

Research Article

Dual Innervation of Human Brachialis Muscle

Shalini Chaudhary^{1*}, Sarvesh², Rimpi Gupta³

^{1,3}Assistant Professor, Department of Anatomy, B.P.S.G.M.C. Khanpur, Kalan, Sonapat, Haryana, India

²Assistant Professor, Department of Anaesthesiology, B.P.S.G.M.C. Khanpur, Kalan, Sonapat, Haryana, India

***Corresponding author**

Dr. Shalini Chaudhary

Email: dr_chaudhary23@rediffmail.com

Abstract: Brachialis muscle anatomy and its innervation has been studied previously by many authors. There have been inconsistent description of the brachialis muscle anatomy in literature. In the present study 40 upper limbs of twenty embalmed Indian cadavers were dissected and found that all specimens of the brachialis had 2 heads, superficial and deep. The larger, superficial head had more proximal origin and distal insertion than deep head. In all specimens, brachialis was supplied by musculocutaneous nerve while only 70% (28/40) cases received branch from radial nerve. All specimens of superficial head and 20% (8/40) specimens of deep head were supplied by branches from musculocutaneous nerve entering in their upper third part only. Branches from the radial nerve were observed to enter in 5% (2/40) specimens of superficial head in upper third part and 65% (26/40) specimens of deep head in lower two-third part. These anatomical facts have implications for humeral surgery including both anterior and anterolateral approaches.

Keywords: Brachialis, Radial nerve, Cadaver, Musculocutaneous nerve.

INTRODUCTION

Attachment of human brachialis muscle has been investigated by many researchers [1, 2] showing the consistent presence of superficial and deep heads in the brachialis with anatomical dissection and /or M.R.I. techniques. Above all, many anatomy students usually has question about the presence of a well defined separation plane in the bulk of muscle as text books [3, 4] describes presence of 2 heads in brachialis as a variation and not a regular feature.

Innervation of the brachialis too is a long running controversy as most of the authors have considered the musculocutaneous nerve to be the sole motor supply or thought the radial nerve contribution entirely sensory. While some workers [5-8] have claimed radial nerve supply to be motor also in function by observing contraction in a part of the brachialis muscle in a patient with completely severed musculocutaneous nerve after giving intra operative stimulation. The reported incidences of radial nerve innervations to brachialis has varied from 67% to 100 % by different workers in different populations [6, 8-10]. Although detailed anatomy of radial supply to brachialis is widely described in literature, but the information on the distribution of radial and musculocutaneous nerve within the muscle in reference to the presence of superficial and deep heads in brachialis remains inconclusive. In the present study an attempt has been made to describe gross morphology and innervation of brachialis muscle in order to refine

the current anterior and anterolateral surgical approaches to the humerus around the elbow joint by better understanding of internervous plane.

MATERIALS AND METHODS

Twenty embalmed cadavers (40 upper limbs) including 11 males and 9 females were dissected on both right and left side. Skin and subcutaneous tissue were removed from the anterior aspect of arm and upper forearm, exposing the muscles. The musculocutaneous nerve was identified in the plane between bicep and brachialis and its branches to the brachialis were recorded. The radial nerve was then cleaned to see its course from the posterior to anterior compartment of the arm and any branch(es) to the brachialis muscle were noted. The brachialis muscle was completely visualized during dissection, and its length was visually divided into three equal segments to allow comparison with previous studies [6]. The segment into which branches from radial and musculocutaneous nerve entered was recorded. We carefully followed each subdivision from radial and musculocutaneous nerve into the brachialis as far as possible by teasing the muscle fibers away from the branches using forceps and scalpel. We also noted the course of the branches after they arose from the main trunk. For each arm, a tape measure was used to measure the distance from the tip of the acromion process to the proximal part of the tip of the lateral epicondyle of the humerus. Measurements of the total length of the brachialis muscle and length of its extramuscular

tendinous part were expressed as a percentage of the distance between the lateral epicondyle and acromion. Histological sections were made of 5 branches of the radial nerve to brachialis to confirm the presence of nerve tissue.

RESULTS

Gross morphology of brachialis

Brachialis muscle was seen uniformly to be consisting of 2 heads, superficial and deep (Fig. 1). The superficial head forming the main bulk of the muscle originated from the anteromedial and anterolateral surface of the middle third of humerus, embracing the deltoid insertion. In addition, it also had attachment to the adjoining part of the lateral intermuscular septum. Its fibers ran vertically and terminated in a thick tendon to be inserted onto the ulnar tuberosity. Fibers of the deep head could be seen arising from the anteromedial and anterolateral surface of the distal third of the humerus. In addition fibers were seen to be attached to the medial and lateral intermuscular septum. Fibers of the deep head coming from anterolateral surface ran obliquely across the elbow joint crossing from lateral to medial side. Some of these fibers invaginated the tendon of the superficial head and rest converged to form a thickened aponeurosis with the vertically running fibers of the deep head (coming from anterior-medial surface) to be inserted on to the medial side of the coronoid process. There was no direct muscular attachment of brachialis to anterior surface of elbow joint capsule. The mean of the total length of the superficial head of the muscle as a percentage of the distance between lateral epicondyle and acromion process was 67.13% (range 60 -72%) and for deep head was 28 % (range 22-34%). The mean length of the extramuscular tendon as a percentage of distance between lateral epicondyle to acromion process for

superficial head was 54.9% (range 50-56.7%) and for deep head was 22.75% (range 18-28%).

The supply to brachialis from musculocutaneous nerve

All specimens of superficial head and 20% (8/40) specimens of deep head were supplied by branches having descending course from musculocutaneous nerve in their upper third part only. In 27.5% (11/40) specimen musculocutaneous nerve was seen to give 2 primary branches and in 72.5% (29/40) only single primary branch was observed. Intramuscularly the musculocutaneous nerve divided into branches and approaches toward the middle third and lateral portion of brachialis. A variable number of these branches entered the deep head at its upper third and in the approximate midline crossing the interval between 2 heads.

The supply to brachialis from radial nerve

70% (28/40) specimens of brachialis were innervated by a branch from the radial nerve. These branches from the radial nerve were observed to enter in 5% (2/40) specimens of superficial head and 65% (26/40) specimens of deep head. In all specimens, radial nerve was seen to give a single primary branch to brachialis, which had descending course in 10.7% (3/28) cases, straight in 82.14% (23/28) cases and recurrent or ascending course in 7.14% (2/28) cases. In all the specimens its entry into the superficial head was in upper third only, while in case of deep head in 78.57% (22/28) specimens it entered in middle third and in 14.2% (4/28) specimen into its lower third (Table 1). After entering the muscle these branches ran for a short and relatively transverse course. Regarding all the parameters that we studied, there were no statistically significant differences between male and female cadavers or between the right and left side.

Table1: Innervation pattern of radial and musculocutaneous nerve to brachialis muscle (S.H.-Superficial head, D.H.-Deep head)

Contributing nerve	Number of primary branches		Course	Site of entry into brachialis muscle					
	1	2		Upper third		Middle third		Lower third	
				S.H.	D.H.	S.H.	D.H.	S.H.	D.H.
Musculocutaneous nerve (100% of cases)	80 % (32/40)	20% (8/40)	Descending 100% (40/40)	100% (40/40)	20% (8/40)				
Radial nerve (70% of cases)	100% (28/28)		-Ascending: 7.14% (2/28) -Striaght: 82.14% (23/28) -Descending: 10.7% (3/28)	7.14% (2/28)			78.57% (22/28)		14.2% (4/28)

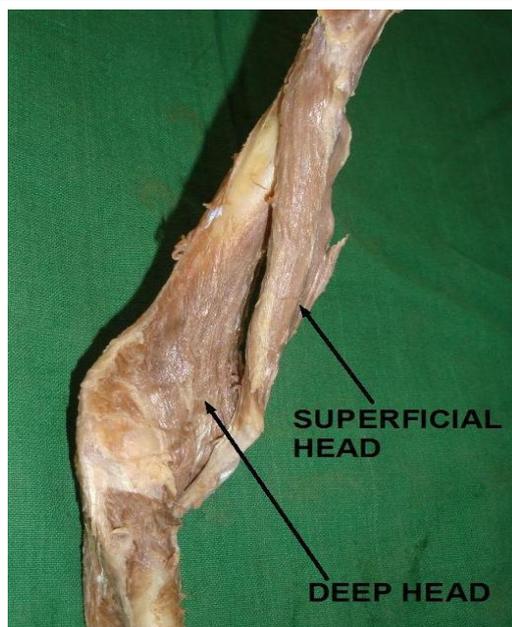


Fig. 1: Lateral view of the arm and elbow, showing superficial and deep head of brachialis muscle

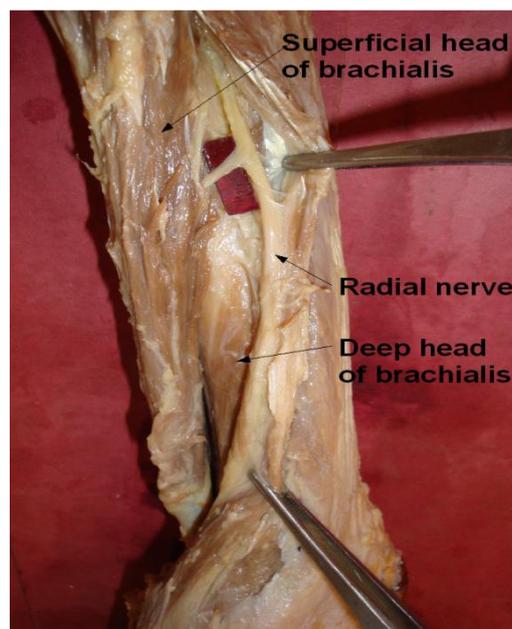


Fig. 2: Radial nerve branch entering into the superficial head of brachialis muscle

DISCUSSION

Our findings suggest that brachialis muscle uniformly consists of 2 heads, superficial and deep which is described in many of the anatomical text books as a variation only. Whereas it goes in favour of 2 previous studies of Hatice Tuba Sanel *et al.* [1] Leonello *et al.* [2]. In the present study, our finding of no direct muscular attachment of brachialis with the capsule of elbow joint concurs with Hatice Tuba Sanel *et al.* [1]. Even though Leonello *et al.* [2] reported to have noticed such attachment and termed it as “articularis cubitus”.

The differing morphology of these 2 heads indicates that they may have different developmental

origins, nerve supply and function. Embryological basis for double innervations of the brachialis muscle by branches from musculocutaneous nerve and radial nerve in 70% (28/40) specimens can be explained by union of hypomere (flexor) and epimere (extensor) muscle masses derived from two different embryonic muscular primordial [6]. In the remaining muscles (30%) specimens, the brachialis must have been contributed to, solely by the ventral muscle mass which is innervated by the musculocutaneous nerve only. We observed that superficial head was pierced by musculocutaneous nerve in all cases and by radial nerve in 5% (2/40) cases in upper third part (Fig. 2). In contrast, Leonello *et al.* [2] reported no radial supply to the superficial head. Our findings of 70% dual

innervation in 40 limbs in Indians differs from the 100% incidence of 16 limbs reported by Ip and Chang in Chinese population [8], 81.6% cases of 152 limbs by Mahakkanukrauh in Thai cadavers [6] and 67% cases of 42 limbs by Blackburn *et al.* in Caucasians [9] but resembles to 72.24% by Prakash *et al.* in 80 Indian cadavers [10]. It may reflect a difference in the sample size or ethnic differences.

Exhaustive study of literature did not yield any functional aspect of 2 heads of brachialis muscle even though Leonello *et al.* [2] claims that the deep head is more important for the initiation of flexion from full extension and the superficial 1 head provides greater power once the elbow is flexed. The possible reason of 25% (7/28) incidences of recurrent or ascending branch from the radial nerve in our study to the brachialis may be due to differential growth of the lateral intermuscular septum such that the radial nerve was pulled distally and a branch arising from it to supply brachialis had to recur.

CONCLUSION

In conclusion, this study has shown that territory of radial innervation for deep head includes its middle and lower third along the lateral margin. While twigs from musculocutaneous nerve passed upto the middle third and lateral portion in all cases of superficial head & 20% cases of deep head, and the variable number of the terminal branches from musculocutaneous nerve cross the intermuscular plane in its upper third part only. Hence lower part of this plane of separation between two heads could be used in the approaches to humerus. The lower two-third fibers of deep head in lateral portion getting supply from radial nerve could then be split from the remaining fibers of deep head (innervated by musculocutaneous nerve) to minimize denervation of the muscle.

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