Eur. J. Anat. 24 (3): 235-238(2020)

Distal biceps tendon insertional trifurcation and a new footprint configuration: Case report of an anatomical variant

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SUMMARY

Distal biceps tendon (DBT) insertion on the elbow bicipital tuberosity is usually bifurcated into distinct long and short head components, and occasionally the tendon may insert as a single unit. A previously undescribed trifurcate insertion of the DBT was observed during anatomical dissections; this new anatomical finding involved 3 distinct divisions of the distal biceps: (1) a distal short head insertion, (2) a proximal long head insertion, and (3) an extra / accessory head that bifurcated from the long head and inserted with an anterior and radial footprint. Recognition of this variant is necessary, as DBT insertional trifurcation may alter radiological interpretation of imaging scans and may obscure endoscopic visualization of the insertional area during diagnostic endoscopy.

Key words: Elbow – Tendon – Endoscopy

INTRODUCTION

Distal biceps tendon (DBT) is composed of the continuation of the proximal long and short components, and its insertion on the bicipital tuberosity is usually bifurcated with distinct long and short head component footprints (Eames et al., 2007; Mazzocca et al., 2007; Hutchinson et al., 2008; Bhatia et al., 2017). A previously undescribed trifurcate insertion of the DBT was observed during anatomical dissections; this new anatomical finding involved 3 distinct divisions of the distal biceps: (1) a distal short head insertion, (2) a proximal long head insertion, and (3) an extra / accessory head that bifurcated from the long head and inserted with an anterior and radial footprint. This variation has important surgical implications, especially with the modern endoscopic techniques for diagnosis and newer footprint repair procedures (Bhatia, 2015; Phadnis and Bain, 2015; Bhatia and Kandhari, 2018; Bhatia et al., 2019).

CASE REPORT

Distal biceps anatomy was analyzed as a part of a larger study in several cadavers. A new variant was found unilaterally in an ethnic elderly male in a fresh-frozen cadaver (left elbow) with no surgical or injury-related scars on the entire upper limb. The exact age of the cadaveric specimen was not available. However, from the records it was estimated to be between 50 and 60 years. The entire biceps muscle was dissected and individual long and short heads in the proximal region were traced distally to their attachment on the bicipital tuberosity. The DBT sheath was intact throughout its usual course, and there were no signs of overuse or traumatic injury (bursal adhesions, tendon sheath damage, fraying or partial tears). The long head insertion was on the proximal aspect of the tuber-

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Submitted: 25 February, 2020. *Accepted:* 18 March, 2020.

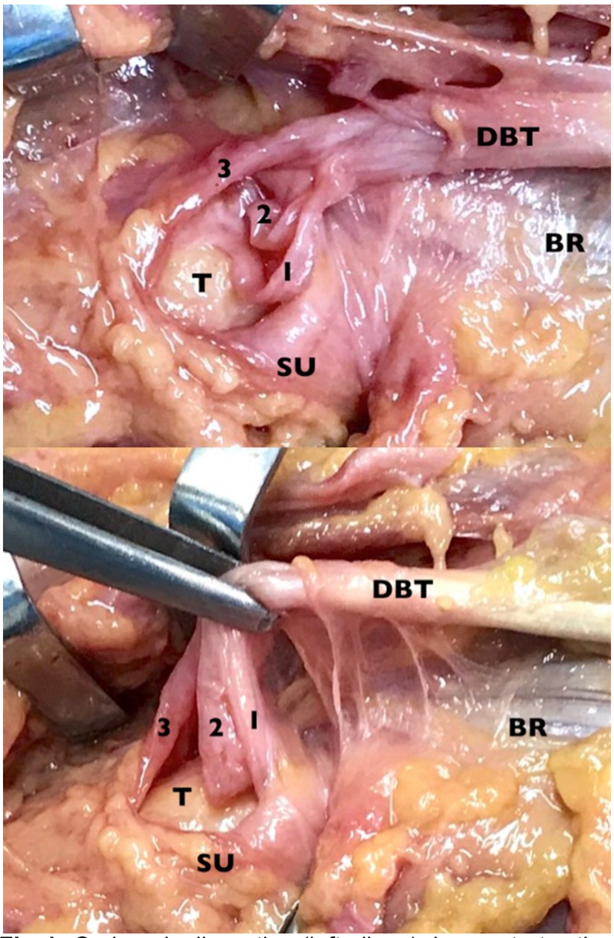

Fig 1. Cadaveric dissection (left elbow) demonstrates the distal biceps tendon (DBT) and its insertion on the bicipital tuberosity (T). **Top image**: The long head (2) inserts proximally on T and the accessory long head (1) attaches further anterior and radial to the long head (1). The short head (3) inserts on the distal aspect of the tuberosity. **Bottom image**: The insertional relationship of the three heads (1,2,3) of DBT are demonstrated after tensioning the proximal DBT. The superficial fibers of the accessory head (1) are seen to be confluent with the supinator (SU). (BR: Brachialis).

osity, and was observed to be separated in two distinct components. Of these, one component of the long head was found to insert on the proximal aspect of the roughened tuberosity area on the ulnar aspect of the tuberosity, and the accessory / variant head inserted further radial and anterior on the tuberosity bare area. Superficial fibres of the accessory head merged with the proximal supinator fibres on the radial aspect of the bare tuberosity area (Fig. 1). The short head inserted in its usual insertional area, distal to the long head, and measured approximately twice the length of each of the long head components. The three heads were inspected for inter-tendinous connections or bands, and there were no connections observed. The ulnar aspect of the DBT was then assessed and was observed to be intact and wrapped around the medial aspect of the tuberosity. The tendons were thereafter disinserted using a scalpel, and the footprints of the three heads were marked and ana-

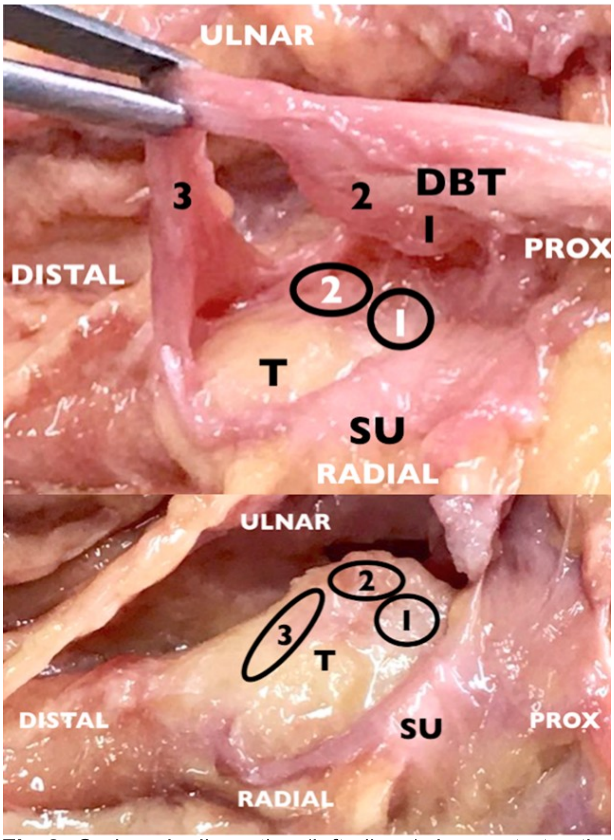

Fig 2. Cadaveric dissection (left elbow) demonstrates the footprint configuration of the trifurcate insertion of DBT. **Top image:** Insertional footprints of the two long heads (1,2) are demonstrated after disinsertion from tuberosity (T). The short head (3) is seen to insert distal to footprint 2. **Bottom image:** Overall orientation of the 3 footprints after disinsertion from tuberosity (T) are shown.

lysed. The short head footprint measured 14.6 mm in length and 4 mm in width. The proximal long head footprint measured 7.8 mm in length and 5 mm in width. The accessory long head footprint measured 6 mm in length and 4.5 mm in width. The overall combined length of the long tendon components was approximately equivalent to the length of the short tendon insertion. The distal biceps footprint index (DBFI, ratio of the lengths of the long tendon footprint and short tendon footprint on the bicipital tuberosity), as described by Bhatia et al. (2017), was calculated to be approximately 0.54 (Bhatia and Kandhari, 2018).

COMMENTS

The DBT insertional area is frequently implicated in anterior elbow pain, and the spectrum of pathology ranges from tendinosis to partial and complete tears. Imaging modalities like MRI and sonography are commonly used to evaluate the insertion, and biceps endoscopy is a minimally invasive procedure to visualize and treat pathology (Bhatia, 2015; Phadnis and Bain, 2015; Bhatia and Kandhari, 2018; Blasi et al., 2019). Precise knowledge of the insertional footprint anatomy and possible variants is necessary for correct interpretation of imaging data for accurate diagnosis and management.

The DBT extends from the musculotendinous junction to the bicipital tuberosity insertion for approximately 7 to 12 cm. The insertional tendinous region separates into a long and short head in 90% of elbows, and these insert into separate footprint areas on the roughened ulnar aspect of the tuberosity (Bhatia et al., 2017). Eames et al. (2007) suggested that the long tendon insertion occupied most of the radial tuberosity in an oval footprint, and described a narrow fan-like insertion of the short head into the distal tuberosity. Hutchinson et al. (2008) described semilunar and oval footprint shapes, and Mazzocca et al. (2007) suggested a "ribbon-shaped" insertional footprint on the tuberosity. Bhatia et al. (2017) quantified the relative contribution of each tendon on the basis of dimensions (DBFI) and insertion site on the tuberosity (on or proximal to the tuberosity), and observed 3 distinct footprint variations (Type 1: Mean DBFI 0.57, long head insertion on the tuberosity, Type 2: Mean DBFI 0.26, long head insertion proximal to and outside the tuberosity area, and Type 3: no separation between the long and short tendons, and a single DBT inserted in a C-shape configuration).

The previously undescribed anatomical finding of a trifurcate DBT insertion is different from all previous descriptions of DBT insertional anatomy. Any possibility of traumatic or disease-induced alteration of anatomy was excluded on the basis of the following: (1) presence of an intact tendon sheath, (2) absence of any anatomical evidence of disease or injury (partial tears or fraying, tendinous or bursal adhesions, intact bursal walls), (3) distinct and well-delineated footprints of each of the three heads. The presence of an accessory head at a more radial and anterior aspect of the tuberosity has important clinical implications: (a) Presence of a third anterior head may mimic a partial tear on diagnostic imaging, and radiologists should be aware of this variant. (b) The DBT insertion has recently been described as an important anatomical dynamic landmark for intraoperative location of neurovascular structures (Bhatia et al., 2019). (c) Distal biceps endoscopy is performed via a proximal parabiceps portal; an anteriorly placed long head may obscure visualization of pathology, and alternate viewing portals may be necessary (Bhatia, 2015; Bhatia and Kandhari, 2018). (d) Newer repair techniques for DBT ruptures involve reattachment of individual heads to the native footprint, and knowledge of this variant may be useful to achieve an anatomic restoration (Bhatia, 2015; Phadnis and Bain, 2015; Bhatia and Kandhari, 2018; Schmidt et al., 2017).

In summary, trifurcate insertion of the DBT over 3 distinct footprints represents a new anatomic variant that is previously undescribed and has important radiological and surgical implications.

Conflict of interest: The author(s) declare that they have no competing interests. All authors, their immediate family, and any research foundation with which they are affiliated did not receive any financial payments or other benefits from any commercial entity related to the subject of this article.

IRB information: No approval was needed for cadaver study. Waiver of review approval for the larger study was obtained (Institutional Ethics Committee (IEC-II), Seth GS Medical College and KEM Hospital, Mumbai, India). Review exemption, Dated 23rd march, 2016. Study number: EC/OA-72/2016.

Author Contributions: Deepak N. Bhatia is the sole author of this manuscript. The contributions include performing dissections, identifying the variant, documentation of images, measurements, data analysis and manuscript preparation.

ACKNOWLEDGEMENTS:

The authors are thankful to the Head of department, Department of Anatomy, Seth GS Medical College, for permission to use the laboratory and cadavers.

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