

# Unilateral presentation of three muscle variants in the pectoral region

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## SUMMARY

A rare case of three muscle anomalies in the pectoral region was discovered during routine dissection of an 85-year-old female cadaver. The muscle anomalies include the congenital partial absence of the pectoralis major muscle, a sternalis muscle, and a pectoralis quartus muscle. All three variants presented on the right side. The pectoralis major muscle demonstrated a normal clavicular head but lacked an abdominal part and had a sternocostal head that attached only to the manubrium. The sternalis arose from the manubrium and appeared to share a common tendon with the contralateral sternocleidomastoid muscle. The pectoralis quartus arose from the costal cartilages of ribs six and seven and inserted onto the fascia of the coracobrachialis muscle deep to the pectoralis major muscle. The sternalis muscle was innervated by intercostal nerves and the pectoralis quartus was innervated by both the medial pectoral and intercostal nerves. The documentation of pectoral muscle variants is not only important for the anatomical record but has clinical implications for surgical procedures in the axillary region and the interpretation of CT and MRI scans.

**Key words:** Pectoralis major muscle – Pectoralis quartus muscle – Sternalis muscle – Anatomical variants – Sternocostal head

## INTRODUCTION

The pectoralis major muscle is the most prominent muscle attached to the anterior thoracic wall

and contributes to the formation of the anterior border of the axilla. The pectoralis major is a triangular muscle that has a clavicular head, a sternocostal head and an abdominal part. The clavicular head attaches to the medial half of the clavicle. The sternocostal head continues inferiorly from the clavicular head and attaches to the anterior surface of the sternum and the superior six costal cartilages. The abdominal part attaches to the aponeurosis of the external oblique muscle. The heads of the pectoralis major muscle blend laterally to form a tendon that inserts on the lateral lip of the intertubercular groove of the humerus. Innervation of the pectoralis major muscle is provided by the medial and lateral pectoral nerves. The pectoralis minor muscle is located deep to the pectoralis major muscle. The pectoralis minor muscle attaches to ribs 3-5 and to the coracoid process of the scapula. It is innervated by the medial pectoral nerve. Complete or partial absence of the pectoralis muscles are frequently reported in the literature. With regard to pectoralis major muscle, the most frequent deficit is the partial or complete absence of the sternocostal head (Bing, 1902; Jones, 1926; Mosconi and Kamath, 2003).

The discovery of anatomic variations in the anterior thoracic region has been well documented in the literature since the nineteenth century (Wood, 1868; Testut, 1884; Le Double, 1897; Bing, 1902; Huntington, 1904). One of the more frequently reported muscle variants is the sternalis muscle. It is reported to be present in 3-8% of the general population (O'Neill and Folan-Curran, 1998; Jeleu et al., 2001; Arráez-Aybar et al., 2003; Ge et al., 2014). This muscle attaches to the anterior sternal border superficial to the pectoralis major. Its fibers run longitudinally from the upper sternum to the lower ribs, costal cartilage, aponeurosis of the external oblique muscle or the rectus sheath (Jeleu

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et al., 2001; Loukas et al., 2004). The innervation of the sternalis muscle has been reported to be supplied by pectoral nerves, as well as intercostal nerves (Kida and Kudoh, 1991; O'Neill and Folan-Curran, 1998; Jeleu et al., 2001; Hung et al., 2012). Despite the well reported descriptions of the sternalis muscle, confusion still remains as to its origin. It has been argued to be a derivative of the pectoralis major muscle, rectus column, sternocleidomastoid muscle, and panniculus carnosus (reviewed in Jeleu et al., 2001; Loukas et al., 2004; Snosek et al., 2014).

Another variant reported in the literature is the pectoralis quartus muscle, located on the lateral border of the pectoralis major muscle. The pectoralis quartus is considered a rare variation, but has been reported to have a frequency of 11-16% (Macalister, 1875; Testut, 1884; Wagenseil, 1937). The pectoralis quartus muscle arises from the costochondral junction of the fifth or sixth rib, the lateral border of the pectoralis major muscle or rectus sheath, and inserts on the humerus or fascia of the arm deep to the pectoralis major muscle (Bergman, 1991; Hardy and Fabrizio, 2009; Bonastre et al., 2002; Natsis et al., 2010). The innervation of the pectoralis quartus muscle has been reported to be supplied by the medial pectoral nerve and fourth intercostal nerve (Birmingham,

1889; Hardy and Fabrizio, 2009; Porzionato et al., 2012; Arican et al., 2006).

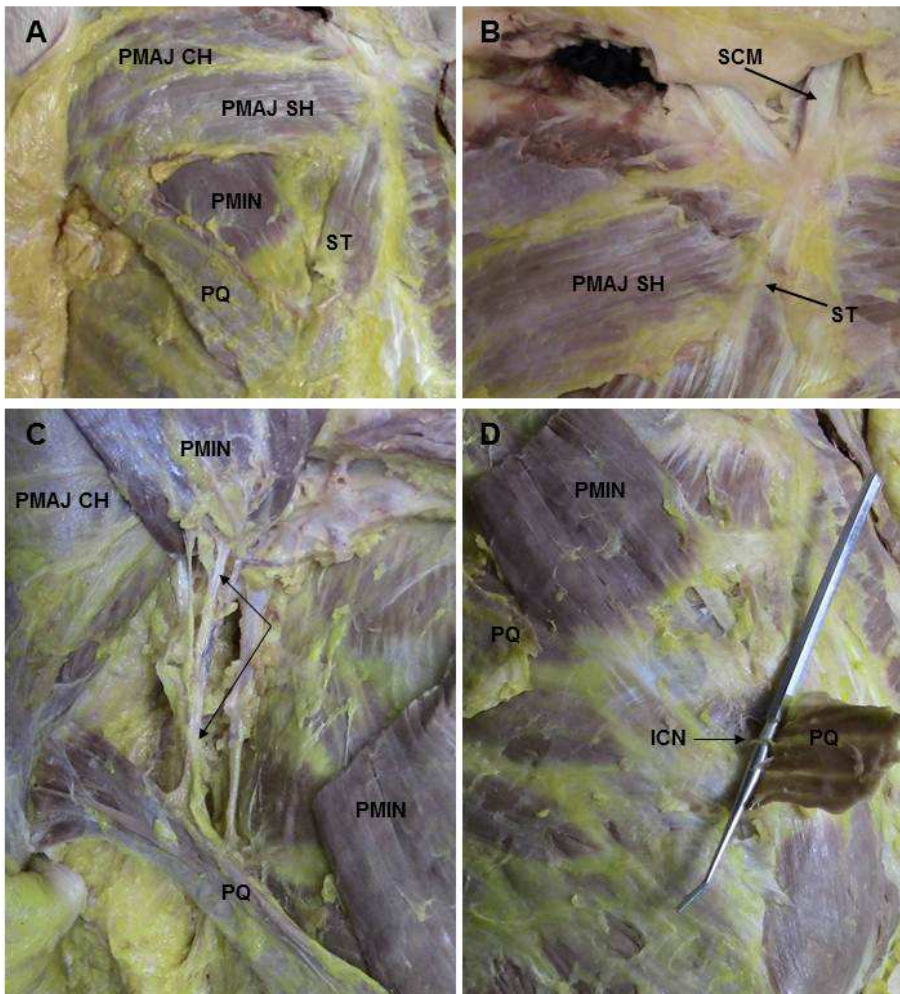
In this case report, we discuss a situation in which three variant muscles presented unilaterally in a single cadaver. These variants included a pectoralis major muscle with a partial absence of the sternocostal head, a sternalis muscle, and a pectoralis quartus muscle. To the best of the author's knowledge, this is the first report of a case with the presentation of these three muscle variants in the same specimen.

### CASE REPORT

During a routine cadaver dissection of the upper extremity in a chiropractic anatomy laboratory, three variant muscles were observed in the right pectoral region of a female cadaver. The first variant was a pectoralis major muscle with a partial absence of the sternocostal head (Fig. 1A). In our specimen, the pectoralis major muscle demonstrated a normal clavicular head. However, the sternocostal head attached only to the manubrium. The rest of the pectoralis major muscle was absent without any attachment to the body of the sternum, costal cartilages or aponeurosis of the external oblique muscle. The clavicular and sternocostal head fused laterally and attached to the lateral lip

of the intertubercular groove. A normal pectoralis minor muscle was present and was visible without need of reflecting the abbreviated pectoralis major muscle (Fig. 1A).

The second variant observed in the specimen



**Fig. 1. (A)** Anterior view of the right pectoral region showing three muscle variants; an abbreviated pectoralis major muscle a sternalis muscle and a pectoralis quartus muscle. PMAJ CH - pectoralis major clavicular head, PMAJ SH- pectoralis major sternal head, PMIN- pectoralis minor, ST- sternalis, PQ- pectoralis quartus. **(B)** The sternalis tendon blends with the contralateral sternocleidomastoid tendon. SCM- sternocleidomastoid. **(C)** A neurovascular bundle can be seen supplying the pectoralis quartus muscle deep to a reflected pectoralis minor muscle (arrows). **(D)** The pectoralis quartus (cut and reflected) is innervated by an anterior branch of the intercostal nerve at its costal attachment. ICN- intercostal nerve.

was the sternalis muscle (Figs. 1A and B). The tendon of the sternalis muscle arose from the manubrium just distal to the origin of the tendons of the right and left sternocleidomastoid muscles (Fig. 1B). Some of the fibers of the tendon of the sternalis muscle blended with the tendon of the contralateral sternocleidomastoid muscle (Fig. 1B). From its origin, the sternalis muscle extended inferolaterally along the sternal border and inserted onto the sixth and seventh costal cartilages just medial to the midclavicular line (Fig. 1A). From our preparation, we only observed innervation of the sternalis muscle by intercostal nerves.

The third variant was determined to be the pectoralis quartus muscle (Figs. 1A and C). The pectoralis quartus muscle arose from the costal cartilages of ribs six and seven at the midclavicular line lateral to the inferior limit of the sternalis muscle. The pectoralis quartus muscle passed superolaterally along the lateral border of the pectoralis minor muscle and inserted onto the fascia of the coracobrachialis muscle deep to the pectoralis major muscle (Fig. 1C). The pectoralis quartus muscle was innervated by branches contained in a neurovascular bundle that extended inferiorly from the deep surface of the pectoralis minor muscle before entering the pectoralis quartus muscle (Fig. 1C). We determined that these were branches of the medial pectoral nerve. Interestingly, the pectoralis quartus muscle was also innervated by an intercostal nerve (Fig. 1D).

## DISCUSSION

The most frequently reported anomaly associated with the pectoralis major muscle is the absence or deficiency of its sternocostal head (Bing, 1902; Jones, 1926; Mosconi and Kamath, 2003). In our case, we report the unilateral absence of the sternocostal head of the pectoralis major muscle that coincided with a sternalis muscle and a pectoralis quartus muscle. Recent reports record the prevalence of the sternalis muscle in the population at 3-8 % with a great variation between the sexes and among different races (Jeleu et al., 2001; Jeng and Su, 1998; O'Neill and Folan-Curran, 1998; Ge et al., 2014). Some recent reports have described examples of a sternalis muscle accompanying defects in normal pectoralis major musculature (Kida and Kudoh, 1991; Hung et al., 2012). Both cases reported innervation of the sternalis by pectoral nerves with no evidence of innervation via intercostal nerves. However, others have reported that the sternalis muscle was innervated by intercostal nerves. O'Neill and Folan-Curran (1998) reported that the sternalis muscle was innervated by anterior cutaneous branches of the intercostal nerves. A review of the literature revealed that innervation of the sternalis muscle by pectoral nerves occurs 55% of the time, intercostal nerves 43% of the time, and a combination of both 2% of the time.

Kida et al. (2000) argued that in the absence of a careful dissection of the lateral border of the sternalis muscle very fine fibers may be mistaken for connective tissue and the innervation by the pectoral nerves will go unnoticed. In our case, we found no evidence of the sternalis muscle being innervated by pectoral nerves; this appeared to be innervated by anterior cutaneous branches of intercostal nerves.

The pectoralis quartus muscle has been reported to arise from the costochondral junction of the fifth or sixth rib, the lateral border of the pectoralis major muscle or rectus sheath, and to insert on the humerus or fascia of the arm deep to the pectoralis major muscle (Bergman, 1991; Hardy and Fabrizio, 2009; Bonastre et al., 2002; Natsis et al., 2010). In addition, there are a number of references of the pectoralis quartus muscle presenting with other muscle variants in the axillary region. The pectoralis quartus muscle has been observed with an axillary arch muscle (Bonastre et al., 2002; Natsis et al., 2010), a pectoralis intermedius muscle (Arican et al., 2006), a sternalis muscle (Huntington, 1904), and an axillary arch and chondroepitrochlearis (Bergman, 1991). The pectoralis quartus muscle is frequently joined to the axillary arch or to the sternalis muscle when those muscles are present (Bergman et al., 2006; Bonastre et al., 2002).

The innervation of the pectoralis quartus muscle has been reported to be supplied by the medial pectoral nerve (Birmingham, 1889; Hardy and Fabrizio, 2009; Porzionato et al., 2012). Additionally, Arican et al. (2006) reported that the pectoralis quartus was innervated by an intercostal nerve. Interestingly, we observed the pectoralis quartus muscle in our specimen to be innervated by both the medial pectoral nerve and an intercostal nerve.

Although reports of anatomic variations in the pectoral and axillary regions appear in the literature, they infrequently appear in clinical anatomy textbooks. The presence of these variants may present challenges to clinicians and surgeons unfamiliar with their frequency and morphology. For example, due to its parasternal location, the sternalis muscle may be misinterpreted as a malignant mass on a routine mammogram which could potentially lead to more invasive testing (Bradley et al., 1996; Pinhal-Enfield et al., 2011; Snosek et al., 2014). Pectoral muscle anomalies are also critical for surgeons to be familiar with, as their presence has implications in breast reconstructive surgery or breast augmentation (Schulman and Chun, 2005; Huber et al., 2012; Snosek et al., 2014).

In this case, we report the presence of the pectoralis quartus concurrent with a pectoralis major muscle with aplasia of both the abdominal part and a portion of the sternocostal head. To our knowledge, this is the first description of the pectoralis quartus muscle with a deficient pectoralis major muscle in the literature. This has clinical impli-

cations, as these muscular variants significantly change the boundaries of the axilla but are rarely detected preoperatively (Natsis et al., 2010; Totlis et al., 2012). When encountered intraoperatively during a lymphadenectomy procedure, such variants may impede access to the axillary region and proper removal of axillary nodes (Natsis et al., 2010; Totlis et al., 2012). A greater recognition of the potential presence of these and other muscular variants in the axillary region may reduce surgical complications resulting in better outcomes (Natsis et al., 2010; JeleV et al., 2007).

The presence of a single muscular anomaly in the thoracic region may present significant challenges to clinicians who may be unfamiliar with pectoral and axillary muscular variants. These challenges may be further complicated by the co-existence of multiple variants in the same individual. Therefore, anatomic study and detailed descriptions of these occurrences are critical to the education of clinicians in the diagnosis and surgery of the chest wall.

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