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RESEARCH ARTICLE

A Cadaveric Study on Morphology and Morphometry of Pectoralis Major Muscle

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Abstract

Background: The Pectoralis Major (PM) muscle is considered one of the key anatomical structures in plastic and reconstructive surgery. The objective of this study was to analyse the morphology of PM muscle, along with a thorough assessment of its dimensions and to note any other anatomical variations.

Subjects and Methods: The study was carried out on thirty upper limb specimens (fifteen right and fifteen left)) of both sexes available in the Department of Anatomy, Esic Medical College And Hospital,Sanathnagar, Hyderabad, India. Morphometric analysis at the origin and insertion was completed and the PM muscle was thoroughly observed for any other anatomical variations.

Results: We observed that the entire length of the clavicle gave origin to the clavicular head in 6.6% of the specimens and the deltopectoral groove was absent in 6.6% of the cases. 66.6% of the specimens showed the continuation of the PM muscle at its insertion along with the brachial fascia. In 3.3% of the cases, the three heads of the PM muscle were not distinguishable. The mean height at the midclavicular line was found to be 13.8 cm and at the midaxillary line, it was found to be 6.6 cm. The average width was found to be 18.7 cm at the origin. The average length at the insertion was found to be 4.8 cm and the height was found to be 0.89cm.

Conclusions: The knowledge regarding the PM muscle is imperative for surgeons in performing procedures in the pectoral region, especially surgeries involving the mammary gland.

Key Words: *Pectoralis major muscle; Morphology; Morphometry; Anatomical variations*

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Introduction

The Pectoralis Major (PM) muscle is a large fan-shaped muscle consisting of clavicular, sternocostal, and abdominal sections. The three sections of the PM muscle are attached to the anterior aspect of the medial half of the clavicle, the anterior part of the sternum, and the cartilages of all the true ribs (attachment to the first and/or seventh costal cartilage is often omitted) and to the aponeurosis of the external oblique, respectively [1] (Figure 1).

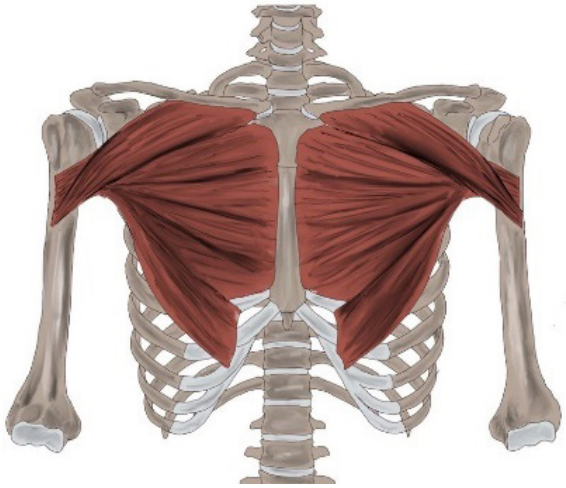

Figure 1) *Schematic representation of Pectoralis Major Muscle (PM). The schematic representation is done in house in the department of anatomy using the application Apple Procreate.*

The movements of the upper limb are performed by various muscles. One of the most important muscles of movement is the PM muscle, particularly during adduction and medial rotation of the arm. The PM muscle is one of the key muscles in plastic and reconstructive surgeries, owing to its relation to the chest wall and breast. The PM muscle can show numerous variations in its anatomy and morphology. This can affect the evaluation of injury to the muscle through imaging. Anatomical variations of the PM muscle are very common. According to Bergmann et al. (2016), all parts of the PM maybe more or less separable [2]. The clavicular head of the PM may extend laterally on the clavicle as far as the deltoid muscle and may be fused with it. The sternal and costal heads may be absent or the whole muscle may be absent in rare cases. However, in the medical literature anatomical variations of the PM are found mainly in the form of scattered descriptions of specific anatomical variations, i.e., case reports or case-series reports [3-16]. Perrin (1871) is the only source that provides detailed classification of PM muscle variations [17]. The present study describes the variations in the morphology and morphometry of the PM muscle.

Materials and Methods

The study was carried out on thirty upper limbs from fifteen formalin-fixed cadavers (fifteen on the right side and fifteen on the left side). Any specimens with scars, traces of trauma, or deformations within the pectoral, shoulder, and brachial regions were excluded from the study. The procedure involved exposure of the PM muscle to visualize its morphology. Morphometric measurements were made using a scale, measuring tape, thread, and digital vernier calipers.

Following morphometric measurements were noted:

- Width of the entire muscle from the sternal angle to the insertion (W)
- Height of PM at the midclavicular and midaxillary line (MCL, MAL)
- The total length of the clavicle is covered by the origin of the clavicular part of the PM (Marked in blue in the above picture)
- Length and height of the PM at its insertion (Figure 2).

Along with this certain other feature, such as the absence of deltopectoral groove, hypertrophy of the muscle, fusion with the brachial fascia, twisting of fibers at the insertion, and nerve supply of the muscle were observed.

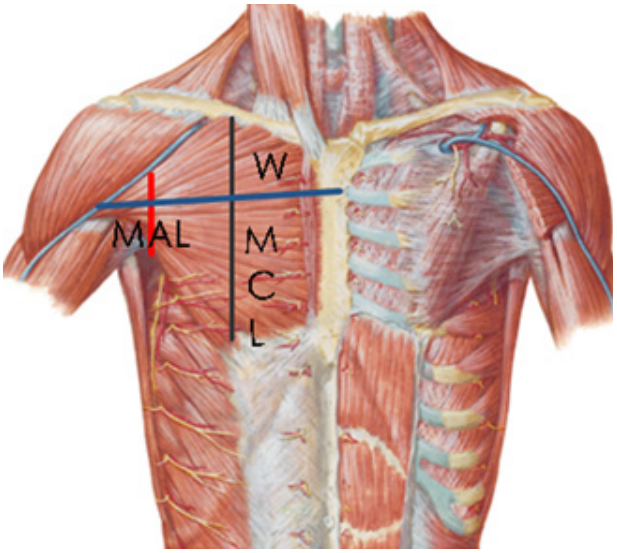

Figure 2) *Diagrammatic representation of the morphometric measurements of PM.*

Results

The mean height at the midclavicular line was found to be 13.8 cm and at the midaxillary line, it was found to be 6.6 cm. The average width was found to be 18.7 cm at the origin. The average length at the insertion was found to be 4.8 cm and the height was found to be 0.89 cm (Figures 3-9) (Table 1).

Figure 3) *The figure represents the typical morphology of the PM muscle. Typical morphology indicates the normal origin and insertion of the muscle.*

Figure 4) *Represents the nerve supply of the PM muscle. The PM muscle is supplied by both the lateral and medial pectoral nerves.*

Figure 5) *Represents the hypertrophy of the PM muscle. The muscle was measured across its length and width and the measurements were noted down to classify it as hypertrophied muscle.*

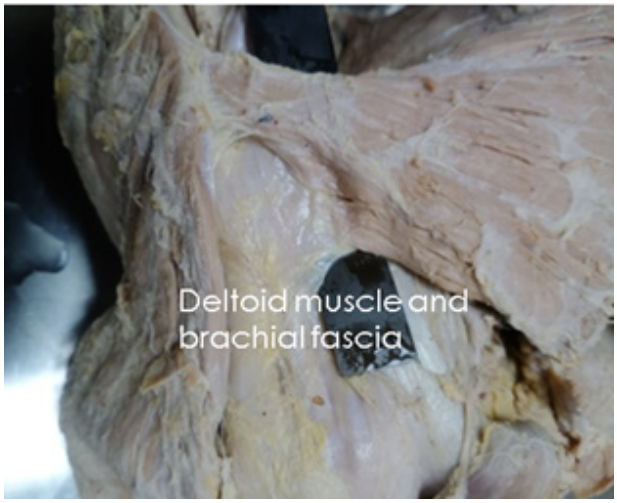

Figure 6) *Represents the Deltoid fusion with brachial fascia.*

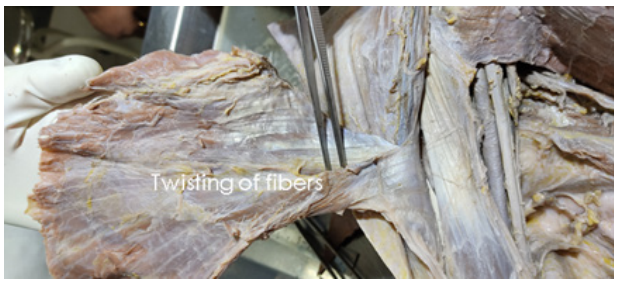

Figure 7) *Represents the twisting of fibres of the PM muscle at its insertion. All the specimens depicted the normal twisting of fibres at their insertion.*

Figure 8) *Insertion of the PM muscle at the lateral lip of humerus.*

Figure 9) *This figure represents the delto-pectoral groove. Except for two specimens, almost all the specimens showed delto-pectoral groove indicating the non-fusion of the clavicular fibers of the PM muscle and the deltoid muscle. Cephalic vein in the delto- pectoral groove.*

TABLE 1

Variations in the morphology of the Pectoralis major muscle.

Types of Variations in the morphology of the Pectoralis major muscle	Total number of specimens in which variation was observed (n=30)	Total prevalence (%) of specimens in which variation was observed
Typical morphology of the PM muscle	20	66.60%
Atypical division of the PM muscle (clavicular portion fused with upper portion of sternocostal fibers)	1	3.30%
Fusion between clavicular portion of the PM muscle and deltoid muscle.	2	6.60%
Twisting of fibers at insertion	30	100%
Fusion of fibers with the brachial fascia in arm	2	6.60%
Hypertrophy of the muscle	2	6.60%
Nerve Supply	Normal	Normal

Discussion

One of the human body's muscles with the highest degree of variability is the PM muscle. The lack of one or more heads or the entire muscle, unique groupings of heads within the muscle or with neighboring muscles, and the existence of one or more accessory muscles are only a few of the anatomical variations that have been described in the literature. Absence of the whole PM muscle is a hallmark symptom of Poland syndrome. The absence of the sternocostal head with associated hypertrophy of the clavicular head are very prevalent among aberrations. It has been widely reported that the abdominal head of the PM muscle can be absent. There are numerous instances of supernumerary muscles.

Unsurprisingly, there are a large variety of clinical manifestations that correspond to the wide variety of morphological variances. Most

patients with atypical PM muscle function are usually asymptomatic [18-20]. In the case of the congenital lack of the PM muscle, research completed by Lee and Chun (1991) [20] indicated modest reduction in peak torque and horizontal adduction power, but other than difficulty with particular motions like throwing and climbing, the patient was not seriously impaired. Atypical PM muscle insertions and the presence of specific accessory muscles, particularly those in the axilla, have the potential to entrap the neighboring axillary artery or brachial plexus branches [18,21-24]. These neurovascular entrapment symptoms frequently resemble thoracic outlet syndrome [20].

Anatomical variations may be difficult for radiologists to diagnose, even though PM muscle alterations are rarely shown on imaging [21]. It can be challenging to distinguish between baseline atypical anatomy and a soft tissue malignancy when a muscle variation does cause symptoms [21]. Even determining whether an accessory muscle is present or absent can be challenging. For instance, studies assessing the prevalence of the sternalis muscle using different imaging modalities have reported prevalence ranging from 0.018% (mammography, n=105,860 specimens) to 10.5% (computed tomography, n=1,896 specimens) [20,23,24].

In the present study, the typical morphology of the PM muscle was found in 66.6% of the cases and variations were observed in the remaining specimens.

Conclusion

PM muscle variations typically result in relatively mild functional impairments because several muscles like the serratus anterior, pectoralis minor, deltoid etc., around the PM muscle are capable of compensating. Being aware of potential variation, however, has significant surgical ramifications for breast operations, flap reconstructions, and other chest wall procedures.

Limitations of the study: A study on the arteries and nerves of the PM muscle was not conducted. This can be performed in detail in a separate study.

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