CASE REPORT

Combination of six variations in a single arm

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Abstract
Variations on the neuromuscular structures of the upper limb reflect the complex development of that region. Many of them may be important during surgical and/or diagnostic procedures; however, some of them are of academic interest. Here we report a case of six neuromuscular variations in a single upper limb. During routine educational dissection for the undergraduate medical students at the Department of Anatomy, Faculty of Medicine, Hacettepe University, Ankara, Turkey, we came across six variations on the left upper limb of a 43-year-old well-built male cadaver. We conformed to the steps described in Grant’s Dissector during the dissection, and photographed the case with a Nikon Coolpix camera. The biceps brachii showed an accessory head that originated from the tendon of pectoralis major, ran downwards superficial to the long head and joined the distal 1/3 of the muscle mass. A thin muscle band accompanying the lateral side of the pectoralis major was identified as pectoralis quartus. It was originated from the sixth rib and inserted to the coracoid process. The coracobrachialis was double-headed having a common origin from the coracoid process, separating into two after a short course and joining again at the middle level of the arm. Musculocutaneous nerve did not pierce the coracobrachialis. Instead, it ran beneath the two bellies of the muscle. The lateral cord of the brachial plexus passed between the two bellies of coracobrachialis; then divided into musculocutaneous nerve and the lateral root of the median nerve at a lower level than usual. The right upper limb showed no variations. The variations described here maybe commonly encountered individually; however, the combination of six of them in a single arm is previously unreported.

Keywords: supernumerary head, biceps brachii, pectoralis quartus, coracobrachialis.

Introduction
A number of variations about the muscles and nerves of the upper limb have been previously reported. Many of them may be important during surgical and/or diagnostic procedures; however, some of them are of academic interest.

The coracobrachialis muscle arises from the apex of the coracoid process of scapula, together with the tendon of the short head of biceps brachii muscle and inserts on a 3–5 cm length impression, which is replaced on the halfway along the medial border of the shaft of humerus, between the attachments of the triceps and the brachialis muscles. Accessory fibers of this muscle are generally attached to the lesser tubercle, medial epicondyle or medial intermuscular septum of humerus [1]. In the literature, there are some authors who claim that coracobrachialis has two heads: superficial and deep. Superficial head originates from the proximal 10 cm of the short head of biceps brachii and the deep one originates from the apex of the coracoid process. The two heads may be separated by the musculocutaneous nerve [2]. The coracobrachialis is completely separated into superficial and deep layers in 16%, incompletely separated in 8% and it is a whole muscle mass in 76% [3, 4].

The coracobrachialis muscle is perforated and also innervated by the musculocutaneous nerve, which is a branch of the lateral cord of the brachial plexus (90.5%). This nerve may also arise from the lateral and posterior cords (4%), from the median nerve (2%), from the medial and lateral cords as two individual bundles (1.4%) or from the posterior cord (1.4%). There are several variations in the course and distribution of the musculocutaneous nerve. The coracobrachialis is not traversed by the musculocutaneous nerve in 3.5–6.5% of the arms. This nerve innervates biceps brachii, coracobrachialis and brachialis, the muscles of the anterior region of the arm. The nerve then continues as the lateral cutaneous nerve of the forearm, a sensory branch, which courses on the lateral margin of the forearm, supplying cutaneous innervation to this area. Instead of penetrating the coracobrachialis muscle, this nerve may pass behind it or between this muscle and the short head of biceps brachii [1, 4].

The biceps brachii muscle has two heads. The short head originates from the apex of coracoid process of scapula with the coracobrachialis as a thick, flat tendon. The long head arises from the supraglenoid tubercle of scapula and its tendon passes through the capsule of the shoulder joint, it is surrounded by a double tubular sheath, it makes an arch over the head of humerus then it leaves the joint and descends in the intertubercular groove. The tendons of the long and short heads come together, pass the elbow joint and attaches as a common tendon to the radial tuberosity. This muscle is very variable. The two heads of this muscle may be totally separate, fused or absent. A supernumerary head of biceps brachii muscle is one of the most common muscular variations in the upper limb; its prevalence varies from 3 to 22.9% [5–7]. Biceps brachii muscle may be composed of one to six heads. An additional
humeral head arising from the coracoid process is found in 12% of the arms [1, 4]. The most common accessory head originates from the humerus at the insertion point of coracobrachialis muscle, courses between the coracobrachialis and brachialis and joins the short head of biceps brachii and the semilunar fascia. The other origins of the supernumerary heads of this muscle are the distal part of the deltoid tuberosity, near the insertion of coracobrachialis and the terminal part of the tendon of the pectoralis major. These heads may also arise from brachialis, brachioradialis, pronator teres muscles or the fascia covering them. The third head may also arise between the insertion of deltoid and the origin of brachioradialis.

Rare anatomic variations of the pectoral muscles are described in the literature. These are: chondroepitrochlearis, pectoralis quartus, axillary arch (Ashselbogen of Langer), sternalis and chondrofascialis muscle. Pectoralis quartus is a long, flat, band shaped muscle that arises from a point close to the costochondral junction of the 5th and 6th ribs, extends laterally along the border of pectoralis major, crosses to axilla and inserts to the tendon of pectoralis major. The width of this muscle is about 1–1.5 cm. A common band of connective tissue that connects pectoralis quartus to axillary arch or sternalis muscle can often be seen at the origin or insertion of this muscle [4, 8].

Materials and Methods

During routine educational dissection for the undergraduate medical students at the Department of Anatomy, Faculty of Medicine, Hacettepe University, Ankara, Turkey, we came across six variations on the left upper limb of a 43-year-old well-built male cadaver. We conformed to the steps described in Grant’s Dissector during the dissection, and photographed the case with a Nikon Coolpix camera.

Results

The biceps brachii showed an accessory head that originated from the tendon of pectoralis major, ran downwards superficial to the long head and joined the distal 1/3 of the muscle mass (Figure 1).

A thin muscle band accompanying the lateral side of the pectoralis major was identified as pectoralis quartus. It was originated from the 6th rib and inserted to the coracoid process (Figure 2).

The coracobrachialis was double-headed having a common origin from the coracoid process, separating into two after a short course and joining again at the middle level of the arm (Figure 3). Musculocutaneous nerve did not pierce the coracobrachialis. Instead, it ran beneath the two bellies of the muscle (Figure 3).

The lateral cord of the brachial plexus passed between the two bellies of coracobrachialis and divided into musculocutaneous nerve and the lateral root of the median nerve at a lower level than usual (Figure 4).

The right upper limb showed no variations.
Discussion

There are several studies on the variations of the upper limb in the literature [2–35].

Based on the studies about the three-headed biceps brachii in the literature, the incidence varies from one population to another. The incidence of the third head of biceps brachii was reported as 8% in Chinese, 10% in white Europeans, 12% in African blacks and 18% in Japanese [4, 9], 20% in Brazilian whites and 9% in Brazilian blacks [10], 6.2% in Nepalese [11], 8.3% in South African whites and 20.5% in South African blacks [12], 15% in 160 arms of Turkish neonatal and adult cadavers [13], 8.3% in Turkish fetuses [14]. Rai R et al. found that three of the 42 arms had third heads with humeral origin in Indian population [15].

Supernumerary heads of biceps brachii have been frequently reported [9, 16–20, 21]. Rodriguez-Niedenführ M et al. found the incidence 15.4% (27 of 175 cadavers), bilateral in five, unilateral in 22 cadavers. According to the origin and localization, they divided into groups as superior (1.5%), infero-medial (9%) and infero-lateral (0.3%) to humeral head [16]. Asvat R et al. described three different origins for the third head of biceps brachii. These are the humeral shaft, inferior to the insertion of coracobrachialis, the medial humeral shaft with the brachialis and a dual origin in which the medial fibers originating from the third head and the lateral fibers originating from the deltoid fascia and the insertion area of deltoid muscle [12]. Kopuz C et al. also found that the most frequent origin was the anterior surface of humerus, distal to the insertion site of coracobrachialis [13] (Table 1).

Pacholczak R et al. reported a case including the absence of the musculocutaneous nerve and a three-headed biceps brachii muscle [5].

In all of the above-mentioned studies, the third head of biceps brachii was innervated by a branch from the musculocutaneous nerve and the insertion of the third head was with the common tendon of biceps brachii to the bicipital aponeurosis and radial tuberosity [12–14, 22].

el-Naggar MM and Zahir FI described a combined variation of coracobrachialis muscle with two bellies and biceps brachii muscle with three bellies [9]. el-Naggar MM also studied on 36 arms and identified the presence of two heads of origin for the coracobrachialis. These heads were found superficial (anterior) and deep (posterior) to the musculocutaneous nerve. The superficial head in general originated from the medial border of the tendon of the short head, and the deep head from the tip of the coracoid process and joined to the lateral border of the tendon of the short head of biceps brachii. In almost all cases, the musculocutaneous nerve gave one branch for each and passed through the muscle [2, 23, 24].

Origins, insertions and innervations of biceps brachii and coracobrachialis according to the references were given in Table 1.

Table 1 – Origins, insertions and innervations of coracobrachialis and biceps brachii in different studies

<table>
<thead>
<tr>
<th>Origin</th>
<th>Insertion</th>
<th>Innervation</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>N, divided into two bellies.</td>
<td>One anteromedial surface of humerus, the other tendon of the medial head, triceps brachii.</td>
<td>Musculocutaneous.</td>
<td>el-Naggar MM and Zahir FI, 2001 [9]</td>
</tr>
<tr>
<td>Coracobrachialis, supernumerary head</td>
<td>Superficial head; medial border of the tendon of short head of biceps brachii. Deep head; tip of the coracoid process.</td>
<td>Joined to the lateral border of the tendon of the short head of biceps brachii.</td>
<td>el-Naggar MM and Zahir FI, 2001 [9]</td>
</tr>
<tr>
<td></td>
<td>The base and inferior surface of coracoid process.</td>
<td>Medial border of the shaft of humerus between the attachment of triceps brachii and brachialis.</td>
<td>Gupta G et al., 2012 [2]</td>
</tr>
<tr>
<td>N</td>
<td>Superficial head; medial intermuscular septum. Distal head; medial border of the shaft of humerus.</td>
<td>Lateral cord of brachial plexus.</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Olecranon process</td>
<td>Musculocutaneous.</td>
<td>Vollala VR et al., 2008 [19]</td>
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</table>
The kinematics of a muscle may be increased by the existence of a supernumerary head. Biceps brachii is a strong flexor muscle, when the forearm is supinated and also the main supinator muscle of the forearm. The supernumerary head of biceps brachii may increase the strength of flexion and supination of the forearm. Also, these additional heads and accessory muscles may cause compression of the neurovascular structures of the arm and forearm and they should have been kept in mind by the surgeons during the operative procedures [18]. Accessory coracobrachialis muscle may cause musculocutaneous or high median nerve palsy and can confuse the surgeons during surgery and evaluation of CT and MRI [25].

Gümüşalan Y et al. reported a case where the coracobrachialis was innervated by a branch arising from the lateral root of the median nerve on the right arm of a 64-year-old female cadaver. Also, the musculocutaneous nerve did not pierce the coracobrachialis and coursed downward medial of the muscle [26].

There are rare cases where the musculocutaneous nerve does not pierce the coracobrachialis. Instead, it runs downward adhering to the median nerve. Koizumi M (1989) claimed that coracobrachialis is a composite muscle that is innervated by at least two different nerves, and any change in the composition of the muscle parts may have something to do with the change in the course of musculocutaneous nerve. He examined 240 arms and found that the branches innervating coracobrachialis could be classified into three groups. In the first group, branches were arising from musculocutaneous and usually innervating the largest area of coracobrachialis. In the second group, a branch arising from the middle trunk of the brachial plexus, supplied the proximal deep part of coracobrachialis (deep branch). In the third group, branches from the ventral surface of the middle trunk, supplied the proximal ventral part of coracobrachialis. The superficial branch was found in five of 27 cases [27].

There are also frequent variations in the course and branches of the musculocutaneous nerve [1, 4]. Nakatani T et al. reported the absence of the musculocutaneous nerve [28].

Accessory muscle bundles in the axillary region have often been reported. Pectoralis quartus usually arises near the costochondral junction of the 5th and 6th ribs. It extends laterally along the border of pectoralis major but is entirely separate from it. It crosses the axilla, passes over the neurovascular bundle to insert on or near the deep surface of the tendon of pectoralis major. The quartus forms a long flat band with an average width of 1–1.5 cm. The origin and insertion of pectoralis quartus are frequently joined by a common band of connective tissue to an axillary arch and/or to a sternalis muscle when these muscles are present [4, 8, 29–31]. The pectoralis quartus is usually derived from the pectoralis major [32]. The prevalence of this muscle is 11–16% [33].

The origin and insertion of the pectoralis quartus muscle are usually constant. The origin may be the ribs, lateral border of the pectoralis major or the rectus sheath. It may course individually or it may be connected to the pectoralis major [33, 34]. It may insert into the bicipital groove, the axillary arch, the fascia of coracobrachialis or the tendon of the short head of biceps brachii [29, 32]. Caudal pectoral nerve arising from the medial pectoral nerve or 4th intercostal nerve innervates the pectoralis quartus [29, 30, 32, 35, 36].

The presence of pectoralis quartus may cause difficulty through a limited area during the axillary lymphadenectomy and also cause compression of the neurovascular bundle lying under this muscle [37].

**Conclusions**

In our study, we found a three-headed biceps brachii muscle. The third head originated from the tendon of pectoralis major, it coursed downwards superficial to the short head of biceps and attached to the distal 1/3 of the biceps brachii. Pectoralis quartus was a narrow muscle band that on the lateral side of the pectoralis major. It was originated from the 6th rib and inserted to the coracoid process. The coracobrachialis had two bellies with a common origin from the coracoid process. Musculocutaneous nerve did not pierce the coracobrachialis muscle; it ran beneath the two bellies of the muscle. The lateral cord of the brachial plexus passed between the two bellies of coracobrachialis and divided into musculocutaneous nerve and the lateral root of the median nerve at a lower level than usual. These variations of the upper arm are common individually; however, the combination of six of them in a single arm
makes this case unique. Such a combination of variations is academically significant and they may be important during surgical and/or diagnostic procedures.

References


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