



Morphological Variations of Biceps Brachii Muscle in Eastern Indian Population: A Cadaveric Study

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Abstract

Background and Aims Biceps brachii (BB) is the commonest muscle in the upper limb showing variations. Supernumerary heads of biceps brachii have been frequently reported in literature. The aim of the present study is to report the occurrence and detailed anatomy of the supernumerary heads of biceps brachii, including its nerve supply among the Eastern Indian population.

Materials and Methods A total of 50 upper limbs (25 right and 25 left upper limbs) of embalmed cadavers were dissected and examined for the variation in the origin of BB.

Observations Out of 50 upper limbs, five upper limbs (10%) showed supernumerary heads of BB. Inferomedial humeral type of supernumerary head was predominant. A significant percentage (80%) of the supernumerary heads were associated with the nervous variation.

Conclusion Biceps muscle is well-known for variation in its origin. Anomalous muscle tear may present as shoulder pain in these patients, magnetic resonance imaging (MRI) may be diagnostic. Detailed anatomy of supernumerary heads serves as a potential tool for graft or flap surgeries with preservation of the function of superior extremities. The awareness of supernumerary heads of biceps brachii in relation to adjacent neurovascular bundles is necessary for modern-day imaging techniques and surgeries.

Keywords

- ▶ biceps brachii
- ▶ accessory heads
- ▶ median nerve
- ▶ musculocutaneous nerve

Introduction

The muscles of the upper limb are commonly known for variations in their morphology and innervation. Biceps brachii (BB), the most dynamic flexor muscle of the arm, shows variable anatomy which may range from its absence to supernumerary/extra heads (SH).¹⁻³ The prevalence of the SH of BB has been reported in several population groups of the world, with the highest being in South African blacks (approximately 25%) and lowest in Chinese (8%).²⁻⁴ The number of SH varies, ranging from the most common three heads to the rare seven heads. The extra heads may be unilateral or bilateral. BB muscle is usually innervated by the musculocutaneous nerve (MCN). Few cases of the absence of MCN have reported when the flexors of the arm are supplied by the median nerve (MN). Cases with SH may also be associated with variations in the course and distribution of MCN.⁵

The extra heads with variable innervations like receiving a communicating branch from MN or solely supplied by MN may manifest differently in conditions like entrapment syndrome and traumatic injury to upper arm.² Very few reports are available in Indian literature reporting the variations in the BB muscle and MCN together. Few reports are available showing variations in BB muscle or MCN separately. The aim of this study is to document the occurrence and detailed anatomy of the SH of BB, including its nerve supply among the eastern Indian population and correlate the possible clinical and embryological significance.

Materials and Methods

The study material included dissected specimens of 50 upper limbs (23 male and 2 female cadavers) assigned to the first-year medical students of the Department of Anatomy,



AIIMS Bhubaneswar between 2012 and 2018. These upper limbs were free from injuries and deformities and preserved in 10% formalin. The cadavers were initially dissected by the students as per the instruction of Cunningham's Manual Of Practical Anatomy and further dissection was performed by the authors meticulously to look for any variation in the adjacent neurovascular structures.⁶ All the upper limbs were examined for the variation in the origin of BB, if the SH were found, and further details including origin, insertion, innervation of SH and associated variation in the MCN were recorded. The specimens noticed with variations were photographed for further interpretation.

Observation

Out of 50 upper limbs, five upper limbs (10%) showed SH of BB (► Fig. 1). In these five upper limbs, one was four-headed (2% of the total) BB and the rest were three-headed (8%).

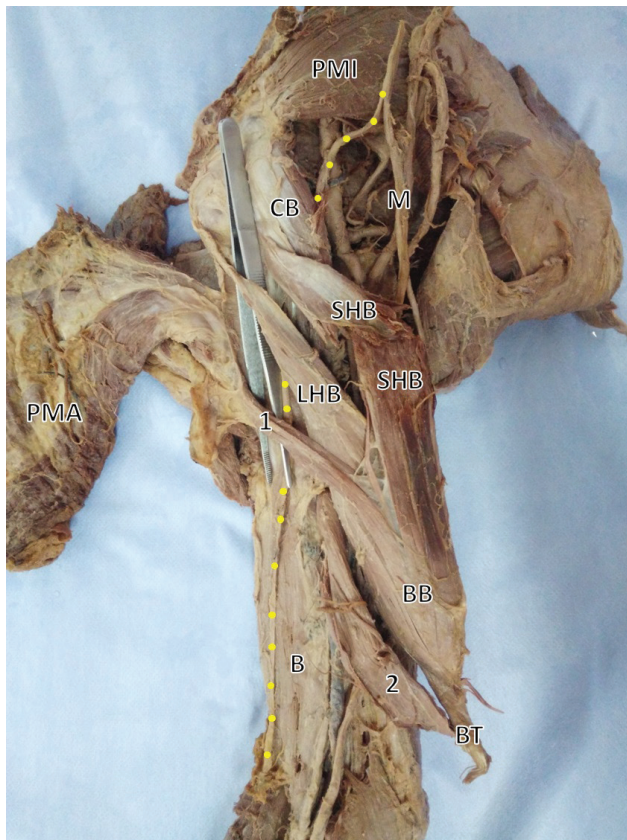


Fig. 1 Photograph of right arm showing four-headed biceps. The long head of the biceps muscle (LHB) originates from the supraglenoid tubercle and the short head of the biceps muscle (SHB) arises from the coracoid process along with the CB. The third superior humeral head of the biceps (1) originates from the external lip of the bicipital groove and the lower deep fibers of the pectoralis major tendon and inserts with the lateral aspect common belly. The fourth inferomedial humeral head of the biceps (2) originates from the medial border and the adjacent anteromedial surface of the humerus and continues inferiorly deep to common belly and inserts directly into the biceps tendon a few centimeters proximal to its bony attachments. Yellow dots showing the course of the musculocutaneous nerve. Abbreviations: CB, coracobrachialis muscle; PMA, Pectoralis major muscle; PMI, Pectoralis minor muscle; M, Median nerve; BT, Biceps tendon; B, Brachialis muscle.

Only one cadaver showed bilateral three heads of biceps and the rest were unilateral three-headed BB. Most of the SH of BB muscle originated from the shaft of the humerus inferomedial to the coracobrachialis insertion. Surprisingly, few fibers of the four-headed biceps originated from the deeper lamina of the pectoralis major tendon. The cases with three-headed BB and the SH were joined with the common belly in the middle part of the humerus, and the common tendon ultimately inserted into the radial tuberosity. In four-headed biceps, one SH contributed to the common belly and the other was inserted directly into the bicipital tendon which, in turn, inserted to the radial tuberosity. In all the cases, the MCN after supplying the coracobrachialis muscle (CB) muscle received a communicating branch from the MN and supplied the SH of BB, except in one case in which there was no communication between the MN and MCN. The observations have been summarized in ► Table 1.

Discussion

The classic description of BB muscle, as illustrated in standard textbooks, is a two-headed muscle with lateral long head having origin proximally from the supraglenoid tubercle and medial short head having origin proximally from the tip of the coracoid process of scapula along with the CB muscle.¹ Both these heads fuse at the distal part of the humerus to form a common belly and tendon which is mainly inserted at the posterior aspect of radial tuberosity, with few fibers fused with the bicipital aponeurosis for insertion into the posterior subcutaneous border of the ulna.¹ Multiple/extra heads of BB is the most common variability as observed in arm flexors.¹⁻⁴ The number of extra heads ranges from three to seven with the third head being the most common in mammals.^{2,3,7,8} The frequency of this third head of BB has a range from 7.5 to 18.3% in different populations with 2% in Indian population.² SH may have multiple sites of origin, that is, from the middle third of humerus, intertubercular groove, lesser tubercle, and rarely from pectoralis major/minor tendon.⁹ Rodríguez et al classified the SH of BB based on their origin in the humerus as superior, inferomedial, and inferolateral humeral head.² Inferomedial humeral heads are the commonest one, which is also seen in our study. Bilateral SH of BB having origin from the pectoralis major muscle, as reported earlier, is also seen in the present study.¹⁰ These extra/supernumerary fibers of biceps originating from pectoralis major tendon are prone to rupture or tear in young healthy athletes undergoing strenuous exercises.

The muscles of the arm differentiate from the limb bud mesenchyme of lateral plate mesoderm during the process of development. At various stages of development, the muscle primordia fuse to form a single muscle and the rest of the muscle primordial disappear.^{11,12} Failure of disappearance of these muscle primordia leads to additional heads.¹² Phylogenetically, the presence of the third head of the biceps muscle in humans might represent the remnant of the long head of the CB of some other primates. The SH of biceps muscle may be considered as a part of

Table 1 Details of supernumerary heads found in the present study

SI no	Side of superior extremity	Number of SH	Type	Innervation	Associated variation
1	Right	2	Superior humeral head	MCN	Nil
			Inferomedial humeral head		
2	Left	1	Inferomedial humeral head	MN	Le Minor-type V
3	Left	1	Inferomedial humeral head	MCN	Le Minor-type II
4	Right	1	Inferomedial humeral head	MCN	Le Minor-type II
5	Left	1	Inferomedial humeral head	MCN	Le Minor-type II

Abbreviations: BB, Biceps brachii; CB, Coracobrachialis muscle; MCN, Musculocutaneous nerve; MN, Median nerve; SH, Supernumerary head of biceps brachii.

the brachialis muscle where the lower insertion of brachialis migrated from ulna to radius.^{7,9,13,14} These SH of BB are considered normal in gibbons. During the evolution of gibbons to bipedal humans, the role of SH of biceps was reduced.¹⁵ SH of biceps may also associate with variation in the morphology of adjacent muscles like brachialis and CB. In the present study, none of the cadavers showed any variation in the adjacent muscles.

SH of BB muscle is commonly associated with variations in the branching pattern and distribution of MCN and MN (► **Table 2**). The MCN in its normal course pierces the CB muscles and supplies it in addition to other flexors of the arm like BB and brachialis. This pattern is absent in 11% of cases. The nerve may be totally absent in the upper limb in 3.6% of cases. The connection between MCN and MN has been classified by various authors.¹⁶⁻¹⁸ The reported incidence of this communication ranges from 27 to 36%.^{19,20} The SH of BB commonly receives a communicating branch from the MN. In one of our cases, the SH of BB is supplied only from the MCN which indicates that the SH of biceps

may be present without any neural variation. Although our sample size was small, all the cases except one received a communicating branch from the MN. The most common variation found in the present study belongs to Lee Minor type II, that is, few fibers of MN running along with the MCN and at the mid-arm level joins with the MCN as a communicating branch. Knowledge about this communication is important for surgeons while correcting the spastic elbow flexion and neurophysiologists while carrying out the nerve conduction study of MN and MCN. This is also important during management of traumatic injury of arm and axilla which needs mobilization or displacement of muscles of the anterior compartment of arm and one of the complications of this procedure is MCN injury.

The SH of BB, as reported in the literature, are rudimentary heads, contributing to less than 10% of total biceps mass.¹³ Unlike earlier reported cases, in one of our cases, the SH was found to be bulky (equal to the size of other heads). The bulky SH of biceps can increase the chance of compression of major neurovascular structures underneath, causing

Table 2 Literature review of supernumerary heads of biceps brachii with its innervation

Author (year)	Population group studied	No. of specimens studied	No. and types of supernumerary heads of BB muscle	Innervation
Nakatani et al (1998) ¹³	Japanese	50 arms	Inferomedial humeral head (4) Muscular slips (2)	MCN MCN
Rodríguez-Niedenführ et al (2003) ²	Spaniards	350 arms	Inferomedial humeral head (31) Superior humeral head (5) Inferomedial humeral head (1)	MCN and
Abu-Hijleh et al (2005) ³	Bahraini	Case report	Inferomedial humeral head (1)	Communication branch between MCN and MN
Lee et al (2011) ¹⁰	Koreans	Case report	Inferomedial humeral head (4)	MCN
Catli et al (2012) ¹¹	Turkish	Case report	Inferomedial humeral head (1) Superior humeral head (1)	Communication branch between MCN and MN
Al-Kushi et al (2013) ²⁴	Germani	40 arms	Inferomedial humeral head (6)	MN
Fraser et al (2015) ¹³	Americans	Case report	Inferomedial humeral head (1)	MCN
Angadi et al (2016) ²⁵	Indian	48 arms	Inferomedial humeral head (1)	MCN
Present study	Indian	50 arms	Inferomedial humeral head (5) Superior humeral head (1)	MCN, MN and Communication branch between MCN and MN

Abbreviations: MCN, musculocutaneous nerve; MN, median nerve.

entrapment syndrome. In patients with features of nerve compression in distal arm or forearm, the possibility SH of BB, must be ruled out.

The functional component of SH in humans has gained various controversial opinions. Considering the evolution, the additional heads may provide extra strength to the muscle during flexion and supination of the forearm. However, because of its rudimentary size (less than 10% of total biceps mass) and the chance compression to adjacent major neurovascular structure, the beneficial role has been questioned.^{2,13}

Tear in the BB muscle due to injury is common at the origin of fibers. The knowledge about isolated muscular variation helps in the differentiation of muscular variation (extra belly) from the muscular tear/rupture in magnetic resonance imaging (MRI) and ultrasonography.⁷ SH may also confuse surgeons during surgery of shoulder or arm. Even though the absence of the long head of biceps is rare, the difficulty in identification of the long head as a landmark in presence of SH of biceps poses a great challenge in arthroscopic procedures of the shoulder joint.³

BB is classified as type V muscle flap with one dominant and multiple secondary vascular pedicles.²¹ The secondary vascular pedicle (proximal and distal perforators) will feed the muscle when the dominant pedicle is sacrificed.²¹ The axillary wound in postmastectomy patients, irradiation injuries, or failed musculocutaneous flap repair requires adequate flap coverage to preserve the axillary vessels and brachial plexus.²² SH of BB muscle flap can be used to cover the axillary as well as upper arm defects in cases of elbow arthrodesis.²³ The cases with SH of BB may be an added advantage in upgrading the procedure without jeopardizing the function of the upper limb. The extra head of BB can also be used for muscle transfer in case of atrophy of the other heads due to denervation injury.

Conclusion

BB muscle is well-known for variation in its morphology and innervation. The commonest variation is an additional head. These additional heads are also associated with variation in the course, distribution, and branching pattern of MCN. This may have an unknown effect on the performance of the muscle, surgical interventions, and pain syndrome related to the upper extremity. Detailed anatomy of SH not only helps in the diagnosis of pain syndrome or atypical palsy due to abnormal innervation but also serves as a potential tool for flap surgeries with preservation of the function of superior extremities. However, larger and more detailed study is required to provide comprehensive knowledge regarding the SH of biceps with reference to its blood supply and nerve supply for modern-day imaging techniques and surgeries.

Conflicting Interest

None.

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