A new variety of chondrocoracoideus muscle, or an additional head of pectoralis major muscle

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Abstract
The pectoralis major and pectoralis minor muscles are located in the anterior chest wall. This region is characterized by high morphological variability. During dissection an additional muscle was found, originating from the lateral border of the pectoralis major muscle. After fusion it passed into the tendinous part coursing under the insertion of the pectoralis major muscle, then formed a common junction with the short head of the biceps brachii muscle, the distal attachment of which is on the coracoid process. Such an accessory structure could lead to neurovascular compression and cause thoracic outlet syndrome, of which pain is usually the first symptom. This muscle has not been described in the literature so far and for that reason we can name the present case as an unique structure.

Keywords Pectoralis major muscle · Pectoralis minor muscle · Chondrocoracoideus · Accessory muscle · Morphological variation · Thoracic outlet syndrome

Introduction
The pectoralis region is characterized by high morphological variability. Interestingly, the PM or PMi can be completely absent [1]. On the other hand, there are cases in which the PM is doubled. Some accessory structures can also occur. For example, the pectoralis quartus originates near the costochondral junction of the fifth and sixth ribs and inserts into the axillary arch or sternalis muscle (this is also a morphological variation, found in only 3–5% of the population). We can also distinguish the pectoralis intermedia, pectoralis minimus, chondrofascialis, sternohumeralis and sternochondrocoracoideus muscles [1].

The present report describes an accessory structure originating in the muscle belly of the PM and fusing with the lateral border of the PM at the level of the seventh rib. After this fusion it passes into tendinous part, crossing under the PM, and is then connected to the short head of the biceps brachii; the common junction has its insertion on

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the coracoid process. Knowledge of the morphological variability of this muscle is essential for all clinicians.

Case report

A 78-year-old cadaver (male) at death was subjected to routine anatomical dissection for research and teaching purposes at the Medical University of Lodz in Poland. The chest and left upper limb region underwent traditional anatomical dissection [2], fixed in 10% formalin solution. Dissection began with removal of the skin, superficial fascia, and fat tissue from the area of the shoulder, the medial side of the arm, and anterior part of the chest. The next step included visualizing the deltoid muscle and the PM, and accurate visualization of the biceps brachii and the coracobrachialis muscles. Following this, all structures were thoroughly cleaned, and an additional pectoral muscle was found—Fig. 1.

In the present case, the PM was divided into three parts: clavicular, sternocostal, and abdominal. The length of the sternocostal part, measured to the passage into the tendinous attachment, was 180.23 mm. The width of this part was 139.62 mm. The tendinous attachment on the lateral lip of the bicipital groove of the humerus was fused with the tendinous portion of the clavicular part, which was 127.38 long. The width, 19.09 mm, was measured from the point of an origin on the medial half of the clavicle to the line connecting the clavicular and sternocostal parts. The third, abdominal, part was 164.44 mm long and 15.99 mm wide—Table 1.

During this anatomical dissection an additional structure divided into muscle belly and tendon was found. Its muscular origin was fused with the lateral border of the muscular abdominal part of the PM at the level of the seventh rib. The length of this fragment was 102.96 mm. At the point of origin the width was 8.76 mm. Next, it passed into a tendinous structure crossing the PM under its tendinous distal attachment on the lateral lip of the bicipital groove of the

| Table 1 Morphometric measurements of distinct parts of the PM and the accessory muscle |
|---------------------------------------------|----------------|-----------------|
|                                             | Sternocostal part (mm) | Clavicular part (mm) | Abdominal part (mm) |
| Length                                      | 180.23             | 127.38           | 164.44             |
| Width                                       | 139.62             | 19.09            | 15.99              |

| Accessory pectoral muscle (mm)             |
|--------------------------------------------|
| Length                                    | 201.88             |
| Muscular part                              | 102.96             |
| Tendinous part*                            | 72.96              |
| Common junction                            | 25.96              |
| Width**                                    | 8.76               |

*To the connection with the short head of the biceps brachii
**In the point of the origin
humerus. Its length measured from the myotendinous junction to the connection with the short head of the biceps brachii was 72.96 mm. The common junction, 25.96 mm long, was attached to the coracoid process—Figs. 1, 2.

An electronic caliper (Mitutoyo Corporation, Kawasaki-shi, Kanagawa, Japan) was used for the measurements. Each measurement was repeated twice with an accuracy of up to 0.1 mm.

No other morphological variabilities were found. Table 1 shows the morphometric measurements of the presented case.

Discussion

As mentioned above, there are several morphological variations in the thoracic region. Knowledge of them could help us to assign an appropriate name to the newly found muscle.

The first interesting variant is a pectoralis minimus muscle, also known as the sternocostocoracoidian. It originates from the first rib cartilage and its insertion is on the coracoid process. In one study, the pectoralis minimus was observed in 5.35% of the population [3]. All cases were innervated by the lateral pectoral nerves [3].

Another morphological variation is a pectoralis intermedium, which originates on the third and fourth ribs between the PM and PMi. It is usually inserted on the coracoid process [1]. The pectoralis intermedium usually coexists with the pectoralis quartus, its proximal attachment arising near the costochondral junction of the fifth and sixth ribs [4]. It inserts to the PM [1].

Another variation is the chondroepitrochlearis, otherwise named costoepitrochlearis or chondrohumeralis, originating from one or more ribs and inserting on to the medial epicondyle of the humerus or into the median intermuscular septum [5]. Some authors found the same muscle but originating directly from the PM [6, 7].

The chondrocoracoideus muscle, sometimes called the costocoracoideus or muscle of Wood [8], is another rare variant of the PM. It originates from the sixth to the eighth ribs and the rectus sheath. Its distal attachment is connected to the short head of the biceps brachii and then attached to the coracoid process [1].

Venieratos et al. [9] found a PM of which the abdominal portion was the accessory pectoral muscle originating in three slips from the sixth to eighth ribs and the external oblique muscle aponeurosis. It was distally fused with the short head of the biceps brachii and then attached to the coracoid process. They called this accessory structure the chondrocoracoideus muscle.

Douvetzemis et al. [10] described a similar case emerging as three slips from the sixth to eighth ribs and the external oblique muscle aponeurosis. At the level of the fifth and sixth ribs it was connected to the sternocostal part of the PM. Its insertion was on the coracoid process, but before the attachment was a small fusion with the short head of the biceps brachii [10]. Tubbs et al. [11] described a PM with an insertion into the shoulder joint capsule.

Considering the foregoing information, the additional muscle in the present case seems most similar to the chondrocoracoideus muscle. However, there are differences indicating that it is not the chondrocoracoideus, but an additional head of the PM or a distinct muscle that has not been described in the literature so far. First, the proximal attachment was represented as one muscle belly not three distinct slips as in the cases described by Douvetzemis et al. [10] and Venieratos et al. [9] Second, the muscle in our case originated from the lateral border of the PM as a fusion with the abdominal part of the PM at the level of the seventh rib. In the cases found by the aforementioned workers, the proximal attachment created the abdominal portion of the PM originating from the sternal line at the level of the sixth to eighth ribs. Clinically, the important fact seems to be that the tendinous part of the accessory muscle in our case was located deeper to the tendinous part of the PM and passed under this
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**Data availability** Please contact authors for data requests (Łukasz Olewnik, PhD—email address: lukasz.olewnik@umed.lodz.pl).

**Declarations**

**Conflict of interest** The authors declare that they have no competing interests.

**Ethical approval and consent to participate** The study protocol was accepted by the Bioethics Committee of the Medical University of Lodz. The cadavers were the property of the Department of Anatomical Dissection and Donation, Medical University of Lodz, and of the Donors and Dissecting Rooms Center, Universidad Complutense de Madrid, Spain. Informed Consents were obtained from all participants before they died.

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References

1. Bergman RA, Afifi AK, Miyauchi R. Illustrated encyclopedia of human anatomic variation: opus I: muscular system: alphabetical listing of muscles. http://www.anatomyatlases.org/AnatomicVariants/MuscularSystem/Text/P/29PectoralisMajor.shtml. Accessed 13 Dec 2021

2. Zielinska N, Tubbs RS, Podgórski M, Karauda P, Polguj M, Olewnik L (2020) The subscapularis tendon: a proposed classification system. Ann Anat - Anat Anzeiger. https://doi.org/10.1016/j.aanat.2020.151615

3. Khizer Hussain Afroze M, Yuvaraj M, Veenapai, Lakshmi Prabha S, Shivaleela C (2015) Study on Sterno‑costo‑coracoidian (Pectoralis Minimus). Res J Pharm Biol Chem Sci 6:1087–1091

4. Arican RY, Coskun N, Sarikcioglu L, Sindel M, Oguz N (2006) Co-existence des muscles pectoralis quartus et pectoralis intermedius. Morphologie 90:157–159. https://doi.org/10.1016/S1286-0115(06)74497-6

5. Natsis K, Totlis T, Sofidis G (2012) Chondroepitrochlearis: an abnormal muscle that may affect axillary lymphadenectomy. ANZ J Surg 82:286–287. https://doi.org/10.1111/j.1445-2197.2012.06015.x

6. Loukas M, Louis RG, Kwiatkowska M (2005) Chondroepitrochlearis muscle, a case report and a suggested revision of the current nomenclature. Surg Radiol Anat 27:354–356. https://doi.org/10.1007/s00276-005-0337-4

7. Voto SJ, Weiner DS (1987) The chondroepitrochlearis muscle. J Pediatr Orthop 7:213–214. https://doi.org/10.1097/01241398-19870300-00021

8. Wood J (1867) On human muscular variations and their relation to comparative anatomy. J Anat Physiol 1:44–59

9. Venieratos D, Samolis A, Piakgou M, Douvetzemis S, Kourotzoglou A, Natsis K (2017) The chondrocoracoideus muscle: a rare anatomical variant of the pectoral area. Acta Med Acad 46:155–161. https://doi.org/10.5644/ama2006-124.200

10. Douvetzemis S, Natsis K, Piakgou M, Kostares M, Demesticha T, Troupis T (2019) Accessory muscles of the anterior thoracic wall and axilla. cadaveric, surgical and radiological incidence and clinical significance during breast and axillary surgery. Folia Morphol 78:606–616. https://doi.org/10.1016/S1286-0115(06)74497-6

11. Tubbs RS, Shoja MM, Shokouhi G, Loukas M, Oakes WJ (2008) Insertion of the pectoralis major into the shoulder joint capsule. Anat Sci Int 83:291–293. https://doi.org/10.1111/j.1447-073x.2007.00214.x

12. Seed C (2000) Thoracic outlet syndrome. J Dent Hyg 74:6

13. van de Sande MAJ, Cosker T, McDonnell SM, Gibbons CLMH, Giele H (2014) Use of the composite pedicled pectoralis minor flap after resection of soft tissue sarcoma in reconstruction of the glenohumeral joint. Case Rep Orthop 2014:1–5. https://doi.org/10.1155/2014/937342

14. Illi SK, Held U, Frank I, Spengler CM (2012) Effect of respiratory muscle training on exercise performance in healthy individuals. Sport Med 42:707–724. https://doi.org/10.1007/bf03262290

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