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The Rare Extensor Digitorum Brevis Manus: an Anatomical Study in Brazilian Cadavers

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ABSTRACT

Introduction: the extensor digitorum brevis manus (EDBM) is a rare supernumerary muscle variation of great medical interest regarding differential diagnosis. This structure is an evolutionary evidence, supposedly atavistic, poorly understood.
Material and Methods: the present study carried out in the collections of the medical schools of two Brazilian universities, evaluated the occurrence of this muscle formation and described morphologically and morphometrically, three samples.
Results: two specimens were classified, according to the standardization proposal of Ogura *et al.*[1] as type III and the third specimen was an atypical finding - it did not fit this classification. The incidence was slightly higher than the average in the literature (3/60 - 5%).
Conclusion: thus, we understand that the extensor digitorum brevis manus muscle (EDBM) needs further investigations: first, to characterize it from a phylogenetic and ontogenetic point of view along with answers to developmental questions; moreover, to allow further anatomical elucidations for differential and surgical diagnosis purposes.
Keywords: extensor digitorum brevis manus; anatomic variations; dorsum of hand.

Introduction

Muscular variations are common and arouse strong anthropological and medical interests. They can be single or multiple and range from agenesis (partial or total) to variations related to accessory formations, supernumerary occurrences, fusions, tendinous pathways, anomalous contributions and deviations of positions. Furthermore, many variations are translated by insufficiencies, as atavistic, and most lack measurable biomechanical evidence[2,3,4,5,6,7,8].

The extensor digitorum brevis manus (EDBM) is one such rare muscle formation[1,2,8,9,10], supernumerary[11], nonspecific etiology[12,13,14] and comparable topographically to the extensor digitorum brevis muscle[13,14]. Furthermore, the EDBM is variable in shape, number, position and size and, by the volume generated on the dorsum of the hand, must be differentiated at diagnosis, from synovial cysts, lipomas, exostoses and tumors. Its mass effect, due to proximity to vessels and nerves, can, when hypertrophied, develop important symptomatic repercussions, mainly due to manual efforts[1,3,7,8,9,10,12,20].

Wood[15] described this muscle formation, with two or three heads, with the denomination "extensor digitorum brevis manus muscle", as a muscle distinct from the dorsal interosseous, and may originate (proximal insertion) from the dorsal interosseous muscles, the metacarpals, and the capitate and hamate bones. Moreover, it is inserted dorsally on the aponeurosis of one or more fingers. Also, Wood[15] reported other anatomists such as Bernhard Siegfried Albinus, German anatomist, who described these formations, for the first time, as a short extensor muscle of the index or middle finger (*Musclus extensor brevis digiti indicis vel medii*)[16]. But it was Macalister[17] who stablished the term "extensor digitorum brevis manus", seeking in his description a parallelism with the extensor brevis muscle of the foot. Ogura *et al.*[1] proposed a standardization based on a wide and careful dissection of 559 limbs, relating the EDBM to its insertion and to the extensor indicis muscle. Thus, in the so-called Type I by Ogura *et al.*[1], the EDBM is inserted in the index finger with absence of the extensor indicis muscle. As for Type II, the EDBM and

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the extensor indicis muscle are present. This type is subdivided into: Type IIa (rudiment of the extensor indicis muscle associated with the variant muscle), Type IIb (the terminal portion of the EDBM inserted together with the extensor indicis muscle) and Type IIc (membranous sliding of the EDBM inserted into the index finger, more medially).

In Type III, the EDBM is related to the middle finger, regardless of the occurrence of the extensor indicis muscle with or without accessory formations. In this study, two of the three findings, from the collections of the University of Uberaba and the Federal University of Juiz de Fora were classified as type III by Ogura *et al.*[1] However, the literature points to an occurrence of greater expressiveness for types I and II compared to type III[18].

Material and Methods

We studied 60 upper limbs of adult specimens preserved in 10% formaldehyde from the collections of the Federal University of Juiz de Fora (38/60) and the University of Uberaba (22/60). The morphological and morphometric analyses were performed by direct inspection, with ambient light and without the use of ampliation resources. The morphometric results, despite the fibroelastic contractions of the preserved tissues, were obtained using a digital pachymeter (Western Pro®), 0.1 mm resolution, a stainless steel millimeter ruler (Rhosse®) and a stainless steel dry point caliper (JON®). As inclusion criteria, the specimens had to be intact, without macroscopic evidence of lacerations and/or destruction by manipulations that could impair interpretation or lead to any morphological suspicions.

As these are descriptive analyses in cadavers under the care of the Laboratory, this work does not require the TCLE used in living humans, as it is supported in Brazil by the liberation for teaching and research through Law 8501/92 and Resolution 196/96 of the National Health Council, followed by Provimento/CG nº 16, of September 26, 1997.

Results

In the collection of the Federal University of Juiz de Fora among the thirty-eight upper limbs (21 from the right antimere and 17 from the left, being 15 pairs and 8 isolated), 13 belonged to the male gender and 2 to the female gender (from the even limbs). The incidence in the formation of the extensor digitorum brevis manus (EDBM) was 5.26% (2/38). These occurred in isolated specimens belonging to the left antimere (without identification as to sex) and previously dissected (table 1). The first variant formation (fig. 1) presented with a single muscular belly of 43.5 mm in total length and 09 mm in width (table 2). It originated from the base of the III metacarpal and capitate bone with an unusual insertion into the lining fascia of the II dorsal interosseous muscle and the dorsum of the II metacarpal which is not classifiable in the categories of Ogura *et al.*[1]. The second variant formation (fig. 2), also of a single muscle belly, showed 65 mm in total length and 10 mm in width (table 2) and a proximal insertion (origin) related, under the extensor retinaculum, to the distal extension of the tendon of the extensor carpi radialis brevis muscle and, in part, to the base of the III metacarpal and capitate bone. The distal insertion occurred at the lateral margin of the dorsal aponeurosis of the middle finger, from the metacarpophalangeal joint. We classified it, according to the criteria of Ogura *et al.*[1], as type III.

As for the University of Uberaba finding from 22 limbs (6 pairs and 10 isolated, being, of the pairs, 04 male and 02 female), an incidence for EDBM of 4.54% (1/22) was shown (table 01). This variant formation (fig. 3) showed two distinct muscle bellies (A and B). The muscle belly

Table 1. Extensor digitorum brevis manus muscle (EDBM). (1) Federal University of Juiz de Fora and (2) University of Uberaba.

Laboratory	Upper Limbs	Right Laterality	Left Laterality	Findings	Percentage
UFJF1	38	21	17	02	5,26%
UNIUBE2	22	10	12	01	4,54%
Total	60	31	29	03	5%

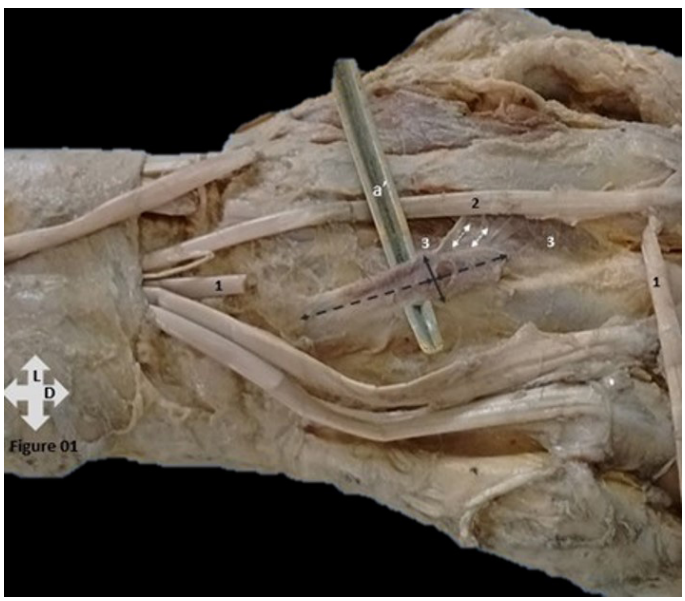

Figure 1. Extensor digitorum brevis manus (EDBM) highlighted on the fluted probe (a'); black dotted arrows: length of EDBM; black continuous arrow: width of EDBM; white continuous arrows: fascial connection of EDBM on the II dorsal interosseous muscle (3); 1: tendon of extensor indicis muscle; 2: extensor digitorum communis muscle; L: lateral and D: distal.

Table 2. Anthropometric information of muscles 1, 2 and 3 (ventre A and ventre B).

EDBM	Length	Width
Muscle 01	43,5mm	9mm
Muscle 02	65mm	10mm
Muscle 03 (ventre A)	65mm	6mm
Muscle 03 (ventre B)	64mm	6mm

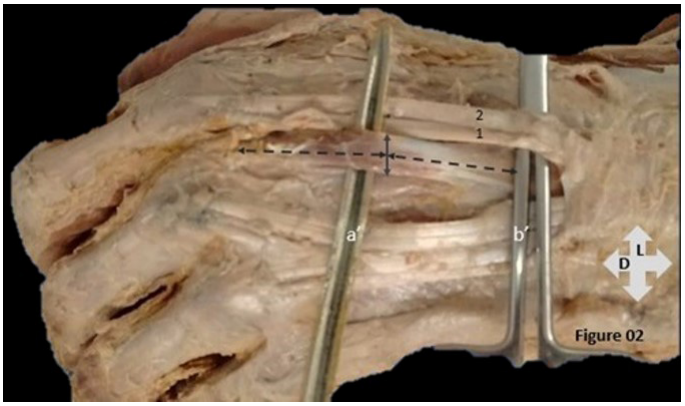

Figure 2. Extensor digitorum brevis manus (EDBM) highlighted on the fluted probe (a'); black dotted arrows: length of EDBM; black continuous arrow: width of EDBM; 1: tendon of extensor indicis muscle; 2: extensor digitorum communis muscle, both muscles 1 and 2 superimposed on the instrumental (b'); L: lateral and D: distal.

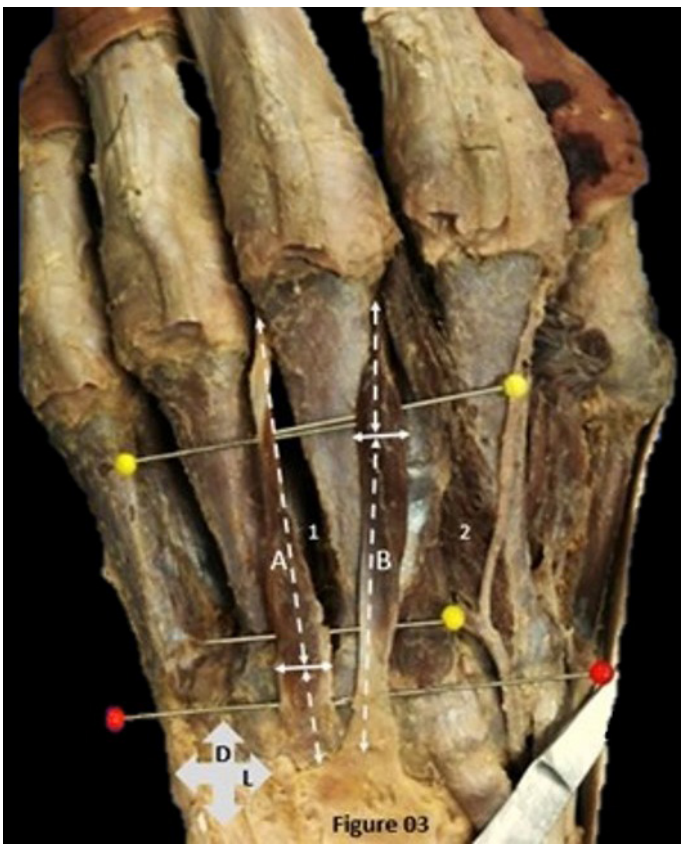

Figure 3. A and B - muscular ventres of the "extensor digitorum brevis manus" (EDBM). Colored pins positioned under the muscle ventres of the EDBM to evidence them; white dotted arrows: length of muscle bellies A and B; white continuous arrows: widths of muscle bellies A and B of the EDBM; 1: III dorsal interosseous muscle; 2: II dorsal interosseous muscle; L: lateral and D: distal.

'A' (6 mm maximum width and 65 mm total length) (table 02) followed from the capitate and hamate bones, with obliquity to the third metacarpal, crossing it from the medial and superficial aspect of its base (origin) to insert, laterally, into the dorsal aponeurosis at the level of the head of the III metacarpal. Belly 'B' (6 mm of maximum width and 64 mm of total length) emerged medially to belly 'A' without connection between both, with its origin related to the hamate bone, base of the IV metacarpal and attached ligaments, and inserted into the dorsal aponeurosis of the III finger, medially, at the level of the metacarpophalangeal joint. Both formations were classified as Type III according to Ogura *et al.*[1].

Discussion

Albini is recognized for being the first anatomist to describe and illustrate the "*Musclus extensor brevis digiti indicis vel medii*"[15,16]. But it was Macalister who named it, in the way it follows to the present day, the "extensor digitorum brevis manus muscle of the fingers"[17]. Le Double[13], made a fruitful revision of this historiography, compiling, from renowned anatomists, the old denominations for the EDBM: "anomalous brevis muscle of the indicator", "anomalous brevis extensor muscle of the middle finger", "supernumerary muscle of the fingers", "Supernumerary dorsal interosseous muscle of the hand", "extensor brevis muscle of the fingers", "biceps muscle of the index finger" and "fascicle of reinforcement of the extensor muscle proper of the index finger".

Le Double himself suggested the term manioso (Manieux)[13]. Tan *et al.*[8], from a review of common variations of the extensor muscles of the forearm and hand with high biological and medical significance. These listed the extensor muscle of the index finger (or the index proper finger), the extensor digitorum Brevis muscle of the fingers (EDBM), extensor middle proprius and the proprius and extensor indicis et medii communis. Lakshmi & Michael[19], in 80 upper limb dissections for variations of the deep extensor group of the forearm, noted, substantiating the findings of Tan *et al.*[8], the same muscle formations and with the lowest of incidences for the EDBM at 2.5%. Cauldwell *et al.*[2], also considered, in their extensive work of dissections in 263 specimens, among numerous variations, the rare EDBM. Gonzalez & Netscher[14], indicate that EDBM is a muscle variant of the dorsum of the hand, possessing a slight male predominance and with an incidence around 2 to 3 % in populations. Jacobina *et al.*[5], in a study of 86 cadavers (172 hands) identified EDBM in only 1.15% of individuals (1 cadaver with bilateral occurrence). Similarly, Gama[20], with 3404 patients, reported 38 findings of EDBM (1.1%). Ogura *et al.*[1], in an extensive work of dissections, report an occurrence of 3% for EDBM from a universe of 559 dissected limbs with statistical irrelevance as to sex. This result is very close to that of L Amar Singh *et al.*[11], where they noted 3.1% occurrences in dissections of 32 upper limbs. Desai *et al.*[9], from 64 dissected hands, obtained 3 specimens with the EDBM variant (4.68%) and in a study with 140 cadavers and 263 upper limbs by Cauldwell *et al.*[2], reports 15.6% multiple muscle variations in dissected limbs and only 1.14% (in 3 limbs) for EDBM.

Results of a meta-analysis conducted by Yammine[18], which pooled a large number of representative publications, totaling 1867 cadavers and 5989 hands in

the study, indicated an overall average incidence of this muscle variant in 4% of dissected cadavers and 2.5% of dissected hands, with no predominances for gender, laterality, and ancestry. However, according to the author, as a limitation of the work, the largest sample studies came from the Japanese population, which may, in the future, with studies that achieve a larger sampling of the various human ethnicities, confirm or refute the ancestry results. As for the embryological aspect of the EDBM, Souter[21], and Dunn & Evarts[3] described that of the three precursor masses of the forearm extensor content (the radial, superficial and deep), the deep one, related to the abductor pollicis longus, extensor pollicis brevis, extensor pollicis long and extensor indicis, is the one with the greatest instability of phylogenetic order, which would even cause evolutionary changes in different primates. Cauldwell *et al.*[2], described that in the deep forearm of primates, in a lower phylogenetic position, there is a greater muscle segmentation for each finger.

In amphibians, fingers are controlled only by intrinsic muscles, and these muscles originate from the carpus and metacarpal, much like the extensor digitorum brevis manus muscle in humans[2,9,3,12,21]. Thus, when comparing animals of lower phylogenetic order, such as amphibians, the evidence points to individual finger control. This role, in theory, is played in humans by the variant muscle - EDBM. Moreover, another accepted theory is that the EDBM is a variant derived from the dorsal interosseous muscles[3], a view contested by Ogura *et al.*[1] who defend the EDBM as being of radial origin (antebrachial) and, therefore, has a connection with the extensor muscle of the index finger, substantiated by the innervation and vascularization - posterior interosseous nerve and anterior interosseous artery (dorsal branch). In addition, Ogura *et al.*[1] noticed a dependency relationship between the EDBM and the extensor indicis muscle, as the absence of the extensor indicis muscle (agenesis) led to the occurrence of the EDBM in 50% of their findings, as a compensation mechanism, considering the greater specialization of the index finger in the human species.

EDBM should be considered in the differential diagnosis of soft tissue and bone pathologies, such as tumor formations, exostoses, lipomas, cystic formations, in addition to diffuse painful sensations and edematous formations associated or not with the fourth compartment syndrome[3,5,8,9,10,12,18,20]. Ancillary means, on the other hand, have proven effective and necessary in the differential diagnosis and should be considered, such as MRI (magnetic resonance imaging)[10,7]. Gonzalez & Netscher[14], report the most common EDBM origin associated with the scaphoid, semilunar or metacarpal bones with insertions on the ulnar or medial side of the extensor indicis muscle and sometimes replacing the extensor indicis muscle.

There was a result similar to the findings of this article, in which we noted the origins or proximal insertions related to the capitate, hamate and metacarpal bones, and one of the origins related in part to the tendon of the extensor carpi radialis brevis muscle. Dunn & Evarts[3], relate these formations to the pyramidal, semilunar, and hamate bones and associated ligaments. Desai *et al.*[9], related their findings to carpal bones, capsules and ligaments. Jacobina *et al.* 2007 associate carpal origin at the level of the capitate bone. Ogura *et al.* 1987, however, verified, macro- and microscopically, in all 17 specimens reported, as to the origins of the EDBM, the dorsal radiocarpal ligament, the distal portion of the radius, and the proximity to the distal ulna line through connective tissue, and there was no origin linked to the carpal bones. Furthermore, the authors asserted, according to their findings, that (I) the origin of the EDBM from the radius bone suggests a derivation from extrinsic muscles, (II) the insertion variations of the EDBM are similar to the variations of the extensor indicis muscle, (III) the EDBM and extensor indicis muscle are often related, and (IV) the EDBM and extensor indicis muscle are supplied by the same nerve and artery. Thus, Ogura *et al.*[1], concluded that the EDBM is a variant of the extensor indicis muscle and disagreed, with strong justification based on neurovascular supply, with findings that relate the EDBM to supernumerary formations linked to the dorsal interosseous muscles and nerve supply by the ulnar nerve[8]. Cauldwell *et al.*[2], report the origins of the EDBM in both the distal segment of the radius bone and the carpal region, a view also shared by Yammine[18]. Souter[21], argues that the EDBM can occasionally be noted, at least in part, adjacent to a dorsal interosseous muscle, something also noted by Dunn & Evarts[3]. Already, Gama[20], reports occasional origin of EDBM from the distal portion of the radius. There is little variation as to distal insertion, muscle belly, and nerve and arterial supply in EDBM findings. Gonzalez & Netscher[14], report that the insertion is commonly related to the ulnar portion of the second finger, close to the extensor indicis muscle and innervated by the posterior interosseous nerve, which is corroborated by Ogura *et al.*[1], which, in their classification, reinforce this insertion condition and report the exclusive nerve supply by the posterior interosseous nerve (which supports the theory of the antebrachial origin of this nerve variant) and the arterial, in part of the findings, by the dorsal branch of the anterior interosseous artery. Tan *et al.*[8], report the nerve supply exclusively through the posterior interosseous nerve. Dunn & Evarts[3], describe that the EDBM can have from 1 to 4 fascicles, the common one being 1 fascicle, is often associated with the index finger, and with few insertions with the middle finger.

Different results in two of the three occurrences in our study, where the formations were related to the middle finger, including a double formation on one hand. H Vinayachandra *et al.*[22], report a double occurrence associated with the extensor hood of the

middle finger, of distal radius origin and innervation by the posterior interosseous nerve. Le Double[13], found no reports of a four-fascicle EDBM, other than any mention of the muscle being related to the thumb. Cauldwell *et al.*[2], report in one of their three findings, one with an unusual double tendon formation from a common belly. Jacobina *et al.*[5], report insertions, in two specimens, near the extensor tendons for the middle fingers, without reporting their neurovascular supplies. Desai *et al.*[9], in 3 findings of 64 simple muscle ventres, report their origins from the middle portions of the III and IV metacarpals and medial direction to the extensor tendon of the index finger with insertion in the extensor hood of the index finger. The nerve and vascular supply, despite the distance, was reported by the authors as from the posterior interosseous nerve and dorsal branch of the anterior interosseous artery.

Conclusion

The EDBM (extensor digitorum brevis manus) is a rare muscle formation, a variant of the extensor muscles of the hand, described almost two centuries ago, but still not understood, including anatomically. This stems in part from the paucity of studies with sufficient population data, anthropometry, and comparative anatomy that would aid in understanding its phylogeny, development, and anatomy.

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