ANATOMICAL VARIATIONS OF THE BICEPS BRACHII MUSCLE IN THE NEPALESE POPULATION: A CADAVERIC STUDY

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ABSTRACT

The biceps brachii is the primary muscle in the anterior compartment of the arm, typically consists of two heads: the long head and the short head. It often presents with anatomical variations, including additional heads, differences in its insertion and nerve supply. The present study aimed to assess these variations in the Nepali population, with a focus on additional heads, insertional variations and nerve connections. The study was conducted on 40 dissected upper limbs from 20 cadavers (18 male and 2 female) in the Department of Human Anatomy at Nepal Medical College Teaching Hospital, Attarkhel, Gokarneshwor-8, Kathmandu, Nepal, from November 2024 to April 2025. The present study observed anatomical variations in 12.5% of the cases, specifically additional heads of the biceps brachii. One rare bilateral variation (2.5%) displayed four heads on one side and three on the other. The four-headed variant included two additional heads originating from the pectoralis major muscle, while the three-headed variant was of the inferomedial humeral type. The inferomedial humeral variation was the most common, found in 10.0% of limbs, with three occurring on the right side. These findings emphasize the inferomedial humeral variation as the most prevalent biceps brachii anomaly. In conclusion, this study revealed additional heads and a communicating branch between the musculocutaneous and median nerves. These anatomical variations can affect function, complicate diagnosis and provide options for reconstructive surgery.

KEYWORDS

Biceps brachii, anatomical variations, additional heads, musculocutaneous and median nerves

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INTRODUCTION

The biceps brachii muscle is a major flexor of the elbow and supinator of the forearm which is essential in upper limb function.[1] The anterior compartment of the arm comprises three muscles: the biceps brachii (BB), brachialis and coracobrachialis. The muscle has two heads: the long head, originating from the supraglenoid tubercle, and the short head, from the coracoid process of the scapula.[1,2] These heads merge into a single muscle belly that inserts at the radial tuberosity and extends into the bicipital aponeurosis.[1]

Variations in the biceps brachii can involve extra heads of origin or differences at its insertion, which may influence the function of muscles and lead to compression of nearby nerves anad blood vessels. These alterations can affect the function of muscles and may cause clinical complications.[3] The biceps brachii is one of the most common muscles to show variations.[4] The anatomical variations of the biceps brachii muscle are essential for anatomists and surgeons, as they can greatly affect surgical procedures in the arm and anatomical assessments. The additional heads may arise from various anatomical locations apart from the long and short heads and are common anatomical variations that differ across populations and are frequently studied.[5-7]

The musculocutaneous nerve can traverse between or through additional heads of the biceps brachii, a variation frequently associated with its interconnection to the median nerve. This pathway shows important difference in anatomy that can affect how the nerve functions.[5] Le Minor classified the anatomical variations between the musculocutaneous nerve (MCN) and the median nerve (MN) into five distinct types.[8]

Type I: This represents the normal pattern, with no communication between the MCN and MN.

Type II: Some fibers from the medial root of the median nerve pass through the musculocutaneous nerve before rejoining the median nerve further down the arm.

Type III: Fibers from the lateral root of the median nerve temporarily travel within the musculocutaneous nerve before merging with the median nerve in the arm.

Type IV: The musculocutaneous nerve and the lateral root of the median nerve initially fuse, then separate distally into their respective nerves.

Type V: The musculocutaneous nerve is completely absent. All fibers that would normally form the MCN are incorporated into the median nerve, which then gives off branches to innervate the biceps brachii and brachialis muscles.[8,9]

Additional muscle bellies can cause neurovascular compression, change the mechanics of the elbow joint and can be misidentified as muscle tears on MRI.[10] A thorough understanding of the anatomical variations of the biceps brachii muscle is crucial for improving diagnostic accuracy and enhancing surgical outcomes in both the shoulder and elbow regions.

MATERIALS AND METHODS

The descriptive observational, cross-sectional study was conducted on 40 biceps brachii muscles of embalmed cadaveric upper limbs at the Department of Human Anatomy, Nepal Medical College, from November 2024 to April 2025. The research was undertaken following ethical approval from the Institutional Review Committee of Nepal Medical College and Teaching Hospital in Kathmandu (Ref. No.: 25-081/082).

The inclusion criteria were the cadavers without any morphological abnormalities involved in upper limb and the exclusion criteria were cadavers involving congenital anomaly, traumatic limbs and fractures in their upper limbs.

The upper limbs were dissected in embalmed cadavers, which were kept in the supine position on the dissection table. A longitudinal midline incision was given on the anterior surface, beginning at the tip of the acromion process and extending approximately 3 cm below the elbow joint. Horizontal incisions were made at both proximal and distal to the main vertical incision. After carefully removing the skin, superficial fascia and fat, the biceps brachii muscle was exposed from its origin to its insertion.[11] The surrounding nerves were also dissected. The biceps brachii was then thoroughly examined for the presence of any additional heads. The origin, insertion, attachment and nerve supply of these additional heads were carefully observed, documented and photographed.

RESULTS

A total of 40 upper limbs from 20 cadavers (18 male and 2 female) were dissected and observed. Anatomical variations of the biceps brachii muscle were observed in 5 limbs (12.5%) as shown in Table 1. These variations included additional heads and variations in nerve communication.

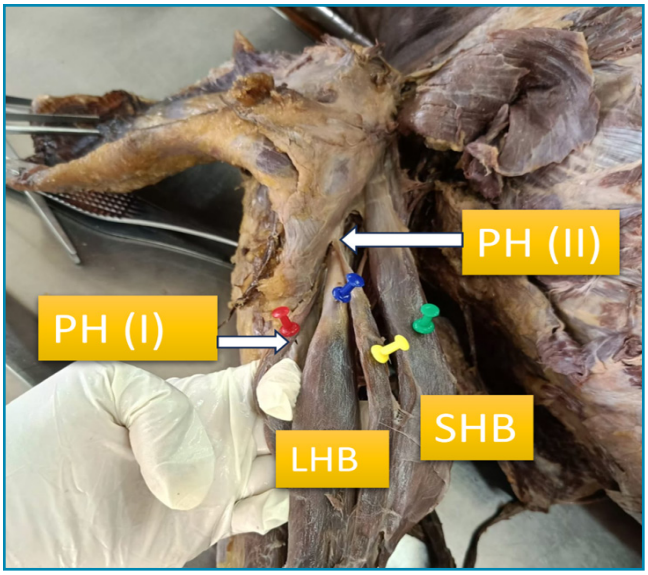

Fig. 1: Four headed biceps brachii muscle (Abbreviations: PH (I) – First pectoral head; PH (II) – Second pectoral head; LHB – Long head of biceps brachii; SHB – Short head of biceps brachii)

Fig. 2: Three headed biceps brachii muscle (Abbreviations: THB – Third head of biceps brachii; LHB – Long head of biceps brachii; SHB – Short head of biceps brachii)

Table 1: Incidence of variation in anatomy of BB muscle observed in the present study

Type of variation	Number of limbs (n=40)	%
Normal (two-headed)	35	87.5
Three-headed (inferomedial humeral type)	4	10.0
Four-headed (pectoral head)	1	2.5

A rare bilateral variation (2.5%) was identified in one cadaver. This included a four-headed biceps brachii on the right side (Fig. 1), with two additional heads arising from the deeper fibers of the pectoralis major muscle and a three-headed biceps brachii on the left side (Fig. 2), classified as an inferomedial humeral type. The inferomedial humeral type of third head was the most common variant, observed in 4 limbs (10.0%), with three cases on the right side and one on the left. Most of the additional heads originated from the anterior surface of the humeral shaft lying inferomedial to the insertion of the coracobrachialis muscle, just above the origin of the brachialis muscle. In all cases, the supernumerary belly merged with the other two heads of the biceps brachii proximal to the elbow joint (Fig. 3).

A communicating branch between the musculocutaneous and median nerves was observed (Fig. 4). Additionally, in one of the limbs with a third head, the supernumerary head was innervated by a branch from the median nerve rather than the musculocutaneous nerve (Fig. 5).

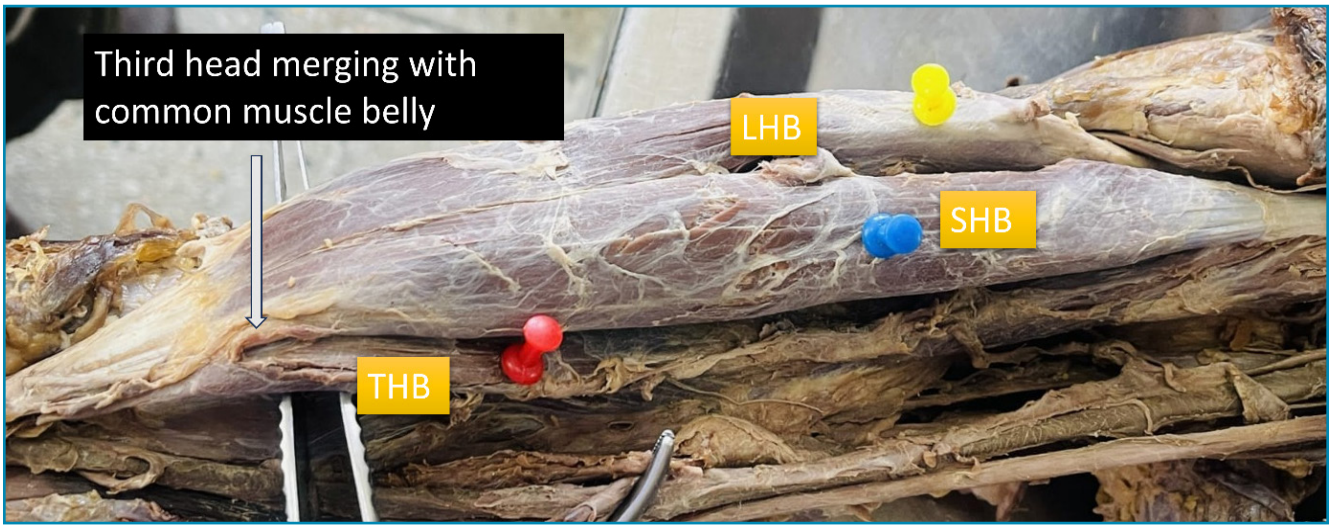

Fig. 3: The supernumerary belly merging with the other two heads of the biceps brachii muscle

Fig. 4: Communicating branch between the musculocutaneous and median nerves

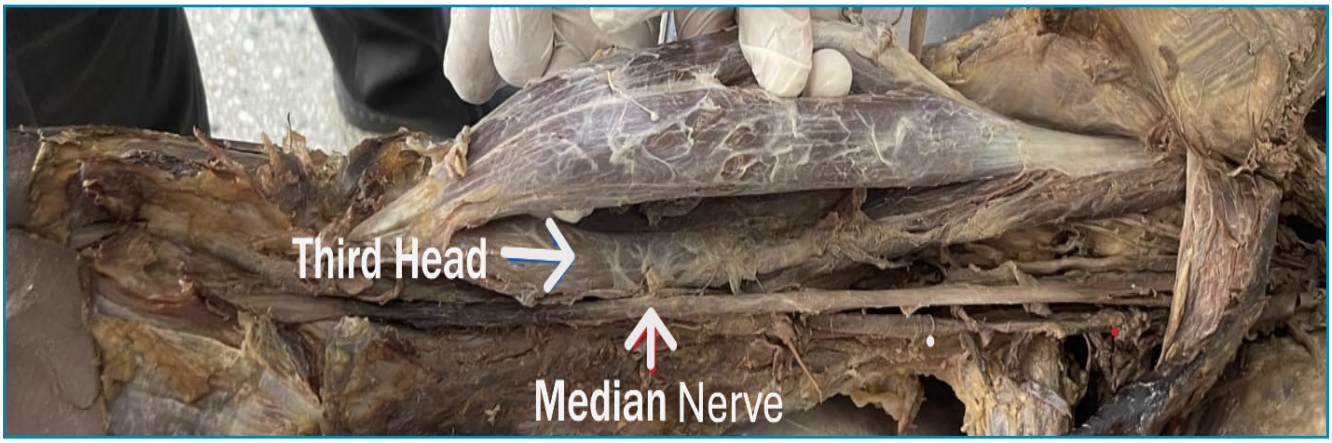

Fig. 5: Third head innervated by a branch from the median nerve

Table 2: Details of additional heads found in the present study

n	Side of superior extremity	Number of additional heads	Type	Innervation	Associated variation
1	Right	2	Pectoral head	MCN	Le Minor-type I
2	Left	1	Inferomedial humeral head	MCN+MN	Le Minor-type II
3	Right	1	Inferomedial humeral head	MCN	Le Minor-type I
4	Right	1	Inferomedial humeral head	MCN + MN	Le Minor-type II
5	Right	1	Inferomedial humeral head	MCN + MN	Le Minor-type II

Abbreviations: MCN-Musculocutaneous nerve, MN-Median nerve

DISCUSSION

The anatomical study of biceps brachii variations is essential for understanding upper limb function, surgical procedures and clinical diagnosis. While such variations have been observed worldwide, limited research exists on the Nepalese population, making this study particularly valuable in highlighting unique anatomical patterns within this group.

In the present study, anatomical variations of the biceps brachii were observed in 12.5% of the study samples. The most common variant, seen in 10.0% of limbs, was a third head of the inferomedial humeral type. A rare bilateral variation (2.5%) included four-headed biceps on one side: with two additional heads arising from the deeper fibers of the pectoralis major and three-headed biceps on the other. Frequently extra heads originated from the humerus and

Table 3: Literature review of supernumerary heads of biceps brachii with its innervation[12]

Author (year)	Population group studied	No. of specimens studied	No. and types of supernumerary heads of BB muscle	Innervation
AI-Kushi *et al* (2013)[22]	Germani	40 ULs	Inferomedial humeral head (6)	MN
Abu-Hijleh *et al* (2005)[23]	Bahraini	Case report	Inferomedial humeral head (1)	Communication branch between MCN and MN
Rodriguez-Niedenfuhr *et al* (2003)[13]	Spaniards	350 ULs	Inferomedial humeral head (31) Superior humeral head (5)	MCN, MN and communication branch between MCN and MN
Nakatani *et al* (1998)[21]	Japanese	50 ULs	Inferomedial humeral head (4) Muscular slips (2)	MCN MCN
Angadi *et al* (2016)[24]	Indian	48 ULs	Inferomedial humeral head (1)	MCN
Ravi *et al* (2020)[12]	Indian	50 ULs	Inferomedial humeral head (5) Superior humeral head (1)	MCN, MN and communication branch between MCN and MN
Presen study	Nepalese	40 ULs	Inferomedial head (4) Pectoral head (2)	MCN, MN and Communication branch between MCN and MN

Abbreviations: MCN - musculocutaneous nerve, MN – median nerve, UL – Upper Limb.

merged with the main muscle near the elbow. Nerve variations included a communicating branch between the musculocutaneous and median nerves, with one supernumerary head innervated by the median nerve.

These findings are consistent with the results reported by Ravi *et al*,[12] which documented a 10.0% incidence of supernumerary heads in upper limbs, including 8.0% with three-headed and 2.0% with four-headed biceps brachii. In their study, extra heads originated from the humeral shaft below the insertion of the coracobrachialis, while in four-headed variants, some fibers arose from the tendon of the pectoralis major. In cases with three heads, the supernumerary head merged with the common muscle belly; in four-headed configurations, one additional head fused with the belly while another inserted directly into the bicipital tendon. Similar to our findings, Ravi *et al*[12] observed a communicating branch from the median nerve to the musculocutaneous nerve supplying the extra head.

Rodríguez *et al*[13] classified the supernumerary heads of the biceps brachii according to their origin in the humerus as superior, inferomedial and inferolateral. Inferomedial humeral heads are the most common, which was also observed in our study. The number of extra heads ranges from three to seven, with the third head being the most commonly observed in mammals.[12,13] The frequency of this third head of BB has a range from 7.5 to 18.3% in different populations. All the supernumerary biceps brachii observed in the present study were found in males, a finding that is also supported by previous studies.[14,15]

The musculocutaneous nerve has been reported to pass between supernumerary heads sometimes even piercing them, often associated with an interconnection to the median nerve.[16] Similar findings were also observed in our study. In comparison, Gupta *et al*[4] reported a 6.67% incidence of additional biceps heads in their study, all being located on the right side. Unlike the present study, all supernumerary heads observed by Gupta *et al*[4] were innervated exclusively by branches of the musculocutaneous nerve, which coursed between the short and accessory heads.

Neural variations involving the musculocutaneous nerve (MCN) and its relationship with supernumerary heads of the biceps brachii were evident in current study. The MCN was the primary nerve of most of the additional heads, either alone or in combination with the median nerve (MN). Communication between the MCN and MN was observed in three limbs, corresponding to Le Minor type II, where MN fibers travel with the MCN and rejoin the MN at the mid-arm level. Two other limbs demonstrated Le Minor type I, where both nerves remained distinct (Table 2). These

findings align with previous studies that report musculocutaneous–median nerve (MCN–MN) communication in 27–36% of cases.[12,17,18,19,20] Understanding such anatomical variants is clinically important during surgical procedures, trauma management, and nerve conduction studies. A review of the literature (Table 3) describes the presence of supernumerary heads of the biceps brachii muscle and their associated patterns of innervation, including variations involving the musculocutaneous and median nerves.

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