Characterization of a unilateral thoracobrachialis muscle by physical examination and ultrasound imaging

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SUMMARY

Foundational knowledge of anatomy is essential for physicians. Resources utilized to impart this knowledge during training focus on typical anatomy. Variation extant in humans is largely ignored, which may compromise patient outcomes. Knowledge of variant anatomy requires physicians to regularly review the literature. Physical examination and ultrasound imaging were used to characterize and identify the muscle, employing a Mindray MX7 ultrasound machine and curvilinear transducer.

The muscle was identified as thoracobrachialis, a variant of pectoralis major. The muscle caused an asymmetry visible on gross examination at the axilla. Palpation revealed it to be tendinous in the axilla, gaining muscle mass as it descended in the brachium. This observation was confirmed by ultrasound. The thoracobrachialis appeared to terminate by merging with the triceps midshaft of the humerus. The muscle described in this report most closely resembles a family of variants that arise in the thorax in association with the pectoralis major, and insert either midshaft of the humerus or on the medial epicondyle. These variants were initially discovered during cadaveric dissection and this is the first report of such a muscle discovered in a healthy living individual without attendant clinical symptoms. Physical examination and ultrasound imaging identified the muscle as thoracobrachialis, a variant of pectoralis major. This report identifies and characterizes a supernumerary muscle of the thorax in a living individual.

Key words: Supernumerary muscle – Thoracobrachialis – Chondroepitrochlearis – Condohumeralis – Costohumeralis

INTRODUCTION

The practice of medicine and the study of anatomy have been closely linked for over 2000 years (Wiltse and Pait, 1998). Cadaveric dissections have historically been performed by physicians in training to acquire foundational academic knowledge. As other fields have expanded and the demands for curricular time have increased, time spent in the gross anatomy lab during medical school has diminished (McBride and Drake, 2018). More than ever physicians in training have come to rely on anatomy atlases for their understanding of anatomy.

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A weakness shared by all atlases is the need to limit images to depictions of the most common, or 'typical' anatomy. Reliance on narrowly focused anatomy atlases for physician training hinders appreciation of the rich diversity of anatomy extant in the human form. Atypical vascular patterns, anomalous nerve branching and supernumerary muscles are rarely represented in anatomy texts. Lack of knowledge of these variants may compromise the delivery of patient care. It is incumbent on practicing physicians to be dedicated life-long learners and to regularly review the literature in order to recognize atypical anatomy not taught in medical school. Awareness of rare supernumerary muscles, such as the one reported here, is an example.

The thorax is a hotbed for supernumerary muscles. A non-comprehensive list from Catalog of Human Variation identified 20 different variant muscles associated with this region (Bergman et al., 1984). Supernumerary muscles in all areas of the body are typically hidden from view on gross inspection. As a result, most published reports result from chance encounters during cadaveric dissection (Loukas et al., 2005; Douvetzemis et al., 2019). The few instances of supernumerary muscles identified in living individuals were precipitated by their interference with normal function, prompting further investigation and clinical interventions (Spinner et al., 1991; Di Gennaro et al., 1998; Tröbs et al., 2014).

In this report, a supernumerary muscle of the thorax was self-identified in a healthy adult male without attendant clinical symptoms. The muscle was unilateral and resulted in a subtle asymmetry that was evident on gross examination. Patient history, physical examination, and ultrasound imaging identified this muscle as thoracobrachialis, an extremely rare variant of the pectoralis major.

CASE REPORT

History, Surface Anatomy and Physical Examination

Subject is a healthy adult male who was aware of a congenital asymmetry in the axillae from an early age. The margin of the anterior axillary fold on the left was extended inferiorly when compared to the right side. A notable vertical depression was seen over the axilla lateral to the pectoralis major on the left that was not seen on the right (Fig. 1B).

Physical exam was performed by a Doctor of Osteopathic Medicine (D.O.) certified in Neuromusculoskeletal Medicine and Osteopathic Manipulative Medicine (C-NMM/OMM). The subject displayed decreased range of motion of the left shoulder in flexion, external rotation, and internal rotation. He acknowledged a history of four left shoulder separations, which may have been a contributing factor. The force of adduction and flexion was increased on the left despite the subject being right dominant.

Asymmetries of the anterior chest wall were noted. The subject had more muscle mass in the left pectoral region and tone of the pectoralis major

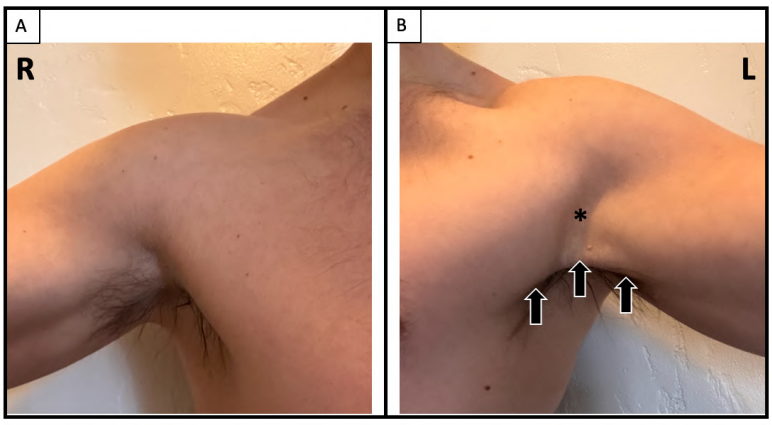

Fig. 1.- Asymmetry of pectoral regions and axillae. A. Typical anatomy of anterior chest wall and axilla on right. Pectoralis major defines the inferior boundary of the anterior axillary fold. Lateral contour of pectoralis major is curved and rounded. B. Atypical anatomy of anterior chest wall and axilla on left. Tendinous structure associated with supernumerary thoracobrachialis muscle (arrows) defines the inferior margin of the anterior axillary fold. Lateral border of the pectoralis major is angular and flattened. A depression lateral to the lateral margin of the pectoralis major is evident (*).

was increased when compared to the right side. The lateral margin of the left pectoralis major was angular and flattened as it approached the axilla. The pectoralis major did not define the inferior margin of the anterior axillary fold on the left. Instead, an anomalous tissue cord was noted at that location (Fig. 1B). It appeared tendinous upon palpation in the axilla, but became more substantial and resembled muscle tissue in the brachium. This supernumerary muscle contracted in unison with the pectoralis major. The anomalous muscle was clearly separate from the coracobrachialis for most of its course through the arm, but the two structures became closely opposed at the approximate midpoint of the humerus. The general path and characteristics of the anomalous muscle suggested that it could be a thoracobrachialis, an extremely rare variant of the pectoralis major.

There was no analogous structure on the right. The inferior margin of the right anterior axillary fold was demarcated by the pectoralis major (Fig. 1A). The subject agreed to undergo ultrasound (US) imaging to gain further insight into this anatomic variation.

Ultrasound Imaging

The subject was reclined supine on an examination table for imaging. The left arm was abducted ~90o and externally rotated to expose the medial surface. A Mindray MX7 ultrasound machine with curvilinear probe was used to perform the scans. MSK settings were used with depth and gain adjusted by the operator to optimize scan quality. Scans were performed along the medial aspect of the arm between the axilla and the elbow. Video captures of 12-15 seconds were generated. Representative individual frames isolated from one of these videos are presented in Fig. 2. The entire ultrasound scan video file "US Imaging of Thoracobrachialis Muscle" can be viewed in supporting information.

The coracobrachialis muscle was identified by the characteristic passage of the musculocutaneous nerve through its substance in the most proximal frame of the scan video and served as a landmark. Subsequently, the biceps brachii and triceps brachii were identified, and the 3 muscles were tracked distally. The putative thoracobrachialis was undetectable near the axilla (Fig. 2A2), consistent with US imaging of an aponeurotic structure (Pruidze et al., 2023). Muscle tissue became evident within the intramuscular septum between the coracobrachialis and triceps brachii in the proximal third of the brachium that was attributed to the thoracobrachialis (Fig. 2B2). Initial appearance of muscle tissue was small in caliber but increased significantly as it traveled distally (Figs. 2B2, 2C2, 2D2). At peak volume, the thoracobrachialis appeared pyramidal in shape and was clearly separated from the coracobrachialis and triceps brachii by fascia (Fig. 2D2). At its distal extent, the thoracobrachialis appeared to fuse with the triceps brachii and lost its status as separate entity. The coracobrachialis was still evident at this point, but nearing its attachment point on the humerus (Fig. 2E2).

DISCUSSION

Supernumerary muscles are rare and typically not depicted or discussed in anatomy texts and atlases. They are most frequently reported in the literature after chance discovery during cadaveric dissection (Loukas et al., 2005; Natsis et al., 2010; Douvetzemis et al., 2019). It is generally believed that supernumerary muscles identified in body donors were clinically benign and not recognized in life.

Supernumerary muscles traversing the thorax and brachium can interfere with upper limb mobility or compress important neurovascular structures, leading to their discovery in living persons (Spinner et al., 1991; Tröbs et al., 2014; Thomet et al., 2016). However, very few reports of clinical manifestations due to supernumerary muscles have been published, suggesting that they rarely interfere with normal function. The current report is the first to describe a supernumerary muscle identified in a living individual without attendant clinical symptoms.

The muscle described in this report most closely resembles a family of variants that arise in the thorax in association with the pectoralis major and insert either midshaft of the humerus or on the medial epicondyle. As these variants were initially discovered during cadaveric dissection,

many names have been assigned to them in efforts to identify precise sites of attachment. These include chondroepitrochlearis, thoracoepicondylaris, costoepitrochlearis, chondrohumeralis, chondrofascialis, and costohumeralis (Bergman et al., 1984; Rachana et al., 2020). Rachana and colleagues have attempted to bring some order to this chaos by suggesting that all of these variants be grouped under the more generic designation of thoracobrachialis (Rachana et al., 2020). This umbrella term is appropriate for the muscle described here. The muscle clearly originates in the thorax and melds with the muscle fibers of the triceps brachii near the medial midpoint of the humerus. The reliance on palpation and US to determine the course of this muscle precluded precise localization of its attachments, so thoracobrachialis is a proper designation.

As the thoracobrachialis involves the lower fibers of the pectoralis major, its presence can af-

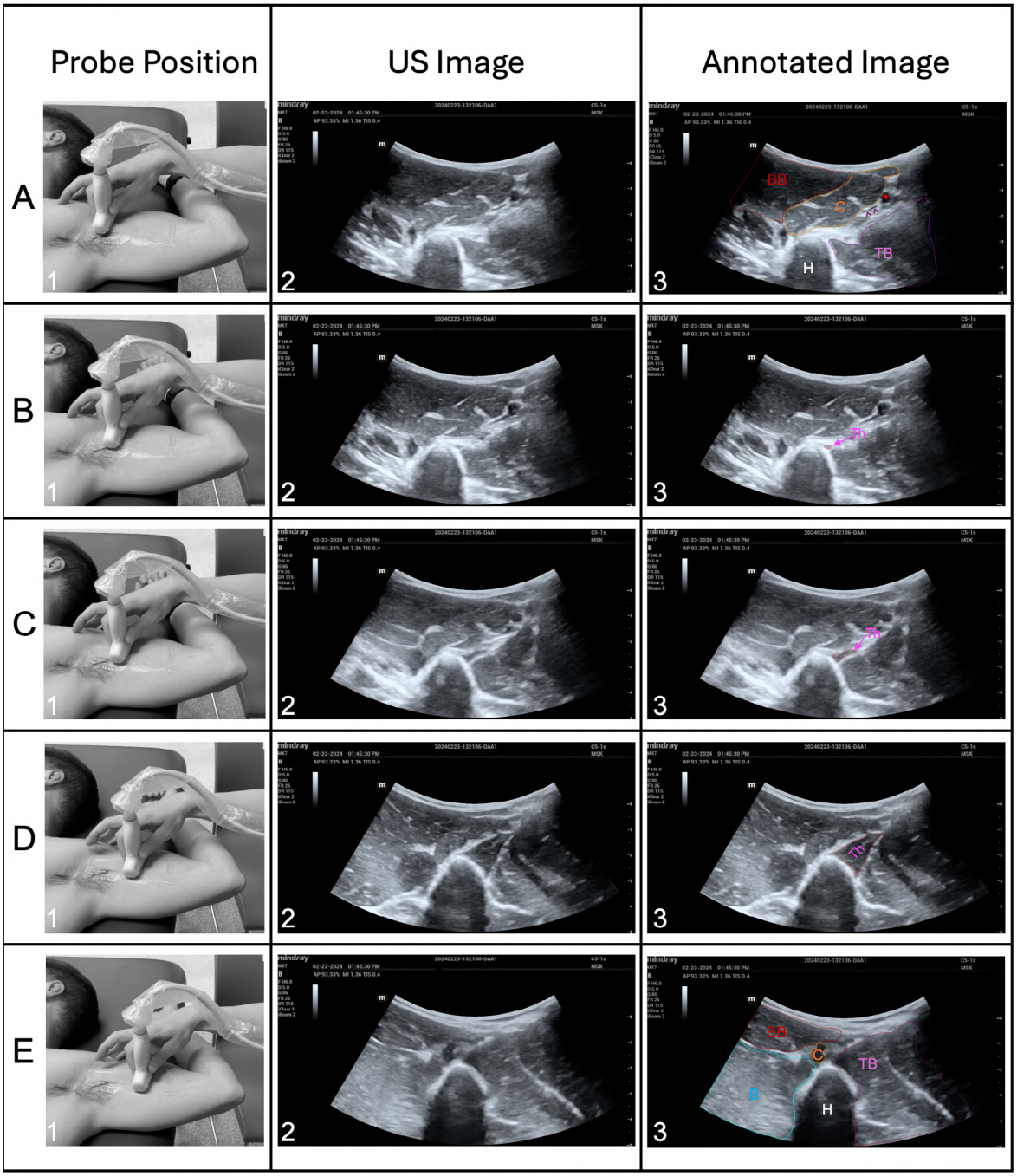

Fig. 2.- Ultrasound imaging. Rows (A-E) correspond to images captured at different points in the arm progressing from proximal to distal. Typical structures of the arm and the humerus are identified in panels A3 and E3. Location of the atypical thoracobrachialis (Th) is indicated in panels B3-D3.

Abbreviations: Biceps brachii (BB); Brachialis (B); Coracobrachialis (C); Triceps brachii (TB); Thoracobrachialis (Th); Humerus (H); Brachial artery (*); Basilic vein (^^)

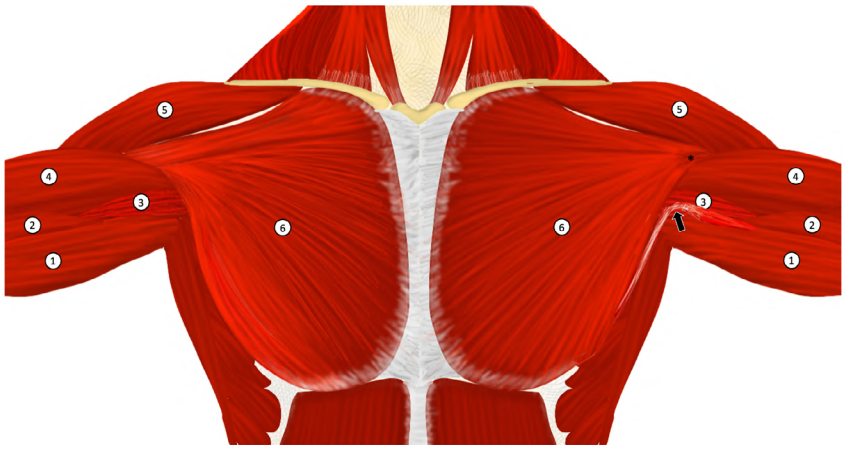

Fig. 3.- Illustration of muscle asymmetry. Right side represents typical anatomy of pectoralis major (6). Costal (inferior) fibers pass deep to clavicular (superior) fibers at axilla. Insertion pattern provides depth to tendon and generates rounded contour to lateral aspect of the muscle. Pectoralis major defines the inferior margin of the anterior axillary fold.

Left side represents hypothesized anatomy when thoracobrachialis (arrow) is present. Tendon of thoracobrachialis defines inferior margin of anterior axillary fold (arrow), descends in concert with coracobrachialis (3) and merges with the triceps brachii (1). Pectoralis major fibers are disordered with costal fibers inserting inferior to clavicular fibers. Depth of the tendon is diminished (*). Lateral aspect of the pectoralis major lacks typical rounded contour.

Muscle numerical identifiers: Triceps brachii (1); Brachialis (2); Coracobrachialis (3); Biceps brachii (4); Deltoid (5); Pectoralis major (6).

fect the attachment of the main pectoralis tendon on the humerus. In most individuals, the lower costal fibers of the pectoralis major insert in the bicipital groove of the humerus deep and proximal to fibers arising from the clavicle and upper sternum (Haładaj et al., 2019). This pattern elevates the clavicular fibers and gives depth to the tendon. Twisting of the lower muscle fibers imparts a smoothly rounded morphology to the lateral aspect of the pectoralis major. In individuals with a thoracobrachialis muscle, the inferior fibers of the pectoralis major often fail to twist and ascend normally This leads to a disordered tendon where the costal fibers insert on the humerus distal to the clavicular fibers (Landry, 1958). We postulate that an aberrant insertion of the pectoralis major tendon occurred in this case and was responsible for the angular lateral border of the muscle, and contributed to the surface depression overlying the axilla (Fig. 1B, Fig. 3). This depression has not been previously documented in association with a thoracobrachialis muscle. The decreased range of motion on flexion demonstrated during physical exam is consistent with disordered pectoralis fiber attachment at the humerus, but this contention is complicated by the history of shoulder separations reported by the subject.

In sum, this report describes the identification of thoracobrachialis, a rare variant of the pectoralis major, in a healthy living adult using a combination of physical examination and US imaging. A surface depression overlying the anterior axilla was noted that may indicate anomalous insertion of the tendon of pectoralis major that is often associated with this variant.

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SUPPORTING INFORMATION

US Imaging of Thoracobrachialis Muscle Video File. A side-by-side video depiction of the ultrasound scan of the thoracobrachialis muscle, alongside video feed of the scan being acquired. The accessory muscle of interest is highlighted in the ultrasound video feed at several frames using a red dot.

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