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CASE REPORT

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Co-occurrence of asymmetrical bilateral extensor carpi radialis intermedius and bilateral sternalis muscles in an anatomical donor

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The presence of anatomical variants in the body may pose clinical challenges to inexperienced surgeons or clinicians and could cause misdiagnosis or treatment errors. Similarly, anatomical variations in cadavers pose educational dilemmas to students in gross anatomy dissection because of the inadequate coverage of anatomical variants in currently available resources, including textbooks. Students experience challenges in their learning experience, dissection process, and translation of clinically relevant information when presented with an anatomical variation. The authors report the rare finding of a bilateral sternalis muscle variant and asymmetrically bilateral extensor carpi radialis intermedius muscles in a single anatomical donor during dissection and the dilemma of students to find out what they were. (Folia Morphol 2024; 83, 2: 461–465)

Keywords: anatomic variation, extensor carpi radialis intermedius, bilateral sternalis, supernumerary muscles, extensor carpi radialis brevis, extensor carpi radialis longus

INTRODUCTION

The literature has described different forms and variants of the radial extensors of the forearm and wrist [1, 16]. Wood (1866) [14] initially documented variations in the tendons and muscles of the forearm, mainly the accessory tendons of the extensor carpi radialis muscles, and categorized them as cleft tendons, extensor carpi radialis intermedius or accessorius tendons, or intermediate tendinous slips. The extensor carpi radialis intermedius represents supernumerary muscles originating from either the extensor carpi radialis longus or brevis muscles and inserting into the second or third metacarpal bone [14]. Another variant, the extensor carpi radialis tertius, originates from the lateral epicondyle and courses between the extensor carpi radialis longus and extensor digitorum to insert on the proximal end of the second or third metacarpal [6]. It may also pass under the abductor pollicis longus before inserting into the metacarpal [6]. The sternalis muscle is an anatomical variant in the anterior chest wall that is superficial to the pectoralis major muscle [11]. Variations are classified either as single-belly, multi-belly, or multi-head [3], or simple, mixed, or other [11]. It may be present as a unilateral structure, commonly on the right, or as a bilateral structure as seen in this donor [12]. While both radial extensor variations and sternalis muscle variants are reported in the literature, the authors report the rare finding of the co-occurrence of bilateral extensor carpi radialis intermedius and bilateral simple sternalis muscle variants in a single healthy donor.

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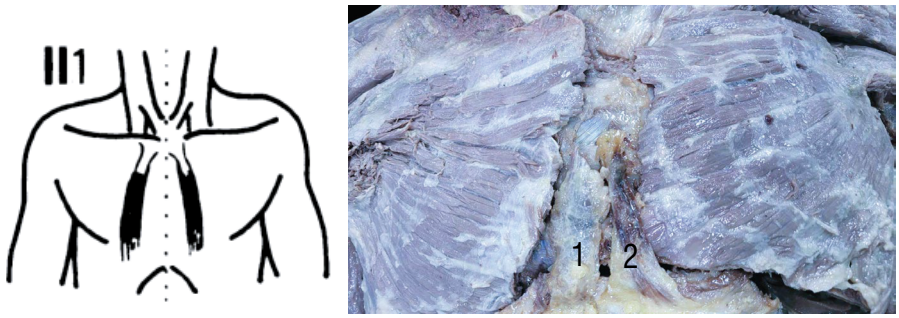

Figure 1. Type II 1 Sternalis muscle classification (left) and remnants of bilateral simple bellies of sternalis (right) as described by Jelev et al. (2001). 1 — right simple belly of sternalis; 2 — left simple belly of sternalis.

CASE PRESENTATION

During a laboratory dissection for a gross anatomy course, first-year dental students dissecting a male hard-fixed anatomical donor cut through strap-like muscles on the chest as they separated the fascia in the pectoral region. The muscles appeared to originate from the sternal region of the sternocleidomastoid muscle on both sides. Inferiorly, these bilateral muscles inserted onto the sternocostal arch below the xiphoid process. According to the classification of sternalis muscles by Jelev et al. [4], the bilateral presentation of the sternalis muscles in this finding can be classified as Type II 1, i.e. two simple symmetric bellies (Fig. 1). Although students had severed the superior attachments of the muscle, remnants of the bilateral simple bellies are shown (Fig. 1). On this same donor, students encountered multiple muscles in both forearms while dissecting the extensor compartment of the upper limbs that were not consistent with their lecture notes or illustrations from the dissection manual or textbooks provided. This created some confusion and dilemma as to what those structures could be.

FINDINGS

The extensor carpi radialis intermedius (ECRI) muscles originated bilaterally between the extensor carpi radialis longus (ECRL) and brevis (ECRB) muscles. On the right and left forearms, the ECRI muscles originated deep to the ECRL and the dorsal side of the ECRB as described in previous literature [1, 15]. However, on the right forearm, there were two separate ECRI muscles from the lateral epicondylar region that travelled deep to the ECRL with two separate tendons consistent with tendon-splitting descriptions in earlier literature (Fig. 2) [6]. On the right, the most proximal muscle to the ECRL was 20 mm wide at the midpoint and 130 mm long. The associated tendon measured 180 mm long and 5 mm wide from its muscular insertion to 2 mm at its midpoint towards the distal insertion. The ECRI proximal to the ECRB muscle was 20 mm wide and 125 mm long. Its tendon was 195 mm long and 14 mm wide at its muscular origin, tapering to 5 mm at the midpoint distally. Just before their insertion on the third metacarpal bone, these tendons fused together (Fig. 2). The two ECRI and the ECRB tendons were inserted into the proximal end of the third metacarpal bone. The muscle belly of the extensor carpi radialis brevis on the right forearm measured 40 mm wide and 145 mm long. Its tendon was 130 mm long and 15 mm wide at its muscular origin to 7 mm at the midpoint towards the distal insertion. The muscle belly of the extensor carpi radialis longus on the right forearm measured 30 mm wide and 150 mm long, with a tendon 180 mm long and 15 mm wide at its muscular origin and 10 mm at the midpoint towards the distal insertion (Table 1).

On the left forearm, there was one ECRI muscle positioned between the ECRL and ECRB. This ECRI muscle belly was 45 mm wide and 120 mm long. Its tendon was 185 mm long and 19 mm wide at its muscular origin and tapered to 7 mm at the midpoint distally. The tendon of this ECRI muscle courses alongside but is distinct from the tendon of the ECRB. Both tendons remain unfused and inserted unfused onto the proximal end of the third metacarpal bone (Fig. 3). The extensor carpi radialis brevis of the left forearm measured 50 mm wide and 150 mm long from the common extensor origin. The tendon was 130 mm long and its width tapered from 15 mm at the muscular origin, to 10 mm at the midpoint, and 5 mm at the distal insertion. The extensor carpi radialis longus muscle on the left forearm measured 30 mm wide and 150 mm long. Its tendon was 185 mm

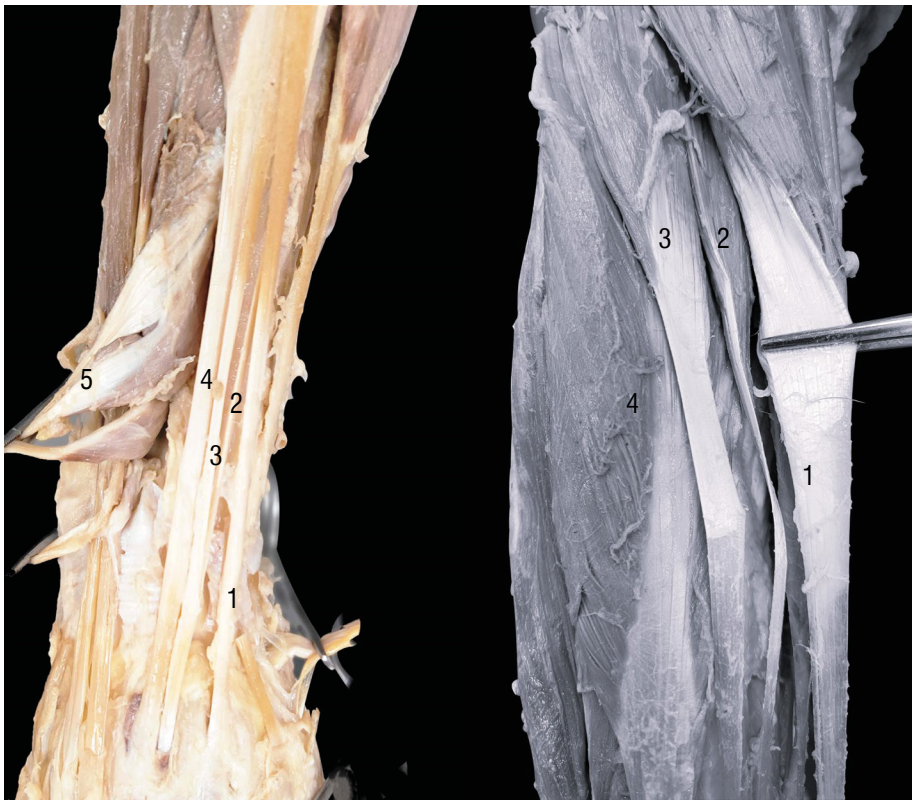

Figure 2. Right forearm showing variations of extensor carpi radialis muscles and tendons inserting into wrist. Left: Tendons inserting into respective areas; Right: Muscle bellies of muscle variants. 1 — extensor carpi radialis longus tendon inserting into the base of the second metacarpal; 2, 3 — multiple bellies of the extensor carpi radialis intermedius muscle and tendons fusing into the proximal end of the third metacarpal; 4 — extensor carpi radialis brevis inserting into the base of the third metacarpal; 5 — cut tendons of Abductor pollicis longus and extensor pollicis brevis muscles.

Table 1. Dimensions of supernumerary muscles of the right and left forearms

Muscle	Insertion	Muscle width [mm]	Muscle length [mm]	Tendon length [mm]	Tendon width (origin) [mm]	Tendon width (midpoint) [mm]
Right ECRI muscle 1	Base of third metacarpal	20	130	180	5	2
Right ECRI muscle 2	Base of third metacarpal	20	125	195	14	5
Right ECRB	Base of third metacarpal	40	145	130	15	7
Right ECRL	Base of second metacarpal	30	150	180	15	5
Left ECRI	Base of third metacarpal	45	120	185	19	7
Left ECRB	Base of third metacarpal	50	150	130	15	10
Left ECRL	Base of second metacarpal	30	150	185	10	5

ECRB — extensor carpi radialis brevis; ECRI — extensor carpi radialis intermedius; ECRL — extensor carpi radialis longus

long and 10 mm wide at the muscular origin, tapering to 5 mm midway toward the distal insertion. The dimensions of these supernumerary muscles and tendons on both forearms appear suitable for muscle and tendon transfers in reconstruction surgeries.

DISCUSSION

The extensor carpi radialis longus and brevis muscles, together with the brachioradialis, differentiate embryologically from one common muscle mass (Salazar et al., 2015 [8]). Therefore, aberrations in the splitting of this mass could lead to the observed supernumerary muscles and tendons [16]. The prevalence of the extensor carpi radialis intermedius, according to earlier studies, has ranged between 12.6% and 24% [1, 16]. While most findings of supernumerary muscles are cadaver-based, diagnosis of supernumerary muscles may be made through inci-

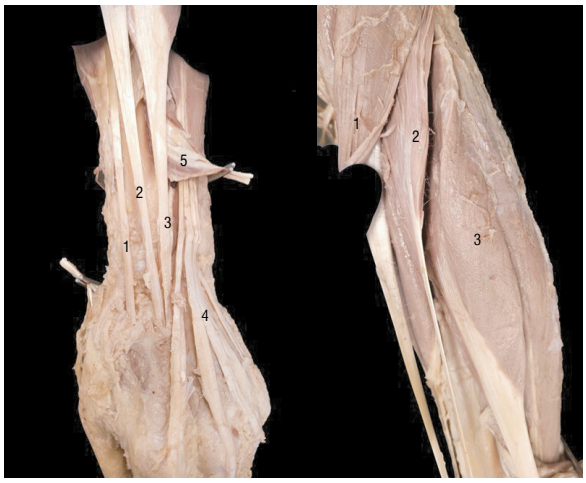

Figure 3. Left Forearm showing extensor carpi radialis muscles and variants and their insertion points. 1 — extensor carpi radialis longus tendon inserting into the base of the second metacarpal; 2 — extensor carpi radialis intermedius inserting into the base of the third metacarpal; 3 — extensor carpi radialis brevis inserting into the base of the third metacarpal; 4 — extensor digitorum tendons; 5 — cut tendons of Abductor pollicis longus and extensor pollicis brevis muscles.

dental radiological investigations or during surgery in asymptomatic patients [13]. Patients could also present symptomatically either as a case of tenosynovitis [10], with complaints of entrapment neuropathy, or as a mass of the distal forearm [13]. Supernumerary muscles are reported as more developed in people who engage in manual labour as seen in this donor who was a construction worker.

The prevalence of the sternalis muscle variant differs among Caucasians, Africans, and Asians, with its average being eight percent [4, 11]. The embryological origins of the sternalis include a derivation from the pectoralis major muscle, rectus abdominis, upper sternum, infraclavicular region of the pectoralis major muscles, and the panniculus carnosus muscles [5, 7].

Without a high index of suspicion and adequate knowledge, supernumerary muscles and sternalis muscle variations may be mistaken for other pathologies leading to misdiagnosis. The supernumerary muscles of the forearm could be mistaken for other conditions such as ganglion or synovial cysts, lipomas, tumours, tenosynovial thickening, or other ectopic masses without adequate examination and radiological interventions [6, 10, 13]. The sternalis muscle variant could predispose patients to errors specific to the thoracic region, such as a radiological misinterpretation of a mammogram, complicating surgical interventions by interfering with submuscular pocket dissection in augmentation mammoplasty, or being mistaken grossly for cancerous growths [5, 7, 9, 12].

While clinical or surgical impacts of variations are frequently identified, the effect on students in anatomy dissection is not. Finding unknown supernumerary muscles or strap-like muscles during routine dissection without references made to these in recommended resources could frustrate students' learning experience in anatomy education. As forearm variations could pose a diagnostic and therapeutic dilemma to young clinicians, the finding of unexpected forearm muscles and anterior chest muscles during dissection contrary to what has been taught and described in the recommended resources could pose a strong educational dilemma in gross anatomy, as seen in these students who expressed much confusion in trying to make meaning of the multiple muscles within the forearm.

Considering the prevalence of both extensor carpi radialis intermedius and sternalis muscle variations and the relevance of anatomical variations, incorporating brief information about the possibility of some common variations in teaching could be beneficial and reduce any confusion should some be identified. Complete ignorance of these variants in students or a lack of their mention in education may pose challenges in learning and translation of clinically relevant anatomy.

Both variations in the forearm and anterior chest wall have clinical benefits in therapeutic interventions, and knowledge of them could prevent misdiagnosis. Supernumerary muscles in the upper limb have been used in surgeries of the hand and other parts of the body that require tendon transfer [1]. Both extensor carpi radialis longus and brevis muscles are used in tendon transfer for hand surgeries [1, 17]. The extensor carpi radialis intermedius and accessory tendons have also been described as suitable for tendon transfers and corrective hand surgeries [1, 15]. Supernumerary muscles have been used in tendon transfers for thumb opposition, or as a motor extensor for the thumb in quadriplegic patients [14, 17]. The sternalis muscle could be used in reconstruction surgeries involving the breast, thoracic chest wall, head, or neck [2, 7]. Even with the well-described clinical relevance of these variants, they are still nearly absent from resources provided to students in anatomy, thus posing an educational dilemma.

CONCLUSIONS

While the literature has focused on the risk of misdiagnosis and treatment problems arising from a lack of knowledge and awareness of muscle variants, educators need to acknowledge that students in gross anatomy may also encounter these variants and face similar problems in their learning and translation of relevant anatomical knowledge. Pedagogical interventions can include introducing students briefly to these variations and correlating the gross anatomical features to their embryological development to explain the observed variation. While not every student may encounter a variation, the awareness of variations is critical for a holistic learning experience and the translation of clinically relevant anatomical knowledge. Clinically, any high index of suspicion could be confirmed radiologically before interventions are carried out to reduce the risk of error and misdiagnosis.

ARTICLE INFORMATION AND DECLARATIONS

Acknowledgments

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Conflict of interest: The authors have no conflict of interest to report.

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