



Received: 16-03-2024
Accepted: 26-04-2024

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Surgical anatomy of the pectoral flaps, their importance in head and neck reconstruction

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DOI: <https://doi.org/10.62225/2583049X.2024.4.3.2749>

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Abstract

The pectoralis major is a broad muscle that originates from the medial part of the clavicle, anterior surface of the sternum, from the cartilages of all the true ribs and from the aponeurosis of the abdominal external oblique muscle. The study was conducted on 10 cadavers (7 male and 3 female). These specimens were dissected and examined to study the gross anatomical characteristics of the pectoralis major muscle. The dimensions of the pectoralis major muscle and its surface area were measured in all the cadavers. The branching pattern of the thoracoacromial vessels was recorded. The pedicle length and caliber were measured using Vernier calipers. In all twenty dissected specimens, the pectoral and deltoid branches of the thoracoacromial

artery were identified. The average size of the elevated flap of the pectoralis major muscle was 10 cm×6.5 cm. In this study, the average diameter of the thoacoacromial artery was 2.3 mm, and along its course, the thoracoacromial artery gave rise to two terminal branches the pectoral and deltoid arteries that supply the pectoralis major muscle and the surrounding structures. The average length of the deltoid pedicle was 6.8 cm and the average length of the pectoral pedicle was 7.5 cm. The current study focuses on the anatomical features of the pectoralis major muscle and its blood supply to increase the success rate of operations in clinical practice.

Keywords: Pectoralis Major Muscle, Thoracoacromial Artery

Introduction

Pectoralis major flap is one of the frequently used flap in the reconstruction of head, neck and supraclavicular areas. It is composed of pectoralis major muscle with or without its covering skin, and it may also include the underlying ribs. Major pedicle of the pectoral muscle flap is thoracoacromial artery, while its minor pedicle is lateral thoracic artery^[13]. For the reconstruction of the head and neck region it is mostly used over its pedicle as muscle or musculocutaneous flap. It has many advantages for the reconstruction of the region as its nearness to the region, provision of both muscle, and skin for reconstruction. Pectoral muscle basically divides into three parts as clavicular part, sternal part, and costal part^[14]. The pectoralis major muscle originates from the medial part of the clavicle, anterior surface of the sternum, from the cartilages of all the true ribs and from the aponeurosis of the abdominal external oblique muscle. The muscle fibers converge toward its insertion on the humerus. Muscle fibers arising from the clavicle pass transversely, and are often separated from the rest of the muscle by a slight gap. The remainder of the muscle courses super laterally^[7]. The tendon of the pectoralis major has a “convoluted” appearance. According to the literature it consists of two layers^[9, 10]. The clavicular tendon constitutes the first layer. The second layer is the common tendon from the sternocostal and abdominal portions. The layers screw around each other and as a result the common sterno-costo-abdominal portion fixes more distally to the humerus compare to the clavicular portion which fixes a bit proximally^[11, 12]. In literature, the different layers are named as anterior and posterior layers (lamina). In cadaver dissection, we correspondingly observed complex organization of the pectoralis major tendon. The three muscular portions together forma broad, flat, strong tendon that extends along the crest of the major tubercle of the humerus, close to the bicipital groove (intertubercular sulcus), which varies in size between 3.0-5.0 cm). However, the tendinous fibres of the three portions form three distinct layers that can be easily separated anatomically. The tendinous fibres of the three layers have different orientations in continuity of and according to the different orientation of the muscle fibres of the three heads, i.e. cranial-medial to caudal-lateral for the clavicular head, horizontal for the sternocostal head, caudal-medial to cranial-lateral for the abdominal head. This allows pulling on the proximal humerus in three different

direction, i.e. proximal direction for the clavicular head, plain adduction for the sternocostal head and distal direction for the abdominal head. Together, they allow better stabilisation of the upper arm in the adduction position. The specific tendon architecture of the pectoralis major allows surgeons to use different portions as independent muscles for shoulder joint or reconstructive surgery.

The main functions of the muscle are adduction and medial rotation of the arm. Sacrifice of this muscle leads to only minimal functional deficit because adjunct muscles of the shoulder belt can almost completely compensate for the loss [3].

The main vascular supply to the pectoralis muscle and its overlying skin derives from the pectoral branch of the thoracoacromial artery originating from beneath the midportion of the clavicle and coursing toward the xiphoid.

The thoraco-acromial artery arises from the second part of the axillary artery under the superior edge of the pectoralis minor. After piercing the clavipectoral fascia it divides into four branches-pectoral, acromial, clavicular and deltoid. The pectoral branch descends between the two pectoral muscles and is distributed to the pectoralis major and breast, anastomosing with the intercostal branches of the internal mammary artery and with the lateral thoracic artery [5].

The course of the pectoral branch of the thoraco-acromial artery can be identified by drawing a line from the xiphoid to the acromion. A second line is made vertically from the midpoint of the clavicle to intersect the first line. The course of the artery corresponds to the line drawn from the midpoint of the clavicle continuing to the medial portion of the acromion to xiphoid line [8].

The lateral thoracic artery follows the lateral border of the pectoralis minor to the side of the thorax; it supplies both pectoral muscles, the serratus anterior, axillary lymph nodes and subscapularis muscle. It anastomoses with the internal thoracic, subscapular, intercostal arteries and the pectoral branch of the thoraco-acromial artery.

The pectoralis major muscle therefore derives its blood supply from the pectoral branch of the thoraco-acromial artery, the lateral thoracic artery and to a lesser extent the superior thoracic artery(ies).

The anatomy of the pectoralis major has a unique organization and function that can be partially compensated by other muscles. Three different portions, unique blood supply, and innervation allow this muscle to be used as local autologous “spare” tissue in orthopedic and reconstructive surgery. Consequently, the pectoralis major has been successfully used for the replacement of other more important muscles with functional dysfunction of different etiology, as well as palsy or ruptures. The pectoralis major is an option for the repair of various organic defects caused by trauma or iatrogeny [18]. The first data about the surgical substitution of the muscle were published in the 30s of the XX century. Durman *et al.* (1945) described the use of the pectoralis major for replacement of the paralyzed serratus anterior [19]. This muscle has been used for scapular winging stabilization [20]. The entire pectoralis major has also been used for the replacement and reconstruction of the biceps brachii [21]. The sternoclavicular portion of the pectoralis major has been used for the elimination of the anterolateral deltoid deficiency [22], the sternocostal and clavicular portions have been used for the treatment of irreversible rupture of the subscapularis tendon [16, 17, 23-24]. Moreover, the different portions of the pectoralis major have been used in

head and neck, chest wall and upper limb orthopedic surgery [15, 25-26]. Deficiency of the rotator cuff of the shoulder has been treated with the combined transfer of the latissimus dorsi and the pectoralis major [27].

Material and Methods

This study was conducted at the Department of Human Anatomy, Faculty of Medicine, Umm AlQura University, Makkah, Saudi Arabia, between May 2024 and July 2024. Ethical clearance was obtained from the Umm Al-Qura University Ethical Committee. There was no evidence of trauma, malformation, or other pathology of the pectoral girdle. The study was conducted on 10 adult formalin-fixed cadavers (7 male and 3 female). Their ages ranged between 45 and 77 years old. These specimens were dissected and examined to study the gross anatomical characteristics of the pectoralis major muscle. The skin paddle is positioned over the pectoralis major muscle along the course of the pectoral branch of the thoracoacromial artery.

Twenty pectoralis major muscles were extensively dissected and studied. The skin is incised around the skin paddle, and the dissection is extended onto the surface of the pectoralis major muscle.

An incision is extended laterally from the peripheral margin of the skin paddle along the anterior axillary fold, which corresponds with the lateral margin of the pectoralis major muscle. The skin and breast tissue above the skin paddle is then widely elevated from the pectoralis major muscle up to the clavicle. The pectoralis major muscle is incised medially and inferiorly to the skin paddle, and is dissected from the ribs and intercostal muscles. The pectoralis major muscle is then freed alongside the sternum. The dimensions of the pectoralis major muscle and its surface area were measured in all the cadavers. The pectoral branch of the thoracoacromial artery was identified, and its course was studied and traced to its origin. The branching pattern was recorded. The pedicle length and caliber were measured using Vernier calipers. The caliper was measured at the most suitable site for use in surgical anastomosis. All measurements and data obtained were registered, recorded and photographed.

Results

The blood supply to the pectoralis major flap was provided by the thoracoacromial artery and venae comitantes via perforators through the muscle (Fig 1)



Fig 1: Showing the thoracoacromial artery and its venae comitantes

In all twenty dissected specimens, the pectoral and deltoid branches of the thoracoacromial artery were identified. (Fig 2). and the thoracoacromial artery was traced to its origin

from the axillary artery. Mostly, four arteries participate in the blood supply of the pectoralis major, including the thoracoacromial artery, the lateral and superior thoracic artery, as well as the intercostal arteries. The thoracoacromial artery arises under the junction between the middle and lateral thirds of the clavicle. It is a large vessel located on the anterior side of the axillary artery; It gives off two large branches-deltoid and pectoral-that are always present. These branches, accompanied by their vena comittants,

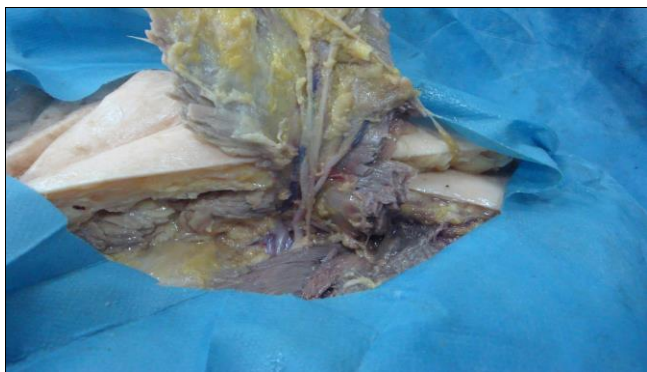


Fig 2: Showing the branches of the thoracoacromial artery

In this study, the average diameter of the thoacoacomial artery was 2.3 mm, and along its course, the thoracacomial artery gave rise to two terminal branches the pectoral and deltoid arteries that supply the pectoralis major muscle and the surrounding structures. The average length of the deltoid pedicle was 6.8 cm and the average length of the pectoral pedicle was 7.5 cm. In this study, the average size of the elevated flap (Fig 3) of the pectoralis major muscle was 10 cm × 6.5 cm.

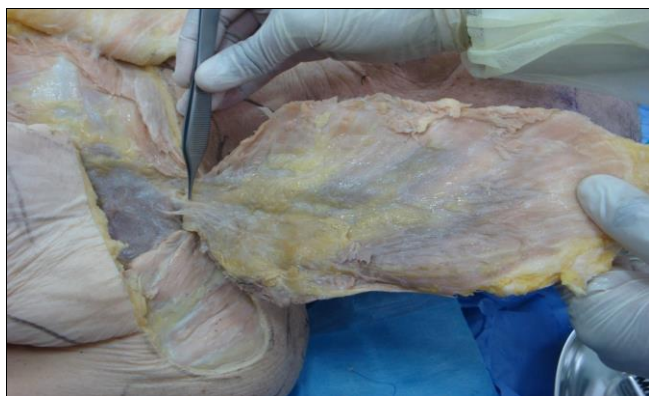


Fig 3: Showing the elevated flap of the pectoralis major muscle

Discussion

In all twenty dissected specimens, the pectoral and deltoid branches of the thoracoacromial artery were identified, and the thoracoacromial artery was traced to its origin from the axillary artery. Mostly, four arteries participate in the blood supply of the pectoralis major, including the thoracoacromial artery, the lateral and superior thoracic artery, as well as the intercostal arteries. The thoracoacromial artery arises under the junction between the middle and lateral thirds of the clavicle. It is a large vessel located on the anterior side of the axillary artery; It gives off two large branches-deltoid and pectoral-that are always present. These branches, accompanied by their vena

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In this study, the average size of the elevated flap of the pectoralis major muscle was 10 cm × 6.5 cm. There was slight difference with the finding of Eduardo *et al.* [28] who stated that the mean proximal to distal border length was 80.8mm (range: 70–90) and the medial-to-lateral border length was 6.1 mm [5-7]. The mean distance from the upper border of the pectoralis major tendon to the apex of the humeral head was 59.3 mm.

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