

## VARIATIONS OF THE BICEPS BRACHII MUSCLE IN BRAZILIANS

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### ABSTRACT

**Background:** The biceps brachii muscle usually has two portions: the long portion, which originates from the supra-supraglenoid tubercle and the short portion that originates from the coracoid process. This study aims to determine the incidence of an accessory head of the biceps and its innervation.

**Materials and Methods:** 74 cadavers were dissected and observed in one year at the Anatomy Laboratory of the Gama Filho University and the Anatomy Laboratory of the Federal Fluminense University.

**Results:** There were variations in 10 cadavers (13,5%), nine of them were male and one were female. We found 8 different types of variations in 14 arms: (1) a biceps with four heads in the right side, where the accessory muscle belly fibers converged to the short portion (1 case); (2) a third head that originated from the lesser tubercle (bilateral); (3) a third portion of humeral origin (5 cases); (4) a third portion originating near the insertion of the pectoralis major muscle and a fourth accessory muscle belly situated near the origin of the short portion and converging to the long portion (bilateral); (5) a case in which a third portion allowed passage of the brachial vessels and the median nerve; (6) a single case where the third head originated from the insertion of the pectoralis major muscle; (7) a case where the third head originated between the pectoralis major and deltoid muscles; (8) the long portion originated near the insertion of the deltoid muscle (1 case). All reported cases were innervated by the musculocutaneous nerve.

**Conclusions:** We believe that the biceps brachii muscle is not as variable as reported in the literature and some of these variations may be clinically significant.

**KEY WORDS:** Anatomic Variations, Biceps Brachii, muscle, Brazilians, Embryology

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### INTRODUCTION

The biceps brachii muscle (BB) is anatomically

described as a “biceps”, as it presents two heads of distinct origin: the long head originates from

the supraglenoid tubercle and the short head arises from the coracoid process. Both heads converge to a common tendon that inserts itself at the radial tuberosity, also, it emits an aponeurotic expansion called bicipital aponeurosis that joins with the antebrachial fascia [1-5]. The main functions of the BB are: flexion of the elbow, flexion and abduction of the shoulder, and supination of the radioulnar joint. The BB is usually innervated by the musculocutaneous nerve, a branch from the lateral cord of the brachial plexus (5,6), although in rare cases the median nerve provides the main innervation of the muscle or communicates with the musculocutaneous nerve (MCN) [7-9].

The BB is one of the most variables muscle in the human body regarding the terms of its heads [10-12], although absence of the long or short head are rare [12]. Variations of the shape and insertions of this muscle were described by several authors, moreover, variations of the innervation and related vascular structures were also described [10-16]. BB variations can be frequently associated to the ethnicity of a specific population, as indicated by some studies [3,5,6].

The current study verifies the incidence of supernumerary bellies of the BB and its innervation in a sample of Brazilian cadavers.

**MATERIALS AND METHODS**

This study was performed at the Anatomy Laboratory of the Biological and Health Sciences Centre of the Gama Filho University and the Anatomy Laboratory of the Morphology Department of the Fluminense Federal University. A series of 74 adult cadavers fixated in 10% formalin solution were dissected in the course of a year. Our goal was to identify the origin and insertions of the long, short and accessory bellies of the BB.

**RESULTS**

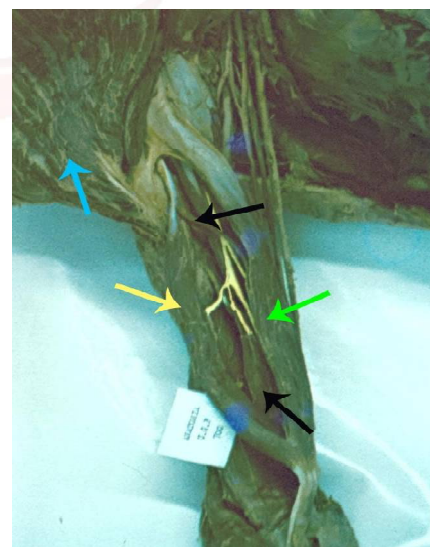
Variations in shape and insertion of the BB were found in 10 out of 74 cadavers (13,5%). In 20 arms of the 10 cadavers, 14 had variations, thus, in 148 analyzed arms, only 9,4% varied. Bilateral variation occurred in 4 arms, and 2 of them were symmetric. Eight different types of variations were found (Table 1):

Types	Percentage
Type I	7%
Type II	15%
Type III	36%
Type IV	14%
Type V	7%
Type VI	7%
Type VII	7%
Type VIII	7%

**Table 1:** Incidence of variation types of the BBM found in this study. N = 14.

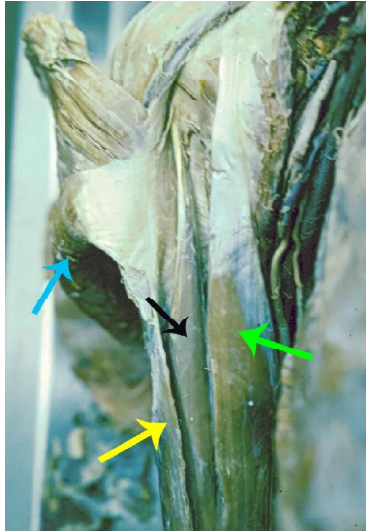
**Type I:** A case with two accessory bellies was observed, as shown in Figure 1. The long and short heads had regular origins, at the supraglenoid tubercle and coracoid process, respectively. The third head originated from the middle third of the medial face of the humerus, inserting itself at the distal tendon of the BB. Between the long and short portions, there was a fourth muscle head that originated together with the long head, but, its fibers converged to the short head of the BB. The left arm presented a third head of humeral origin, described in the type III.

**Fig. 1: Biceps variation type I.** Photograph depicting the supernumerary heads (black arrows), long head of the biceps brachii (yellow arrow), short head of the biceps brachii (green arrow) and the deltoid muscle (blue arrow).



**Type II:** It was observed a bilateral symmetric variation, where the muscle presented a third head, located between the long and short portions of the BB. This variation has its origin at the anterior surface of the humerus (minor tubercle), and its tendon ran below the pectoralis major muscle, as shown in Figure 2. The MCN provided the innervation. The long and short portions had regular origins.

**Fig. 2: Biceps variation type II.** Photograph depicting the second type, the accessory belly can be seen (black arrow), the long head of the biceps brachii (yellow arrow), short head of the biceps brachii (green arrow) and the pectoralis major muscle (blue arrow) can be seen.



**Type III:** This variation was the most frequently found (5 cadavers). The accessory belly originated from the middle third of the medial face of the humerus, in proximity with the coracobrachialis muscle insertion. The accessory belly then joined the common tendon of the BB. Out of these five cadavers, four of them presented a unilateral variation, three of them at the left arm and one at the right arm, as shown in Figure 3. The remaining cadaver had an asymmetric bilateral variation, as his right arm presented the type I variation, described earlier.

**Fig. 3: Biceps variation type III.** In this oblique view, we can see the supernumerary belly (black arrow), the long head of the biceps brachii (yellow arrow), short head of the biceps brachii (green arrow), the deltoid muscle (blue arrow), and the musculocutaneous nerve (white arrow).



**Type IV:** In another symmetric bilateral variation, the third portion had its origin near the pectoralis major muscle insertion, joining the long portion of the BB. A fourth belly originated laterally to the short head of the BB, its fibers converged to the long portion. The MCN passed between the fourth and short heads (Figure 4), and innervated the four heads.

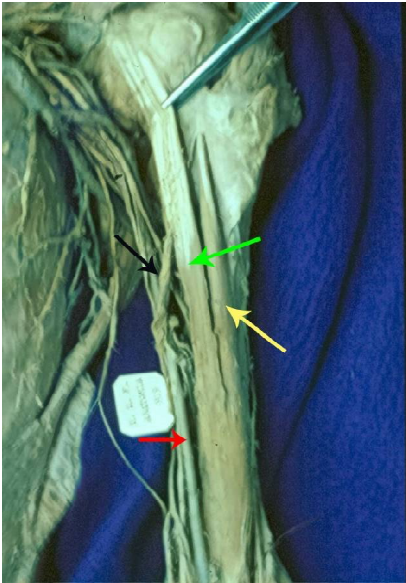
**Fig. 4: Biceps variation type IV.** Anterior view of the biceps brachii. We can observe two accessory heads (black arrows), the long head of the biceps brachii (yellow arrow), short head of the biceps brachii (green arrow), the pectoralis major muscle (blue arrow), and the musculocutaneous nerve (white arrow).



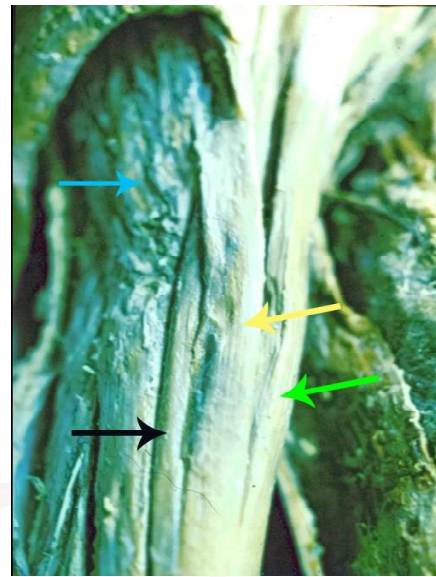
**Type V:** We observed an unilateral variation in which the third portion had a common origin with the short head of the BB (Figure 5). This variation was found at the left arm, and it was perforated by the brachial vessels and the median nerve. Those structures created a tunnel as they passed through the fibers of the accessory belly, thus, leaving their trajectory unaltered. The long and short portions had typical origins and insertions, but the third belly inserted at the medial intermuscular septum.

**Type VI:** It was observed one case of a unilateral variation with three muscles bellies. The accessory belly originated together with the insertion of the pectoralis major muscle (Figure 6). This variation occurred at the right side and the accessory belly connected the long and short portions of the BB through a tendon, which, inserted at the radial tuberosity. The long and short head had its traditional origins.

**Fig. 5: Biceps variation type V.** Anterior view of the biceps brachii. We can observe the accessory head (black arrow), the long head of the biceps brachii (yellow arrow), short head of the biceps brachii (green arrow), and the brachial artery (red arrow).



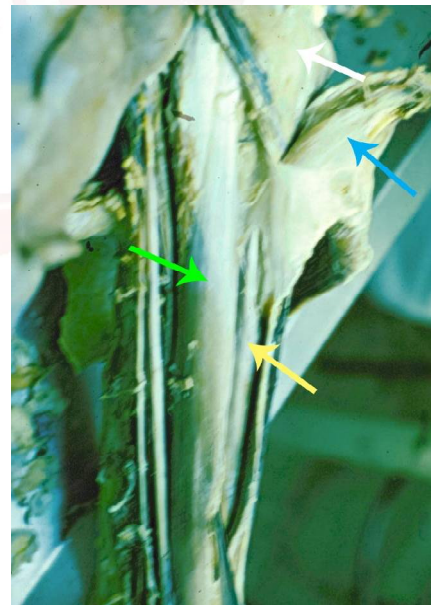
**Fig. 7: Biceps variation type VII.** In this close anterior view of the muscle compartment, we can observe the accessory belly (black arrow), the long head of the biceps brachii (yellow arrow), short head of the biceps brachii (green arrow) and the deltoid muscle (blue arrow).



**Fig. 6: Biceps variation type VI.** The accessory belly can be seen (black arrow), the long head of the biceps brachii (yellow arrow), short head of the biceps brachii (green arrow) and the pectoralis major muscle (blue arrow) can be seen.



**Fig. 8: Biceps variation type VIII.** The origin of the long head (yellow arrow) can be seen. The short head (green arrow), the deltoid muscle (white arrow), and the pectoralis major muscle (blue arrow) are also depicted.



**Type VII:** We found an asymmetric bilateral variation, the right side had a third head, which originated at the pectoralis major muscle and deltoid muscle insertions (Figure 7). The long and short heads had its typical origins. The left side had the regular two heads, although the origin of the long belly came from the deltoid muscle insertion (Figure 8), thus, we chose to classify the left side as a Type VIII.

## DISCUSSION

The arm muscles are developed in situ from the myotomes (or somites) of the upper limb bud. These somites divides into an anterior condensation and posterior condensation, the anterior portion originates the flexors and pronators muscles of the upper limb, and the posterior condensation develops into the extensors and supinators muscles of the upper limb, thus, the BB is originated from the

anterior condensation of the myotome. At a certain stage of development, the anterior condensation forms a single muscle mass that divides and originates the coracobrachialis, brachialis and BB muscles. In order to give each muscle its usual morphology, some cells suffer death, and failure of this apoptotic process could cause the appearance of supernumerary heads [6,17,18]. During latter phases of fetal development, the BB long head tendon is formed deeply to the capsule of the glenohumeral joint, as showed by Neale (1937) [19]. Yeh et al. (1999) [20] described an anomaly of the long head of the BB, which consisted of an intracapsular origin about 2 cm lateral to the superior glenoidal labrum. This was consistent with Neale's theory, as it seems that there was an incomplete differentiation of the joint capsule and the long head BB tendon which in turn caused this anomalous origin. Macalister (1875) [10] also found the long head originating from the capsular ligament.

The presence of accessory slips seems to link man's origin with lower primates, as they needed a more powerful upper limb in order to support part of their weight, since they were bipedal. They were also described as a remnant of a "tuberculo-septale head" that is present in *Hylobates*, a gibbon genus [12,21-23]. Moreover, it is speculated that the functions of the BB may be enhanced by the presence of those accessory heads [13,14,24], as the absence of a long or short head can provoke a decrease of its flexor functions [12].

Our results showed that the appearance of an accessory head at the BB is not so common, as previously reported by some authors, although it has been reported in the literature the presence of a BB with four, five, six and seven heads, albeit, the "three-headed" BB is the most prevalent of these variations [1,4,10,12,23-27]. Furthermore, it seems that the BB can vary regarding its insertions: its heads can originate from the coracoid process, pectoralis major tendon, head of the humerus, articular capsule of the humerus, or from the shaft of the humerus [10,12,18,28]. Its usual distal insertion is the radial tuberosity, although it has been described to insert into the medial intermuscular septum, and the medial epicondyle, or, to join

fibers with the flexor carpi radialis, brachialis, brachioradialis, and pronator teres muscles [10,23]. Variations of the BB and muscles from the same compartment have been described in the literature [18].

The presence of supernumerary heads of the BB ranges from 0.25% to 37.5% [10-12,20-30]. Testut and Latarjet (1960) [5] described the presence of a third head in cadavers regarding the race: 8% in Chinese, 10% in Europeans, 12% in Africans and 18% in Japanese; Kopuz et al. (1999) [27] found a third head of the BB in 15% of a Turkish neonatal and adult population. Greig et al. (1952) [29] described variations in 28 out of 130 cadavers (22%). Gray (1945) [31] described variations in 17 cadavers out of 226 (7.5%). Mori (1964) [32] found a third head in 20% of Japanese. Bergman et al. (1984) [11] reported that da Silva (1926) summarized the whole literature - 148 reports - and concluded that the supernumerary head was present in 10% of 1453 subjects. Kumar et al. 2008 [33] reported an incidence of 3.33% in their sample consisting of 96 upper limbs.

The supernumerary belly during muscle contraction can cause compression of the brachial vessels and the median nerve that passed through its fibers, as seen in the type V. Thus, the physician should be aware of these variations in order to avoid confusion during differential diagnosis, as the median nerve compression diagnosis is uncommon and inconclusive, furthermore, knowledge of these variations are essential in surgery, as they can confuse the surgeon, which can lead to an iatrogenic injury, furthermore, supernumerary heads can also create difficulty in diagnosis during magnetic resonance imaging (MRI) [9,13,14,27-35].

## CONCLUSION

Healthcare professionals should be aware of variations regarding this muscle in order to ensure a correct diagnosis and subsequent treatment.

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**Conflicts of Interests:** None

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