

Variant Bicipital Aponeurosis: A Cadaveric Study

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ABSTRACT:

The bicipital aponeurosis, also called lacertus fibrosus, is a band of fibres arising from the tendon of biceps brachii muscle getting inserted on to the upper part of the posterior border of ulna. The function ascribed to the aponeurosis is of protection of the median nerve and the brachial artery, which pass deep to it. The bicipital aponeurosis also performs the important function of drawing the posterior border of the ulna medially during supination of the forearm. Various clinical cases have been reported implicating the aponeurosis in causation of clinical conditions like median nerve entrapment, compression of brachial artery, pronator syndrome etc. We report three cases of variant bicipital aponeurosis found during the routine dissection for teaching undergraduate medical students (year 2012-13). The cases include thickened tendinous slips bordering the aponeurosis, a third head of biceps forming the aponeurosis and the aponeurosis giving rise to some muscle fibres which join extensor carpii radialis muscle.

KEY WORDS: Biceps brachii, bicipital aponeurosis, brachial artery, median nerve, supination

INTRODUCTION:

Biceps brachii is one of the most variable muscle in the human body in terms of number and morphology. Anatomical texts describe biceps brachii as having two heads, the short head arising from a thick flattened tendon from the apex of the coracoid process and the long head from the supraglenoid tubercle of the scapula. The two tendons lead to elongated bellies that, although closely applied, can be separated to within 7 cm or so of the elbow joint. At this joint, they end in a flattened tendon which is attached to the rough posterior area of the radial tuberosity. The tendon has a broad medial expansion, the bicipital aponeurosis, which descends medially across the brachial artery to fuse with the deep fascia over the origins of flexor muscles of the forearm.^[1]

The bicipital aponeurosis attaches the biceps brachii to the posterior border of ulna, the distal end of which is drawn medially in supination. Thus, it assists

the main tendon of biceps during supination. The aponeurosis is also believed to protect the neurovascular bundle on the antecubital fossa.^[2]

Although the variations in the origin of biceps brachii are plenty, there are a very few cases reported on the variations in the insertion of this muscle. The knowledge of the accessory tendon of the biceps is crucial in avoiding pitfalls while performing tendon reconstruction and repair in cases of avulsion.^[3]

The present variations could be useful in understanding the cause of neurovascular symptoms and unusual displacement of the bone fragments subsequent to fractures in that region.

CASE PRESENTATION:

We report 3 cases of variant bicipital aponeurosis observed during routine dissection for teaching undergraduate medical students [year 2012-13]. The bicipital aponeurosis is usually formed from the main tendon of biceps. However, in the present study it was noted that the aponeurosis also received or contributed some fibres to other sources.

CASE – I:

In right upper limb of a 41 years old adult male

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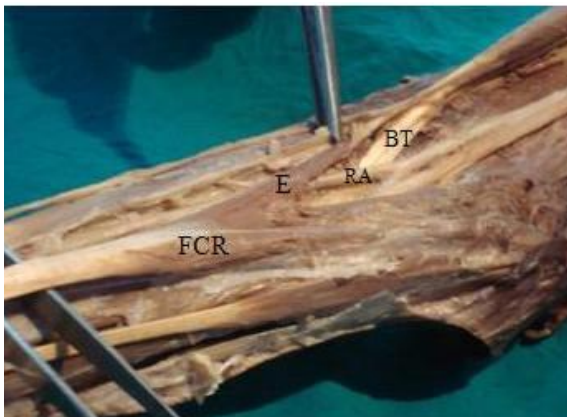
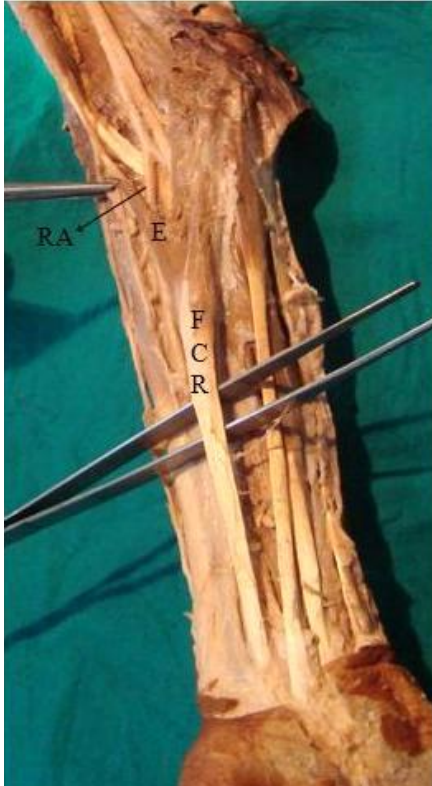


Figure 1: Extra muscle fibres originating from bicipital aponeurosis (E) and merging with the muscle belly of Flexor carpi radialis (FCR). RA: radial artery, FCR: flexor carpi radialis, E: extra muscle fibres originating from bicipital aponeurosis, BT: tendon of biceps

cadaver variant biceps brachii muscle was found. The muscle had a normal origin and course. However, some muscle fibres originated, distally towards insertion, from the bicipital aponeurosis and the terminal part of tendon of biceps brachii muscle. These muscle fibres crossed the cubital fossa from lateral to medial side, over the radial artery, and merged with the muscle belly of flexor carpi radialis muscle [Figure 1].

CASE – 2:

In a male cadaver, aged 30 years, on right side,

a third head of biceps was observed. This head originated from the superomedial aspect of the brachialis muscle. The muscle fibres of this head, instead of joining the main tendon, independently formed an aponeurosis which crossed the cubital fossa and merged with the lower margin of bicipital aponeurosis formed by the main tendon of biceps [Figure 2].

CASE – 3:

In the right upper limb of an adult male cadaver aged 36 years, the origin of the muscle was normal. But distally two discrete tendinous slip were seen to be arising as a continuation of medial and lateral most fibers of biceps brachii muscle respectively. The lateral slip merged with the bicipital aponeurosis. The medial tendinous slip passed deep to the brachial artery and then merged with bicipital aponeurosis. The brachial artery thus passed through the fibrous tunnel formed by the bicipital aponeurosis and the medial tendinous slip [Figure 3].

DISCUSSION:

There is abundant literature regarding the variations in origin of biceps brachii muscle and its supernumerary heads. But, the anatomy of distal biceps tendon still needs to be explored through contemporary research since the transition of muscle into the tendon remains vaguely understood.

Joshi SD et al (2014) reported that bicipital aponeurosis in its proximal part is contributed by the short head and distally it was derived from the fascial sheath over the tendon of long head of biceps.^[4]

Eames et al (2007) suggested that the bicipital aponeurosis may either be derived from long and short heads respectively in two distinct parts or may arise singly from interdigitating fibres of both heads.^[2]

Paval and Mathew (2006) reported a variant biceps brachii insertion in which some of the muscle fibres formed two tendinous slips. One slip passed superficial to the brachial artery and median nerve and merged with the fascia covering the flexor carpi ulnaris and the other slip passed deep to the nerve and the vessel and attached to medial supracondylar ridge of the humerus.^[5]

Bhat et al (2012) reported a tendinous slip originating from the undersurface of bicipital aponeurosis which became muscular and gave extensions to both pronator teres and flexor carpi radialis. They suggested that the knowledge of the muscular variations, in any

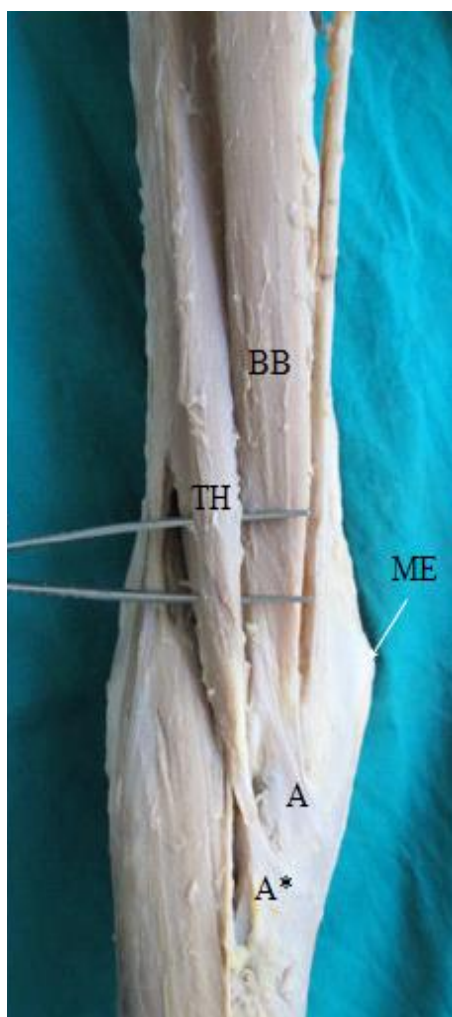


Figure 2: Third head of biceps (TH) independently forming an aponeurosis (A*) which merges with the lower margin of bicipital aponeurosis (A). BB: biceps brachii muscle, TH: third head of biceps, ME: medial epicondyle, A: bicipital aponeurosis, A*: aponeurosis formed by third head of biceps.

region, might be important for explaining the uncommon neurovascular symptoms, due to their unusual association with the neurovascular bundles in that area.^[6]

In our 1st case a muscular slip to the flexor carpi radialis passed over radial artery and in 3rd case brachial artery passed between the fibrous tunnel formed by bicipital aponeurosis and medial slip from medial side of biceps. These aberrations in the aponeurosis may thus cause compression of the underlying vessels.

In our 2nd case, a third head of biceps was found and it flared out forming an aponeurosis which merged with the bicipital aponeurosis formed by the main tendon.

Such findings could be useful for the surgeons as the accessory head and its aponeurosis could provide additional strength or cause unusual displacement of

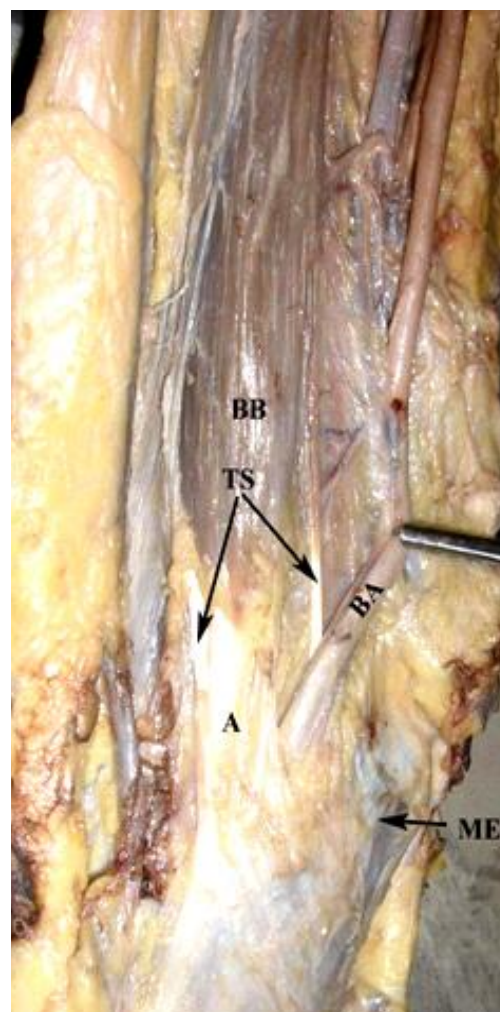


Figure 3: Two Tendinous slips (TS) originating from the biceps brachii (BB) and merging with the bicipital aponeurosis (A). BB: biceps brachii muscle, TS: tendinous slips, BA: brachial artery A: bicipital aponeurosis, ME: medial epicondyle.

the bone fragments subsequent to fractures.^[3] The double tendon insertion may also allow an element of independent function of each portion of the biceps.^[2] The knowledge of such muscular variations may be important during surgeries of the arm and elbow. Investigators have suggested that in cases of biceps tendon injury anatomic repair to both the distal tendon and the bicipital aponeurosis are required to prevent the known complication of decreased range of elbow motion, specifically of supination.^[3,7] In addition, these variations in the musculature may also cause diagnostic perplexities while interpreting MRI or CT scans.^[6] These extra slips to and from the aponeurosis can be explained embryologically by the fact that in the fourth week of intrauterine life the confined somites are individually migrating to the developing limb bud, but later several fuse to form a specific muscle.

Topographic and temporal molecular regulation leads to patterning of the muscles via differential growth and also by apoptosis. The imbalance in this process may lead to presence of additional slips to or from the bicipital aponeurosis.^[8]

Besides being the causative factor for above mentioned clinical conditions, these variations may also have some functional relevance.

Benjamin (2009) suggested that the region where a tendon, ligament or joint capsule attaches to a bone is an area of great stress concentration. Some tendons and ligaments, therefore, flare out at their attachment site to gain a wide grip on the bone and have fascial expansions to the neighboring structures to reduce this stress, as in the case of aponeurosis of biceps brachii.^[9]

Eames et al (2007) have also stated that the bicipital aponeurosis may stabilize the tendon of biceps brachii distally. In doing so, it reduces movement near the insertion site and thus stress concentration at that site.^[2]

The numerous variations reported in origin and those found in insertion suggest that biceps is a still evolving muscle. The human ancestors required a more forceful supination for throwing stones or spears at their prey.

Evolutionary evidences suggest that the Neanderthals had larger bicipital tuberosities than the modern humans and that they were probably able to use their biceps for supination over a wider range of pronation-supination. It is possible that they relied more on their biceps for forceful supination without the assistance of the supinator muscle like in modern humans.^[10]

The forearms of *H. sapiens* are less powerful in pronation and supination.^[11] Now supination is only needed during screwing-unscrewing movements, opening a door knob or picking up the food and taking it to mouth. But in sportsmen performing Discus throw or Javelin throw, again a powerful supination is required and hence they develop stronger biceps.

CONCLUSION:

The variations seen in bicipital aponeurosis may be the cause of unusual neurovascular symptoms due to entrapment of underlying vessels and nerves. It may also lead to unusual displacement of bone fragments

subsequent to a fracture or it may cause confusion during interpretation of a CT or MRI scan. These extra slips to or from the aponeurosis may also help in distribution of stress concentration and may function independently. Therefore, while performing surgery for avulsion injuries or tendon rupture both the main tendon as well as aponeurosis should be repaired to provide full range of supination.

The gradual changing need for less powerful pronation-supination, as suggested by the archaeologists, may be the cause of these variations in bicipital aponeurosis. Thus, the variations found in bicipital aponeurosis are important clinically and functionally as well as it holds some evolutionary significance also.

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