VIA MEDICA

CASE REPORT

Folia Morphol.
Vol. 82, No. 2, pp. 407–411
DOI: 10.5603/FM.a2022.0037

ISSN 0015–5659
eISSN 1644–3284
journals.viamedica.pl

A unique bilateral accessory forearm flexor muscle

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[Received: 3 March 2022; Accepted: 23 March 2022; Early publication date: 5 April 2022]

Muscular and neurovascular variations in the upper extremity are of utmost clinical significance. Here we report a unique bilateral accessory muscle in the forearm and palm of an 89-year-old male cadaver. The accessory muscle presented two bellies on the right side, one in the forearm, innervated by the anterior interosseous nerve, and the other in the palm, innervated by a branch of the median nerve. A long tendon interconnected the two bellies. On the left side, the muscle had a single belly in the palm, which began at the end of a long tendon that extended from the forearm. However, on both sides, the muscle originated from the posterior surface of the flexor digitorum superficialis belly and inserted along with the first lumbrical muscle into the dorsal digital expansion of the index finger. The proximal parts of the variant muscles were sandwiched between the flexor digitorum muscles. The palmar bellies coursed distally through the carpal canal and lay deep to the superficial palmar arch, and superficial to the first lumbrical, between the thenar muscles and the lateral-most tendon of the flexor digitorum superficialis. Arguably, the accessory muscle might be a variant of a lumbrical muscle, as reported before, but innervation of the proximal belly by the anterior interosseous nerve suggests that the muscle may well be a deep accessory muscle at the forearm, probably appeared as a diverted part of the flexor digitorum profundus. Its space-occupying course through the forearm and palm, especially through the carpal canal, might be clinically significant as it might contribute to nerve compression pathologies in the upper extremity. This accessory muscle also indicates the complex nature of individual muscle formation and evolution of the upper extremity with constant changes in the morphology of muscles based on their changing functions. (Folia Morphol 2023; 82, 2: 407–411)

Key words: anatomical variations, accessory muscle, first lumbrical muscle, forearm, flexor digitorum superficialis muscle, median nerve

INTRODUCTION

Accessory muscles of the flexor compartment of the forearm are not uncommon, and when present, they may cause nerve compression syndromes or simulate soft tissue tumours [4]. Numerous variations of flexor digitorum superficialis (FDS) have been reported in literature, often consisting of one or more accessory bellies associated with a varying number

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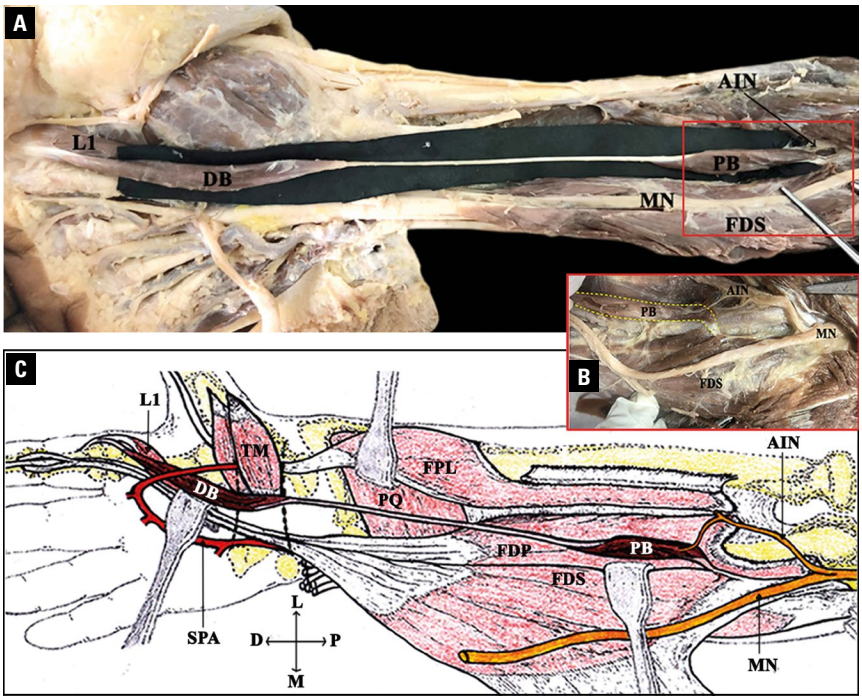

Figure 1. The accessory digastric muscle on the right forearm and hand of an 89-year-old male; **A.** The forearm (on the right side of the figure) showing the proximal belly (PB), innervated by the anterior interosseous nerve (AIN), originating from the deeper aspect of proximal flexor digitorum superficialis (FDS). The tendon of the PB extends distally to connect the distal belly (DB), which accompanies the first lumbrical (L1) for a common insertion in the hand (shown on the left side of the figure); **B.** An enlarged view of the boxed area in panel A showing a twig arising from the thick AIN innervating the PB (confined to the area bounded by broken line) from its lateral side. Note that the median nerve (MN) along with FDS has been deflected to the ulnar side; **C.** A diagrammatic representation of the accessory muscle, its PB and DB. The description of the muscle given in panels A and B are clearly depicted. Note the relationships of the muscle with the FDS, flexor digitorum profundus (FDP), pronator quadratus (PQ), flexor pollicis longus (FPL), thenar muscles (TM), and the superficial palmar arch (SPA); Compass: P — proximal; D — distal; M — medial; L — lateral.

of tendons. They were categorised into five classes by Elliot et al. [6] depending on their location and attachments. They may remain confined to the forearm [3, 23, 25] or extend for varying distances in the palm [11, 13, 19, 21]. Such anomalies of FDS or its tendons, especially to the index finger, presenting as masses or pseudo-tumours within the palm, have gained importance in recent years due to the clinical problems caused by them that require surgery [6, 21]. Of these, one that bears slight resemblance to the present case only by virtue of its 'digastricism' is that reported by Caetano et al. [2]; it was, however, a small variant confined purely to the forearm, being placed close to the FDS and inserting rather unusually, into the medial epicondyle of the humerus. Abundant literature also exists documenting different types of variant lumbricals, especially the lateral two [12, 14, 15, 24]. Rarer variations, such as those associated with flexor carpi ulnaris (FCU) [4, 18] and flexor pollicis longus (FPL) [8] have also been reported.

We report a unique bilateral case of a supernumerary muscle spanning remarkable portion of both forearm and palm, originating from FDS and sharing a common insertion with the first lumbrical into the dorsal digital expansion of the index finger. Innervation of the proximal belly of the right aberrant muscle by the anterior interosseous nerve and its antebrachial origin proximal to the flexor retinaculum suggest that the present case does not fit into either of the two commonest muscular variations of the upper limb. In fact, the palmar bellies of both the muscles by virtue of their location and innervation, are suggestive of an atavistic trait seen normally in amphibians [24].

CASE REPORT

During routine dissection of upper extremities at our medical school, a distinct bilateral variation was noted in the forearms of a male cadaver aged 89 years. A digastric muscle was observed on the right side, consisting of proximal and distal bellies connected by a long tendon (Fig. 1A, C). The proximal belly, about 7.5 cm long, took origin from the posterior surface of FDS by a short tendon, and then continued in the forearm as a long tendon of 12 cm length.

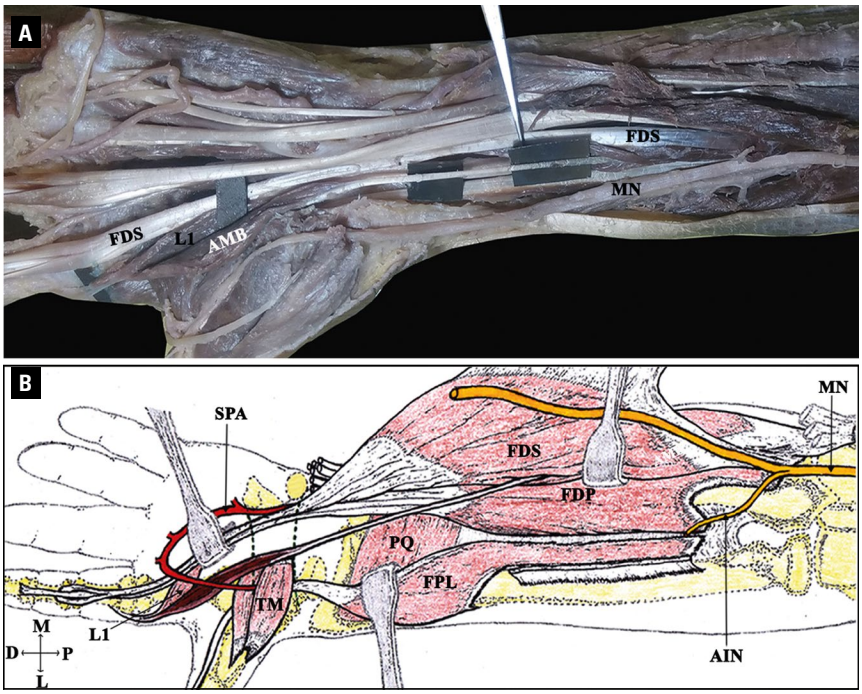

Figure 2. The accessory muscle (AM) on the left forearm (shown on the right side of the image) and hand (shown on the left side of the image) of an 89-year-old male; **A.** The AM took a tendinous origin from the middle of the deeper aspect of the flexor digitorum superficialis (FDS) and coursed distally through the carpal canal to join a muscle belly which we called accessory muscle belly (AMB), which similar to that on the right side, joined the first lumbrical (L1). The median nerve (MN) innervated the AM; **B.** A diagrammatic representation of the AM depicting its relationships with other structures in the vicinity such as the anterior interosseous nerve (AIN), flexor digitorum profundus (PDP), pronator quadratus (PQ), thenar muscles (TM), and the superficial palmar arch (SPA); Compass: P — proximal; D — distal; M — medial; L — lateral.

On reaching the wrist, the tendon transformed into a slightly longer distal belly about 8 cm, which entered the palm through the carpal canal on the radial side of FDS tendon for the index finger and was inserted by a short tendon with the first lumbrical to the radial side of the dorsal digital expansion of the extensor tendon of the index finger (Fig. 1A, C). On the left side, the accessory muscle took origin from the middle of the length of the fleshy belly of FDS muscle by a thin tendon, about 8 cm long, which continued distally as a fusiform muscle belly, 7 cm in length, traversing the carpal canal, and joining the first lumbrical in a common insertion similar to its counterpart on the right (Fig. 2A, B).

On both sides, the original FDS and flexor digitorum profundus (FDP) tendons for the index finger had normal insertion. The proximal belly of the right accessory muscle was innervated by a branch of the anterior interosseous nerve (Fig. 1B). The innervation of palmar bellies on both sides was by the median nerve.

The proximal belly of the muscle on the right side and the tendons on both sides were superficial to the FDP and deep to the FDS. The FPL formed the lateral relation of the proximal parts in both forearms. On both palms, the palmar belly passed through the carpal tunnel and more distally, lay deep to the superficial palmar arch and immediately superficial to the first lumbrical, with which it shared a common insertion. The tendon of the FDS to the index finger was medial to the muscle throughout its course.

DISCUSSION

Variant morphology of FDS has been listed by Bergman et al. [1] and reported by several others [5, 11], but an accessory muscle belly taking origin from the dorsal surface of the FDS and inserting with the first lumbrical, though does find mention in literature, is rare [9, 10]. Elliot et al. [6] had classified FDS into five types (I–V), based on variations reported between 1866 and 1999. Though the variant described in the present case share some similarities with types III and IV described by him, it is a separate accessory muscle present bilaterally, with origin from the FDS, but insertion independent of FDS tendon for the index finger.

Though the concept of atavism is no longer considered relevant, the fact that the same anomalies recur regularly is difficult to explain as purely by chance [2].

The palmar bellies reported in this case closely resemble the unilateral variant reported by Wesser et al. [24] both by virtue of their location and innervation, but they may well be atavistic structures representing intrinsic flexors of the hand seen in amphibians and most reptiles, where forearm flexors act on the wrist, never inserting distal to metacarpals [6]. Their digits are flexed by superficial and deep groups of intrinsic flexors in the palm. The mammalian musculature appears to have evolved by the forearm muscle bellies retreating proximally from the carpus, while their insertions became parts of long flexor tendons passing through the carpal canal into the palm. The superficial short muscles either disappeared or became parts of superficialis tendons in the palm, while lumbricals developed from the central part of the deep short flexor muscles [2, 3]. Some authors project accessory muscle bellies observed in the forearm attached to the FDS to be anomalous lumbrical muscles with abnormally proximal origins [12, 15, 22]. Koizumi et al. [12] reported a case of a bilateral anomalous muscle quite similar to this case. The author performed nerve tracing analysis and concluded that the aberrant muscles have a close relationship to the first lumbrical muscle owing to similar innervation. Subsequently, many authors who reported similar findings also quoted the same hypothesis [22].

The FDP and pronator quadratus are believed to represent the deeper layer of forearm muscles of amphibians [6, 10]. In the present case, the proximal belly of the right variant, however, was remarkably distant from the palm and gained innervation from the anterior interosseous nerve. It is, therefore, quite unlikely to be an accessory lumbrical, but could rather be a remnant of the primitive deep group of forearm muscles which gained attachment to FDS. Alternatively, it could be part of FDP which did not fuse with the main muscle during phase 3 of muscle ontogenesis, when muscle primordia from different layers fuse to form a single muscle, or it could be part of muscle primordia that normally disappear, but persisted and, later differentiated into an accessory belly [3–5, 7]. The former explanation is more likely as suggested by its innervation. The palmar bellies of the variants could be remnants of the deep group of palmar intrinsic muscles, which perhaps became attached to a separated part of FDP tendon.

Analysis of anatomical variations can contribute to obtaining an actual, not idealized image of the inside of the human body, which is of crucial importance in everyday clinical practice [26]. Accessory or variant muscles of the forearm and palm are of interest to clinicians. They often appear as abnormal swellings, especially palmar bellies commonly manifesting as painful or painless masses [6, 9, 19], that may be misdiagnosed as lipomas, ganglia, vascular malformations, or tendon sheath tumours [13, 21].

In many studies, anatomical variations of the upper limb correlate with nerve entrapment and such compressions are frequently attributed to some type of accessory muscle [16]. Hence it is important to know the normal anatomy and the possible variations of the structures concerned so as to avoid non-specific differential diagnosis of such conditions [16]. Carpal tunnel syndrome is the most common peripheral nerve entrapment encountered worldwide [17]. Although aetiology of carpal tunnel syndrome can vary, ranging from muscle hypertrophy [17] to persistent median artery [17, 20], when forming a content of the carpal tunnel or Guyon's canal, the supernumerary muscles like the ones reported here, are likely to cause compression of neurovascular structures, most commonly, the median or ulnar nerves [9]. According to Elliot et al. [6] symptoms of nerve compression could be intermittent, manifesting only during proper flexion, when muscle bellies move proximally. The possibility of an aberrant muscle belly should be considered when any abnormal mass detected is soft, in line with a digit, or when it shows increased firmness on active contraction against resistance [9]. Diagnosis of such conditions necessitates confirmation through electrophysiological testing and/or imaging techniques to decide whether or not more invasive surgical intervention is required [17]. While radiographs are of little value in such diagnosis, MRI scanning proves to be of greater use in addition to thorough history and physical examination [21]. Ultrasonography is another useful and more affordable option that has the added advantage of capturing movements of potential aberrant muscles [21]. The palmar bellies reported here were considerably long, traversing the entire span of the carpal canal but as to whether symptoms of nerve compression were present in the person concerned could not be ascertained, as this was an incidental finding observed during dissection, with no clinical history available.

CONCLUSIONS

This is a unique case of bilateral variant musculature of upper extremity. Not only does it add a new

facet to the evolutionary pattern of limb musculature but also warrants diligent investigation of such unprecedented variations for accurate diagnosis and suitable therapy in case of clinical conditions involving them. The need for surgical excision will depend on diagnosis and symptoms.

Acknowledgements

The authors gratefully acknowledge the technical assistance of Mr. Mayilswami and Mr. Anandhu Umeshan in dissection procedures, and Mr. Varghese MM in formatting figures for the manuscript.

Conflict of interest: None declared

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