexed 90^o (Figs. 3B and C).

2.5 Statistical analysis

The data were presented with descriptive statistics.

3. RESULTS

3.1. Palpation. In the explored fingers of all seven subjects, keeping the MCP extended (0^o flexion) upon active flexion of the PIP joint, a firm cord became palpable at either side of the PP. These cords moved widely forward with PIP flexion and dorsally with PIP extension with an estimated 5 to 10mm span.

3.2. Ultrasound scanning. The US study on the ulnar side of the middle and ring fingers' PP showed that the cord corresponded to the ulnar LB. However, in contrast with the palpation, the palmaward displacement of the LBs measuring from the PP's mid-point, in the middle finger, keeping the MCP extended (0^o flexion), only had a median of 1.8mm (range 0.7-3mm) when the subjects flexed the PIP 90^o. In the ring finger, the LB moved forward a median of 1.1mm (range 0.3-2.7mm) with flexion of the PIP (Figs 2A and B, Table 1). Thus, the movement of the LBs was far less, as assessed by the US, than the action suggested by palpation.

3.3 Cadaveric dissection. The dissection of the fingers' extensor apparatus confirmed that the firm cord noted by palpation and the US findings at the sides of the PP corresponded to the LBs. The dissection also showed that the PIP's passive motions also caused a palmward and dorsal displacement of the LB. The embalmed nature of the specimens precluded an accurate measurement of this motion.

4. DISCUSSION

There were three main findings in this study. The first was the tightness of the LBs when, while keeping the MCPs in extension, the participants actively flexed the PIP; the pre-tension of the LBs caused by the former was necessarily augmented by the latter. The second finding was the forward displacement of the LBs

concurrent with the PIP flexion. In PIP flexion, the base of the middle phalanx becomes palmar to the head of the PP. This movement causes a forward sliding of the radial and ulnar lateral slips of the extensor tendon. Because the PP head becomes wider from dorsal to palmar (Harris Jr and Rutledge, 1972), this added width, via the lateral slips, adds tension to the LBs. The tension changes between the central slip and the lateral bands vary as the finger goes from extension to flexion (Standring and Gray, 2016). However, we have been unable to find in the clinical literature, orthopedic or other, mention this displacement, thus missing its possible clinical implications. Because -it would be irrelevant to the physical finding under investigation, MCP flexion was not part of this study. However, MCP flexion also results in a palmar displacement of the LBs because the DA moves distally and falls from the wider metacarpal head onto the thinner PP (Gausepohl et al., 1998). The third finding of interest was the meager forward displacement of the LB by US compared with palpation. This difference could result from a haptic illusion of movement (Hoffmann et al., 2019). Because active MCP extension tenses the ET and PIP flexion tenses the LBs, being both structures linked by the DA, palpation during repeated PIP flexion and extension may create an illusion of displacement as the tensile load sequentially shifts from dorsal to palmar and vice versa. A somewhat similar phenomenon is the apparent sliding of the iliotibial tract (ITT) on the lateral femoral epicondyle during flexion and extension of the knee. The created visual illusion (Fairclough et al., 2006) occurs because in knee extension, the anterior fibers of the ITT tense up, and in knee flexion, its posterior fibers tense up.

We studied the dominant hand's middle and ring fingers because, based on many MSK clinical seminars held by the authors, these are the fingers where the LBs are usually most prominent. Also, the authors' impression that some of the LB are barely felt in some fingers. These include the index' radial and the little finger's ulnar. There are individuals with very prominent LBs, while in others, they are inconspicuous. Finally, the LBs in the non-dominant hand tend to be thinner than on the dominant side. These informal clinical observations, which to the best of our

knowledge have not been made by others, albeit consistent, require validation in larger prospective studies.

The current study's limitations include a small number of observations, only the middle and ring fingers were assessed, the palpatory findings were not measured, the dominant and the non-dominant hand were not compared, only adults were examined, and the dissected hands were embalmed, which precluded an accurate measurement of the LBs displacement. Larger, well-designed clinical, US, and anatomical studies of the LBs of the digits' extensor apparatus would have been definitory. However, based on our small samples consistent with our clinical observations, we have identified a striking, albeit neglected, physical finding with potential clinical applications. Furthermore, we have likely identified a novel haptic illusion of motion.

In conclusion, we confirmed that the cords palpable at the sides of the PP during PIP flexion and extension, keeping the MCPs extended, are the LBs of the extensor apparatus. The difference between the striking palpatory and the meager US findings may represent a haptic illusion of motion. The clinical assessment of the LBs may help evaluate patients with intrinsic muscles hyperactivity or palsy, such as the striatal hand of Parkinson's disease, the Trousseau sign of tetany, early swan-neck deformity in rheumatoid arthritis, and early ulnar palsy.

Conflict of Interest

The authors declare no conflict of interest.

Author contributions

JJC, EN, JRMV, JMG, and VP-R were involved in the study's conceptualization and design. JJC, EN, LM-E, JMG collected the data. EN and VP-R prepared data and performed analysis. JJC. drafted the manuscript, which was co-edited by all authors

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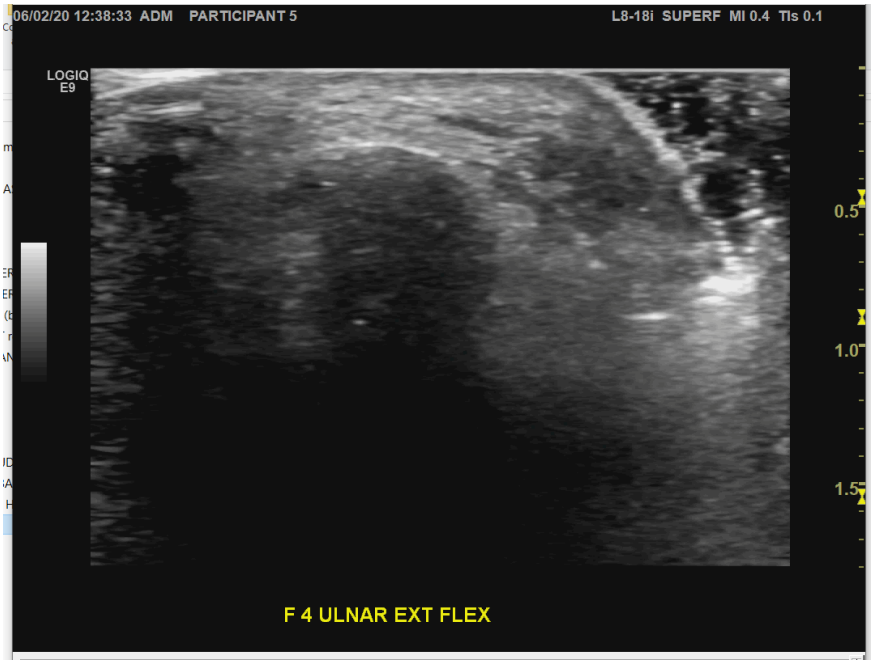
SUPPLEMENTARY MATERIALS

Ultrasound Videoclip: The ulnar lateral band of the extensor mechanism, ring finger, during active flexion of the PIP joint. When the PIP joint flexes 90º, the lateral band (top) moves palmward (right side of the ultrasound image) on the PP's ulnar aspect.



TABLES

Table 1.

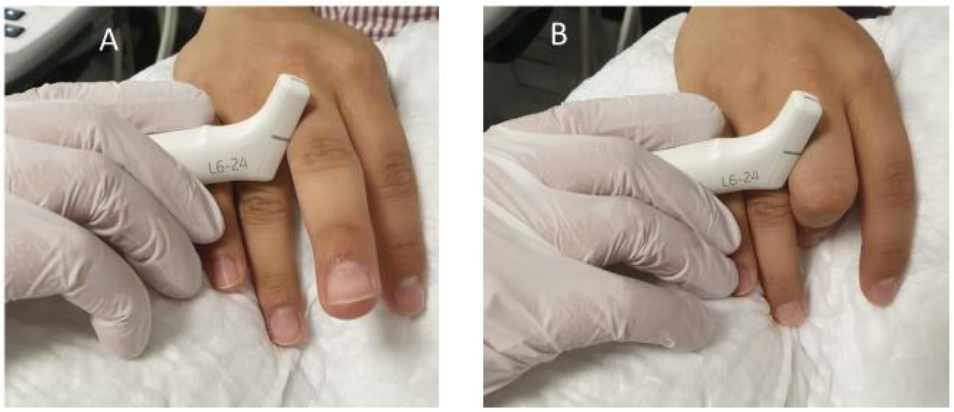
Palmar movement of the ulnar lateral band (LB) by flexing the proximal interphalangeal (PIP) joint while keeping the metacarpophalangeal joint extended (0^o flexion)

	Middle finger			Ring finger		
Subject number	PIP 0^o flexion*	PIP 90^o flexion*	Movement of LB	PIP 0^o flexion*	PIP 90^o flexion*	Movement of LB
1	0.9	3.9	3.0	1.8	2.8	1.0
2	0.6	2.4	1.8	0.7	2.4	1.7
3	1.3	2.8	1.5	1.6	2.7	1.1
4	2.8	5.7	2.9	0.9	3.6	2.7
5	1.8	2.5	0.7	1.8	2.4	0.6
6	2.0	3.7	1.7	2.5	3.8	1.3
7	1.0	2.8	1.8	2.0	2.3	0.3

*The distance in mm between the midpoint of the deep aspect of the LB and the midpoint of the bone profile of the PP's ulnar aspect was measured employing a distance measurement software of the US machine

FIGURE LEGENDS

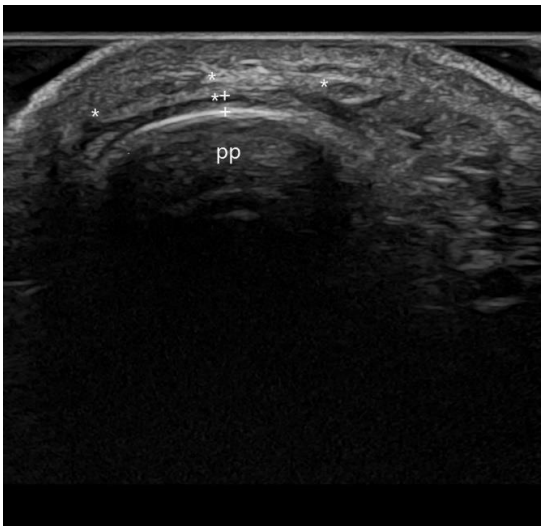
Figure 1 A and B.



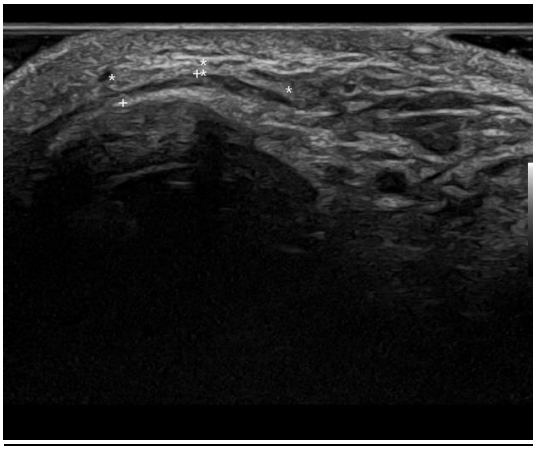
Placement of the US probe. The US probe was placed transversely to the midpoint of the middle and ring fingers' PP. The MCP joint was extended (0^o flexion). The PIP joint was actively extended (A) and flexed 90^o (B) to identify the LB.

Figure 2 A and B

A

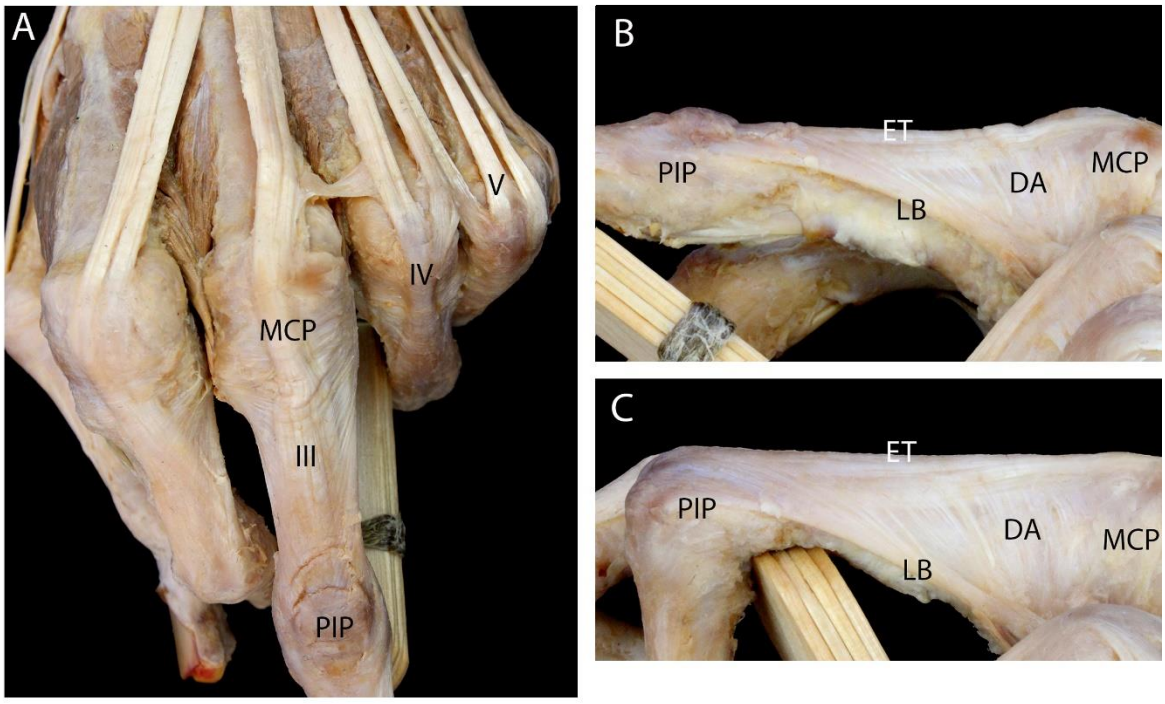


B



Palmar displacement of the LB with PIP flexion. The middle finger, proximal phalanx (pp), ulnar side. A. MCP joint in extension (0^o flexion), PIP in extension (0^o degree flexion). The lateral band appears as a flat, ellipse-shaped fibrillar hyperechoic structure between asterisks (*). The mid-point of the pp and the mid-point of the LB's underside are marked as (+). B. MCP, in extension, PIP at 90^o degrees flexion. The LB (between asterisks) is partially displaced towards the pp's palmar aspect (right side of the ultrasound image).

Figure 3 A, B, and C

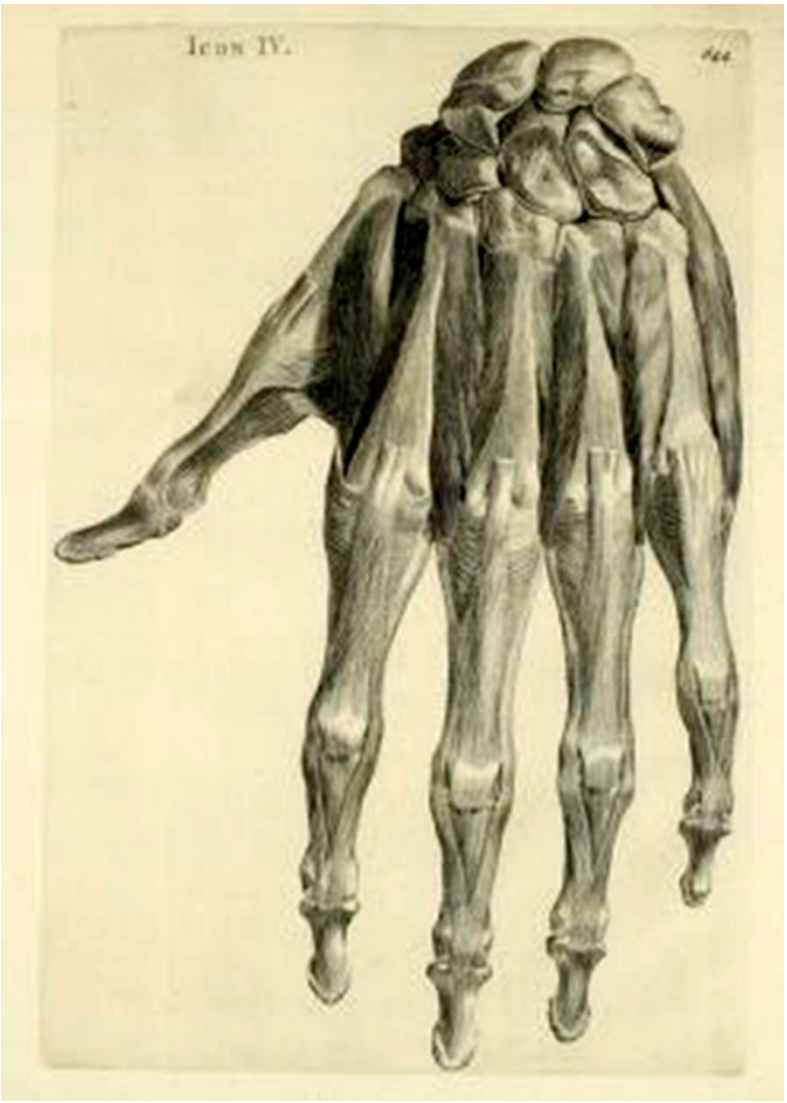


Effect of PIP flexion on the LB. A. Dorsal view of the extensor apparatus left middle finger. Metacarpophalangeal (MCP) joint and proximal interphalangeal (PIP) joints extended (0^o flexion). B. Ulnar view, MCP and PIP in extension. The extensor tendon (ET) is at the top, the MCP joint is to the right, the PIP is to the left, and the lateral band (LB) is at the lower edge of the extensor apparatus extending diagonally from dorsal at the PIP, to near palmar at the MCP. The dorsal aponeurosis (DA) is the collagenous layer that fills the space between the ET and the LB. C. PIP flexed 90^o. The LB has moved forward.

SUPPLEMENTARY FIGURES

Figure 4, panels A and B

A. The extensor apparatus of the digits, according to Albinus, 1734, dorsal view



B. The extensor apparatus of the digits, according to Weitbrecht (1742). Lower panel. The dorsal interosseous of the right ring finger is depicted, from proximal to distal, as it approaches the proximal phalanx

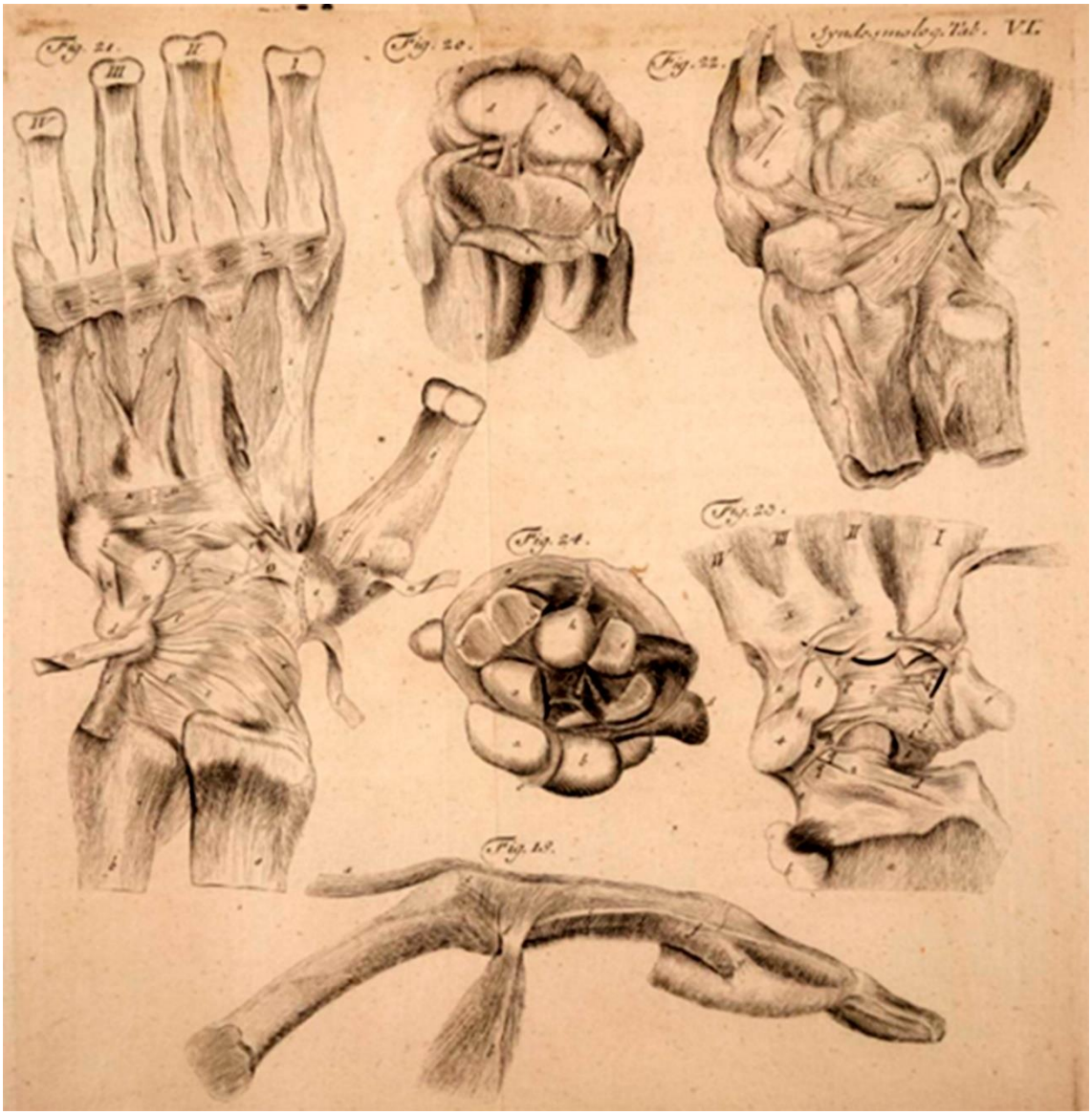


Figure 5, panels A, B, and C.

The extensor apparatus according to Poirier and Charpy (1911). A. Dorsal view, deep plane. According to subsequent authors, a slip to the proximal phalanx is minimal or not present. B. Dorsal view, superficial plane. C. Lateral view.

A

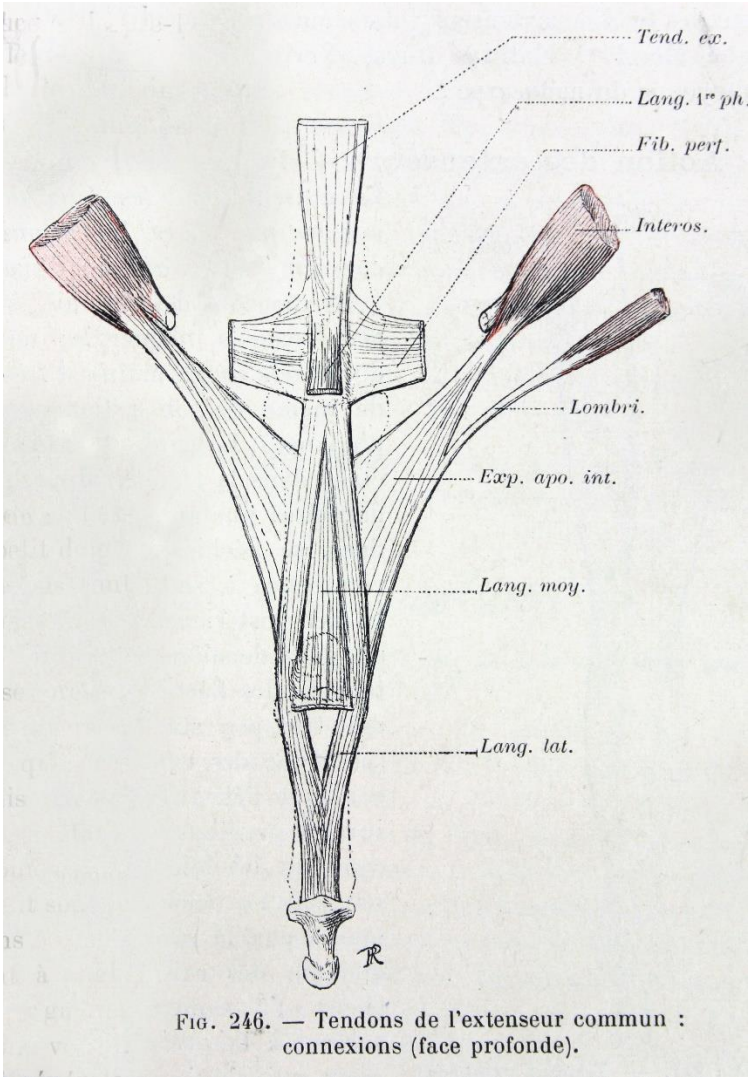


Fig. 246. — Tendons de l'extenseur commun : connexions (face profonde).

B

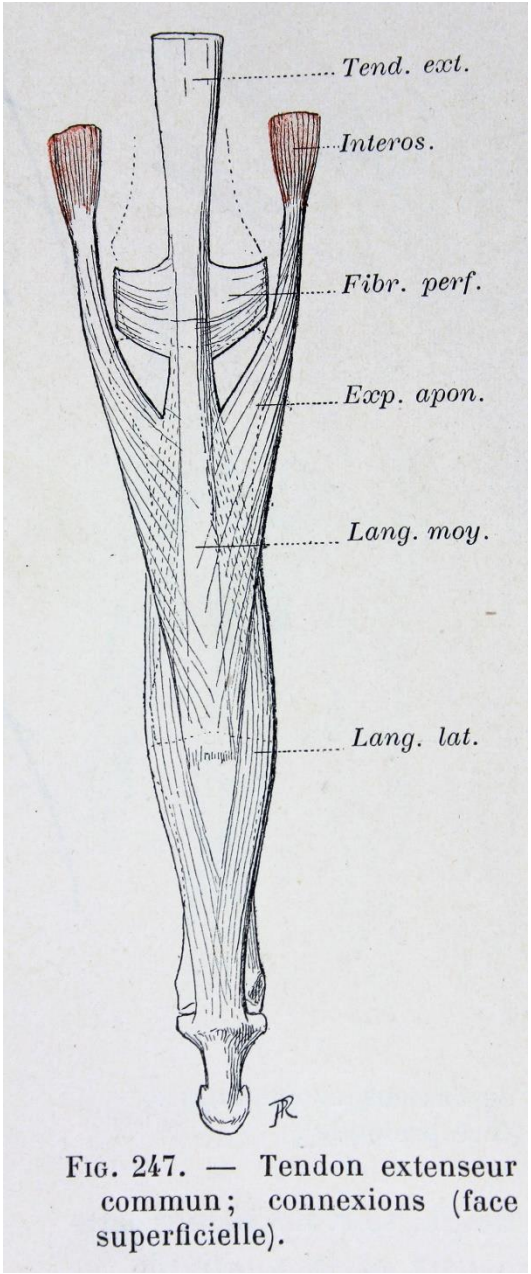


FIG. 247. — Tendon extenseur commun; connexions (face superficielle).

C

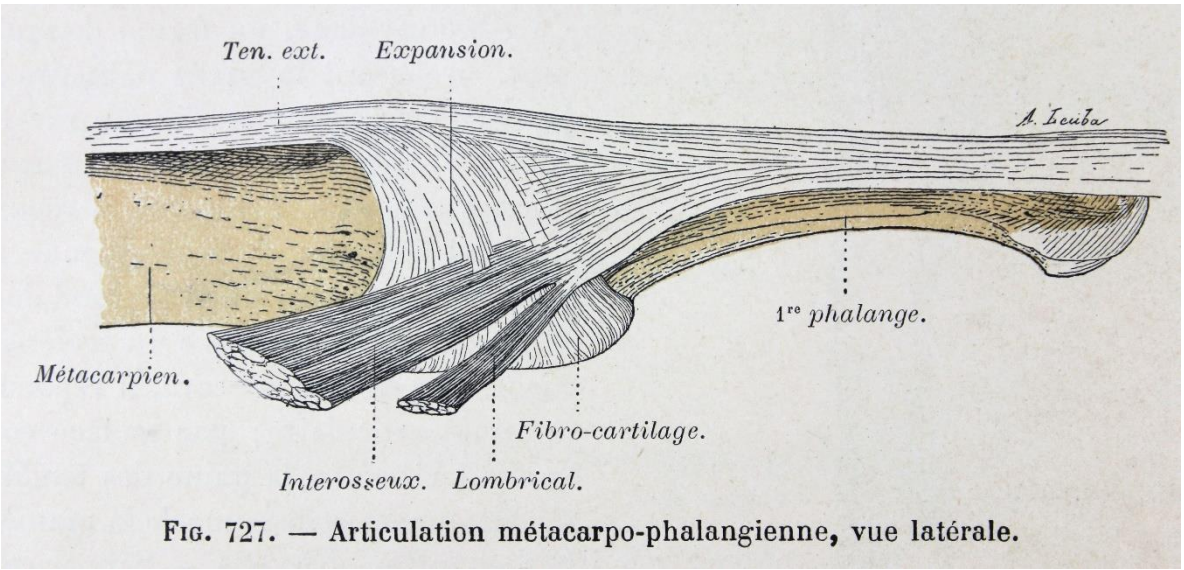


FIG. 727. — Articulation métacarpo-phalangienne, vue latérale.