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SCIENTIFIC ARTICLE

Distal insertional anatomy of the triceps brachii muscle: MRI assessment in cadaveric specimens employing histologic correlation and Play-doh® models of the anatomic findings

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Abstract

Objectives Assess the insertional anatomy of the distal aspect of the triceps brachii muscle using magnetic resonance imaging (MRI) in cadavers with histologic correlation and Play-doh® models of the anatomic findings.

Materials Elbows were obtained from twelve cadaveric arm specimens by transverse sectioning through the proximal portion of the humerus and the midportion of the radius and ulna. MRI was performed in all elbows. Two of the elbow specimens were then dissected while ten were studied histologically. Subsequently, Play-doh® models of the anatomic findings of the distal attachment sites of the triceps brachii muscle were prepared.

Results MRI showed a dual partitioned appearance of the distal attachment sites into the olecranon in all specimens. In the deeper tissue planes, the medial head muscle insertion was clearly identified while superficially, the terminal portion of the long and lateral heads appeared as a conjoined tendon. Histologic analysis, however, showed continuous tissue rather than separate structures attaching to the olecranon.

Conclusion Although MRI appeared to reveal separate and distinct attachments of the triceps brachii muscle into the olecranon, histologic analysis delineated complex but continuous tissue related to the attachments of the three heads of this muscle. The Play-doh® models were helpful for the comprehension of this complex anatomy and might serve as a valuable educational tool when applied to the analysis of other musculoskeletal regions.

Keywords Magnetic resonance imaging · Triceps brachii tendon · Insertion anatomy · Cadavers

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Introduction

The insertional anatomy of the triceps brachii muscle into the olecranon has been the subject of previous investigations using magnetic resonance imaging (MRI) and ultrasonography (US) [1–6]. These studies have confirmed the complex distal tendinous anatomy but with discordant observations and conclusions. As a complete understanding of this anatomy is required in the planning of surgical procedures used for the treatment of injuries of the triceps brachii muscle and tendons [7–13], an investigation using MRI to study this anatomy has clinical importance. Two questions have to be addressed: are there any associated lesions and what is the classification of the triceps tear?

A review of the literature of the last 10 years reveals several orthopedic investigations related to the tendinous anatomy of this muscle, mainly utilizing anatomic dissections of this region in cadavers with few corresponding MRI studies. Most of the pertinent imaging studies have employed US, which is clearly an important clinical technique in the analysis of complete or incomplete tears and of superficial or deep injuries of the triceps brachii muscle and tendon [1, 3, 6–10]. Part of the difficulty in interpreting some of these anatomic and imaging studies is related to the inconsistent and sometimes confusing terminology. This inconsistency has led to misdiagnosis and often overestimation of the extent of the injury when MRI has been applied to the analysis of tears of the triceps tendons [7, 11–14]. Specifically, there have been conflicting interpretations regarding single or dual insertional anatomy, based in part on the discordant results related to gross anatomic and histologic investigations [11, 14].

Surprisingly, until now there were no imaging studies that really correlated all three planes of MRI with corresponding slices of cadaveric specimens. Several important structures described in the anatomic literature such as the lateral expansion, short medial head tendon, and rolled edge were never mentioned in the imaging literature. Indeed, this was the stimulus for us to initiate an imaging, anatomic, and histologic study of the triceps insertional anatomy in cadavers and, also, to employ models made of Play-doh®.

Materials and methods

Cadavers and specimen preparation

Twelve elbow specimens were obtained from 9 cadavers (four women and five men) from which bilateral elbows were utilized in 3 cadavers and single elbows were utilized in 6 cadavers. The average age of the donors at the time of death was 81 years (range 57–97 years). The specimens were obtained by sectioning the upper portion of the arms at the level of the proximal aspect of the humerus and the lower aspect of the arms through the proximal portion of the radius and ulna. None of the specimens had evidence of prior surgery or injury. MRI was performed in all specimens. Two of the elbow specimens were dissected, while the remaining 10 elbows were deep-frozen at − 40 °C (Forma Bio-Freezer®; Forma Scientific, Marietta, OH) for sectional anatomic and histologic study.

Magnetic resonance imaging

The specimens were thawed to room temperature for 24 h prior to MRI. All specimens were placed supine in a flexed

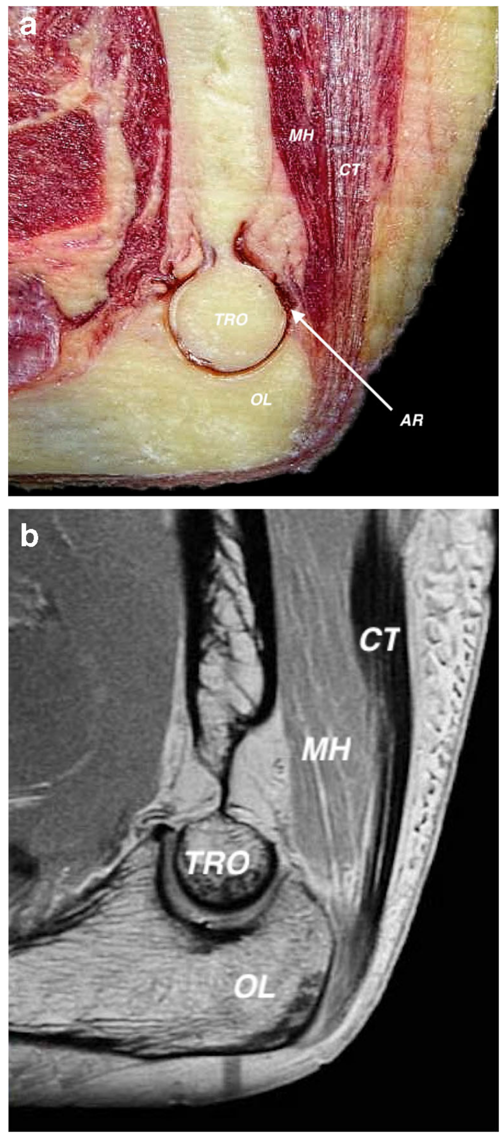

Fig. 1 Sagittal sections of a cadaveric elbow specimen showing the insertion of the triceps brachii apparatus into the olecranon. **a** Gross anatomy. **b** MRI. Representation of the two layers of the triceps attachment apparatus. Notice the muscular insertion of the medial head (MH) into the olecranon behind the central tendon insertion. White arrow indicates the articular recess (AR). AR, articular recess; CT, central tendon; OL, olecranon; TRO, trochlea

position of 90° in the center of the gantry of a 1.5-T MRI unit (Signa; GE® Medical Systems, Milwaukee, WI) in a 3-in. dual surface coil. T1-weighted spin-echo images (512/3, 3.0 mm section thickness, 0.3 intersection space, 8 × 8 cm field of view, 256 × 284 matrix) were then acquired in the axial, sagittal, and coronal planes.

MRI was interpreted in consensus among three radiologists (FVW, FJR, JRN) each having a minimum of 5 years' experience in musculoskeletal imaging. Histologic analysis was performed by an experienced orthopedic pathologist (PH), while gross anatomic inspection was performed by an experienced orthopedic surgeon (SRW).

Anatomic inspection and histologic analysis

Twelve elbow specimens were frozen (− 40 °C) immediately after the completion of MRI. Ten of these were later sectioned into slices 3 mm thick (to correspond to the thickness and level of the MRI scans) with a band saw. Eight elbows were sectioned in the sagittal plane and two in the axial plane. These slices were photographed under floodlights with a digital camera (Nikon Coolpix® 5400; Nikon, Seoul, Korea) and imaged with high-spatial-resolution radiography (Faxitron®; Hewlett-Packard, McMinnville, OR). Twelve tissue samples were obtained from 9 cadavers (12 elbows) from different transverse and sagittal sections.

The tissue samples were suspended in 10% neutral buffered formalin for at least 72 h, decalcified, and embedded in paraffin wax. After being cut into 4-μm-thick slices with a sliding microtome, the tissues were mounted onto slides, stained with hematoxylin-eosin, and analyzed under a light microscope.

The two remaining elbows were thawed and dissected. The insertional anatomy was analyzed and photographed by one of the radiologists (JRN) and the pathologist (PH).

Triceps footprint models

Based on the findings of the anatomic-imaging correlation and with knowledge of the descriptions of the footprint anatomy contained in the previously published anatomic and clinical studies, one of the authors (RM) prepared several models of the distal triceps muscles and tendons made with synthetic masses, commercially known as "Play-dohs®" (Hasbro, Pawtucket, RI).

In order to better visually and separate the many anatomic structures identified in these models, different colors were employed to represent the various tendons and muscles. These tendons and muscles were modeled over a commercial PVC replica of the elbow joint (Wellden International Inc., Richmond Hill, ON). These models were then photographed with a Nikon® camera, model D5100, with 18–200-mm lens (Nikon, Tokyo, Japan), and the photographs were edited in a MacBook Air® (Apple, Cupertino, CA) computer, with the assistance of the software ON 1 Photo Raw® 2019.5 (On 1, Portland, OR) and Adobe Photoshop Lightroom® 4 (Adobe, San Jose, CA). Vascular and neural structures were intentionally omitted from the final models.

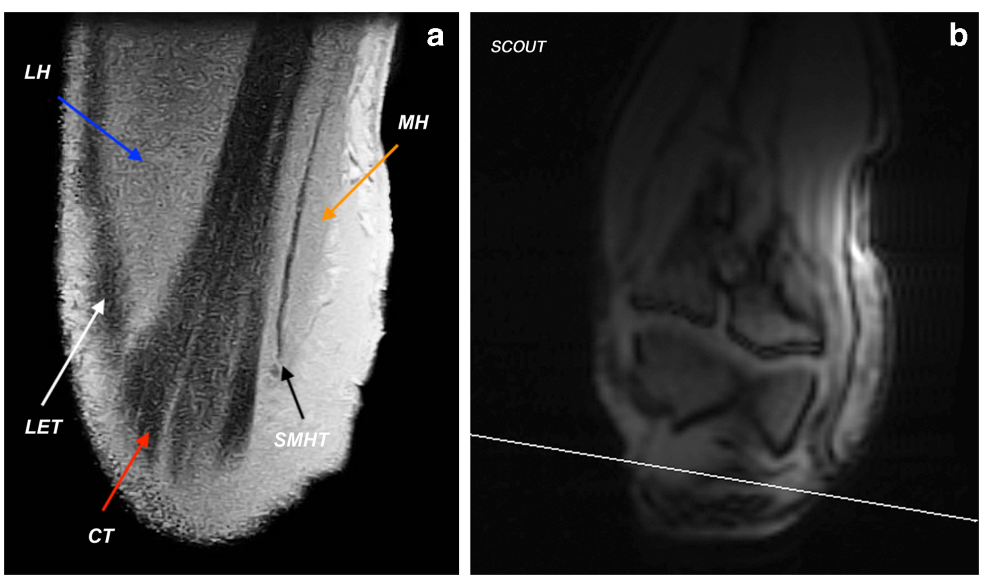

Fig. 2 **a** Coronal T1-weighted spin-echo MRI of the distal insertion apparatus of the triceps with the elbow flexed. The white arrow indicates the lateral expansion tendon (LET); the red arrow, the central tendon (CT); and the black arrow, the tendinous slip of the medial head tendon (SMHT). Between the central tendon and the lateral expansion tendon, there is the lateral head (LH) muscle belly. Medial to the central tendon there is a portion of the medial head muscle. CT, central tendon; LET, lateral expansion tendon; LH, lateral head; MH, medial head; small medial head tendon. **b** Scout image of triceps on elbow

Results

MRI and anatomic inspection and correlation

The sagittal plane showed the two layers of the triceps attachment apparatus, i.e., deep and superficial. The deep layer was composed of the muscle insertion of the medial head and a short thick tendon of the same head, which inserted directly on the olecranon. The superficial layer was composed of the central, or conjoined, tendon formed by the confluence of the lateral and long head tendons (Fig. 1).

In the coronal plane with the elbow flexed, three tendinous insertions into the olecranon were observed: the short medial head tendon, conjoined (central) tendon, and the lateral expansion tendon. On both sides of the central tendon, it was possible to see the muscle bellies of the lateral and long heads (Fig. 2).

In the axial plane, the muscular-tendinous transition and the footprint could be identified at different levels. At the footprint, it was possible to identify the insertions of the central tendon and the short tendon of the medial head; however, the muscle strip between the central tendon and the short medial head tendon was not evident in the MRI scans (Fig. 3). At the tip of the olecranon, these two insertions were very close and almost had the appearance of a single tendon insertion (Fig. 4).

Proximally, it was confirmed that the central tendon originated as the confluence of the lateral and long head tendons. The central tendon had a contiguous deep and medial thickened region, which has been previously designated by anatomic studies to be the rolled edge. The rolled edge received fiber contributions from the long and medial heads (Fig. 5). The bulky medial head muscle insertion was located behind the central tendon but was more visible in the sagittal plane (Figs. 1 and 6). In the axial plane, it was also possible to identify the lateral tendon expansion, which was contiguous with the fascia of the lateral expansion, also known as the lateral retinaculum [15] (Figs. 7 and 8). The lateral retinaculum blended with the fascia of the forearm above the anconeus muscle.

Histologic analysis

In all 12 specimens, histologic analysis did not show a separation between the central tendon and the tendon of the medial head in the region of their tendinous insertion. Instead, the triceps tendon was found to have a single insertion (Fig. 3), with the confluence of the fibers of the short tendon of medial head and the conjoined tendon.

Triceps footprint models

The models derived from the imaging and histologic data displayed a two-layered structure. The deep layer was composed of the muscular insertion of the medial head (green), as well as a short medial head tendon (red) (Fig. 9).

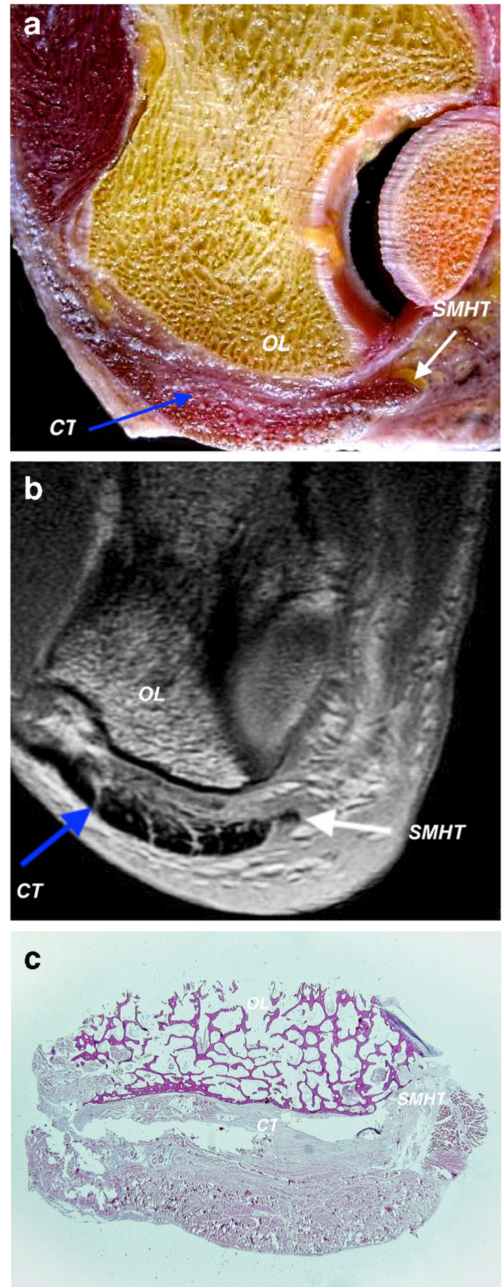

Fig. 3 Photograph of an axial cadaver specimen section (**a**), corresponding T1-weighted spin-echo MRI (**b**), and histologic hematoxylin-eosin preparation (**c**) of the distal insertion of the triceps apparatus into the olecranon (OL). The blue arrow indicates the superficial central tendon (CT), which is formed by the fibers of the lateral and long heads. The white arrow indicates the short medial head tendon (SMHT). CT, central tendon; OL, olecranon; SMHT, small medial head tendon

The muscular component and the short tendon of the medial head inserted directly into the olecranon. There was a second superficial layer above the deep one, formed by the

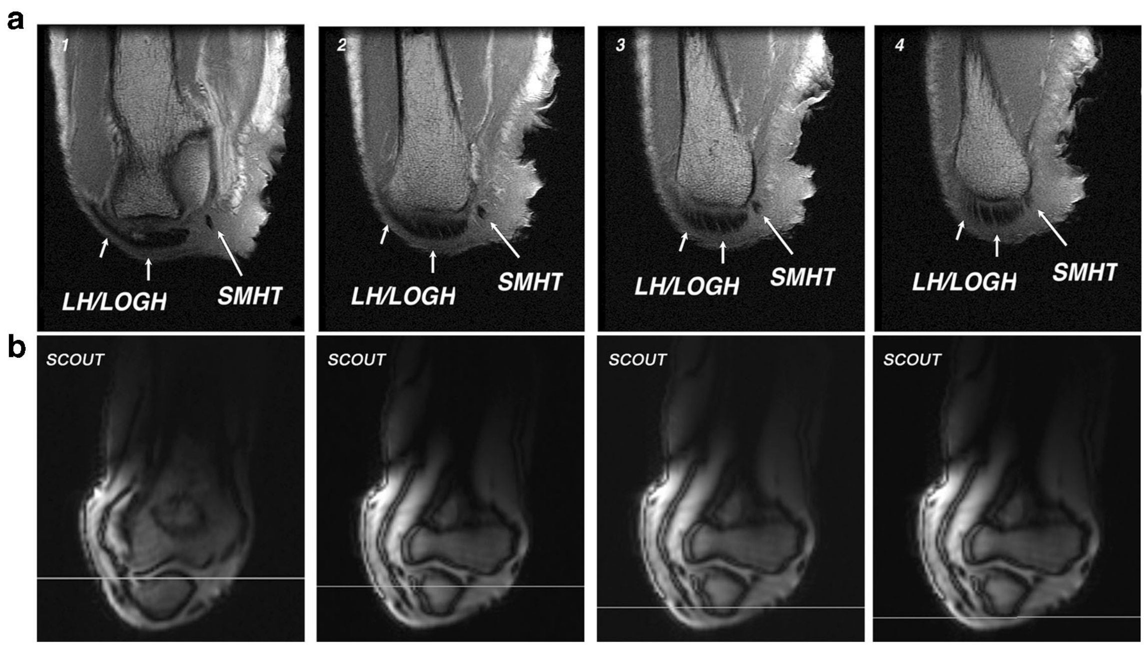

Fig. 4 **a** (1–4) Sequence of axial MRI scans of the distal triceps apparatus. The short medial head tendon has an independent origin from the central tendon. However, at the tip of the olecranon, both tendons are very close to each other separated by a muscle strip visualized in gross inspection, but not identified on MRI scans. LOGH, long head; LH, lateral head; SMHT, small medial head tendon. **b** Scout images of the sequence of axial MRI corresponding to the scans

muscular components of the long (pink) and lateral (blue) heads and a tendinous component derived from both of them (orange) (Figs. 10 and 11), represented by the central tendon and its lateral expansion (Fig. 12). Between the central tendon and the short medial head tendon insertions, a muscle strip (white) was displayed between both insertions in the olecranon (Fig. 11). The central tendon and lateral expansion were artificially separated in the models, and the lateral expansion was displayed as a structure that extended over the anconeus muscle (yellow) (Fig. 12). After opening the middle of the central tendon, the so called rolled edge was visible (Fig. 13).

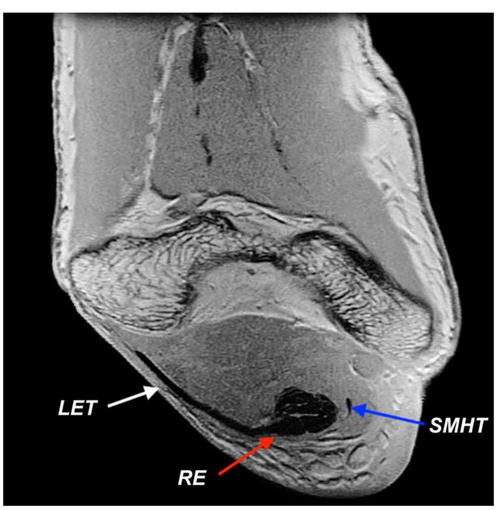

Fig. 5 T1-weighted axial spin-echo MRI at the level of the epicondyles in the distal humerus. The white arrow indicates the lateral expansion tendon (LET); the red arrow, the rolled edge (RE); and the blue arrow, the slip of medial head tendon proximal to its insertion into the olecranon (SMHT). RE, rolled edge

Discussion

A precise understanding of the anatomy of the distal triceps insertion has clinical importance in surgical planning for such procedures as reduction of displaced fractures of the distal posterior surface of the humerus, osteotomies of the olecranon, and repairs of partially or completely torn triceps tendons. Also, it is important to know that the most common associated traumatic lesion in instances of triceps tendon injuries is a fracture of the radial head, probably because of the same mechanism of injury (fall on an outstretched arm). Other possible associated lesions are medial collateral ligament tears or laxity, ulnar or radial nerve compression, and fractures about the wrist or of the humerus [14, 16–21].

Giannicola et al. [22] classified the triceps tears according to four criteria: (1) the location of the tear (muscle belly, musculotendinous junction, tendinous body, tendinous insertion); (2) the depth of the tendinous lesion (superficial tear, deep tear, and full thickness tear); (3) the degree of the tendinous and/or muscular tear (complete or partial); and (4) the

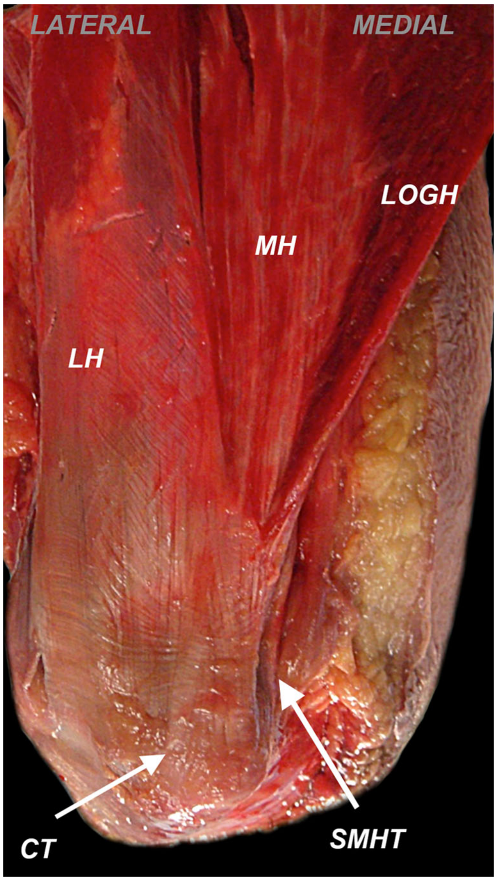

Fig. 6 Panoramic view of the medial head of the triceps apparatus after creating a window through the bellies of the lateral and long head muscles. This view allows the clear visualization of the deep (medial head) and superficial (lateral and long heads) layers. CT, central tendon; MH, medial head; LH, lateral head; LOGH, long head; SMHT, small medial head tendon

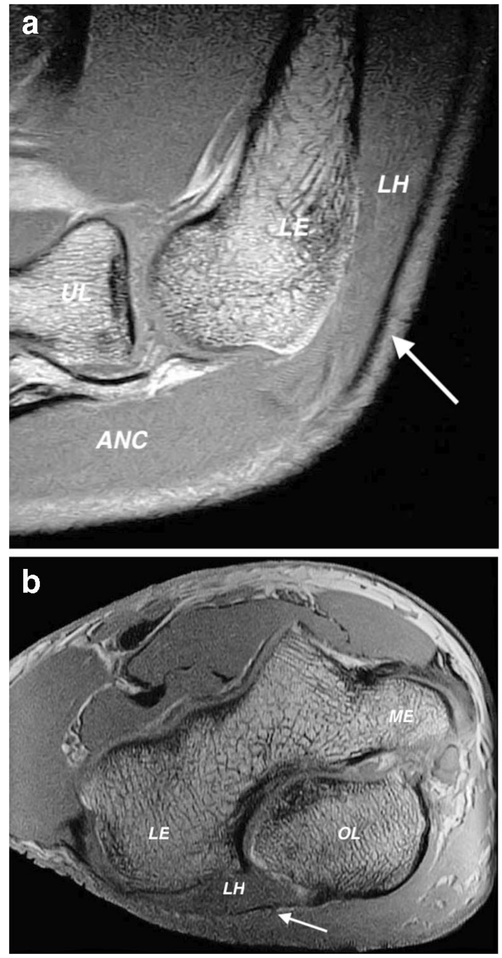

Fig. 7 T1-weighted spin-echo MRI in the sagittal (**a**) and axial (**b**) planes. The white arrows in both images show the lateral fascia. Notice that the lateral head of triceps (LH) is almost contiguous with the anconeus muscle (ANC) in the sagittal plane. ANC, anconeus; LE, lateral epicondyle; ME, medial epicondyle; OL, olecranon; UL, ulna

involvement of the lateral expansion (intact or torn). In cases of partial tears, it is important to define which head (s) is (are) torn. Sometimes, even with extensive tears, the integrity of the lateral expansion of the triceps may compensate for any loss of function related to the other torn heads, leading to an underestimation of the full extent of the injury based on clinical findings. The triceps lateral expansion may have a function similar to that of the biceps lacertus fibrosus.

Prompt surgical repair of an acute tear (less than 6 weeks old) is generally recommended with reinsertion of the footprint using suture anchors. When treatment is delayed, the degenerated and fragile aspect of the stump may prevent reinsertion of the tendon. One of the techniques used in these cases is the "anconeus slide," a complex treatment method requiring assessment of the lateral expansion anatomy and its continuity with the anconeus muscle and aponeurosis [22].

Unfortunately, despite the complex anatomy of the distal triceps mechanism and the clinical importance of defining the precise nature of any injury to this mechanism, this subject has not been addressed adequately in the imaging literature [1, 3, 11]. Traditional anatomic descriptions indicate three heads of the triceps brachii muscle, i.e., the long head, the lateral head, and the medial head, that merge to insert into the olecranon. The long head has a broad origin at the infraglenoid tubercle of the scapula and inferior glenohumeral joint capsule. The lateral head has three points of origin: the posterior surface of the humerus between the teres minor tendon insertion and the superior aspect of the spiral groove, the lateral border of the humerus, and the lateral intermuscular septum. The medial head originates from the posterior surface of the humerus, distal to the spiral groove and medial aspect of the intermuscular septum [13, 15, 19, 22, 23]. The lateral and medial heads serve only as elbow extensors, whereas the long head assists in adduction and extension of the glenohumeral joint [24].

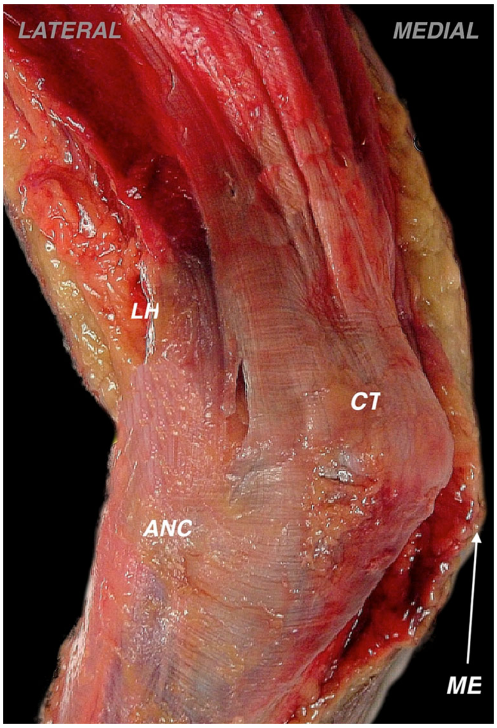

Fig. 8 Panoramic view of the triceps apparatus (with the arm located superiorly and the forearm located inferiorly). Central, or conjoined, tendon (CT) inserting into the olecranon. **a** Superficial lateral expansion fascia covers the lateral head (LH) and is contiguous with the fascia of the forearm over the anconeus muscle (ANC). CT, central tendon; LH, lateral head; ME, medial epicondyle

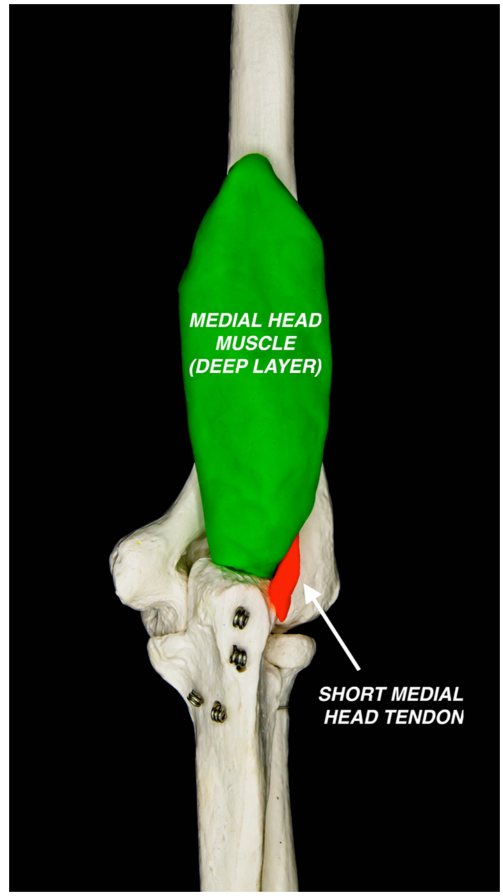

Fig. 9 Frontal view of a Play-doh® model of the first layer of distal triceps tendinous apparatus with the medial head muscle (green) and its short tendon (red)

Previous morphological and surgical investigations of this anatomy have divided the distal triceps tendinous apparatus into lateral and medial portions and superficial and deep regions [12–14, 19]. The inconsistent terminology that has been employed has led to confusion, likely affecting the accuracy of imaging reports that deal with triceps tendon tears. Specifically, the lateral and medial regions of the triceps muscle and tendinous apparatus are not synonymous with the lateral and medial muscular heads of the triceps.

Our anatomic-imaging study was intended to clarify the meaning of the medial and lateral portions of the distal triceps muscle and tendinous apparatus using MRI and employing cadaveric specimens and Play-doh® models. Based on our data, the lateral and long heads converge centrally to terminate as a superficial conjoined tendon, which has a thickened medial and deep region, the so called rolled edge. The rolled edge, as described by Keener et al. [12, 13], has contributions from both the long and the medial heads, and its location in this study was very easily identified in the axial MRI images.

Our anatomic inspection also allowed identification of a thin strip of the tendon of the medial head that was located adjacent to the central tendon, a muscle strip that was previously identified by Keener et al. [12]. This strip, however, was not visible on MRI in any of our specimens.

The superficially located central tendon and part of the medial head muscle were considered the medial portion of the distal triceps apparatus. There was also a medial head expansion equivalent to the lateral expansion, but it was not as prominent as the lateral expansion and likely does not have the same functional importance.

The lateral muscle head and corresponding tendon and the lateral retinaculum were the components of the lateral portion of the distal triceps apparatus. Previous anatomic studies distinguished the regions of the central tendon and the lateral expansion [12, 19, 21, 23]. During inspection of the specimens, it was possible to identify this interface as a shallow sulcus between the central tendon and the lateral expansion tendon. Celli [19] used the designation of decussation to describe the distal region of this interface [19].

In a more recent study, Barco et al. introduced a different description of the olecranon footprint of the triceps brachii muscle and tendinous apparatus. These investigators described three components of the footprint: the muscular medial head insertion, the conjoined (central) tendon, and the articular capsule [15]. On axial MRI, as described by other authors

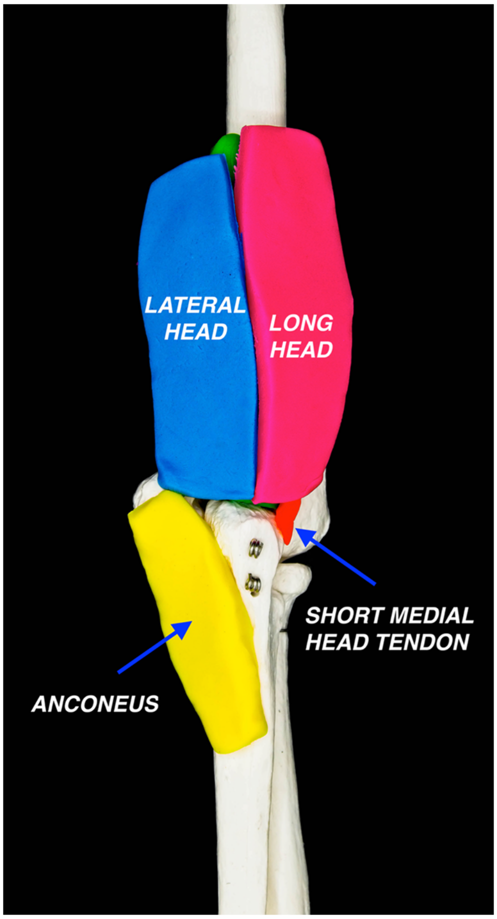

Fig. 10 Frontal view of a Play-doh® model of the second layer of distal triceps tendinous apparatus with the lateral (blue) and long (pink) head muscles. The central tendon and lateral expansion were omitted to allow better visualization of the muscular structures beneath. The close proximity of the lateral head and anconeus muscle (yellow) sometimes makes it difficult to distinguish both muscles in sagittal MRI. The short medial head tendon is partially seen (red)

[12, 13, 15] and confirmed by our investigation, the central tendon was thicker and easily distinguished from the thinner lateral expansion fascia, the latter structure also known as the lateral retinaculum [13, 15, 19, 24, 25]. However, it was not possible for us or for Barco et al. [15] to delineate the exact point of transition between the lateral tendon and the lateral fascia on the axial and sagittal MRI. This fascia extended over the anconeus muscle, and it blended with the forearm fascia to insert distally into the ulna.

In clinical practice, when interpreting imaging studies, the precise identification of the lateral expansion becomes important as most of the triceps tendinous tears are incomplete [18, 26]. Tagliafico et al. [18] reported that tendinous tears of the medial head were rare, such that careful analysis of what initially may seem to be a complete rupture of the triceps tendinous apparatus will often indicate that some of this complex insertional anatomy remains intact. These investigators also highlighted the functional importance of incomplete tears because even with tears that involve 95% of the triceps tendinous fibers, the lateral expansion, if intact, could provide some degree of elbow extension [18]. Furthermore, the lateral expansion may act in a similar fashion as the lacertus fibrosus of the biceps brachii myotendinous apparatus. That is, the degree of retraction of a torn triceps tendon is likely dictated by the integrity of the lateral retinaculum [24].

Clearly, based on our study and other investigations [12–15, 19], the distal triceps tendinous apparatus had a layered appearance. In our study, the deep component was composed mainly of the muscular attachment to the olecranon of the medial head. Except for the thick short medial head tendon that inserted next to the central tendon, a distinct tendon merging with the central tendon before attaching to the olecranon was not visible with MRI, in spite of its description in the literature [11, 12, 15]. Histologic analysis, however, confirmed joining of the three tendons of the triceps muscle bellies before their insertion into the posterior portion of the olecranon. Although Belentani et al. [11], using a different MRI protocol, described the distal insertion of the triceps tendinous apparatus as bipartite, our histologic analysis provided definitive evidence of a single distal insertion, an observation that was also reported by Hayter and Adler [6]. We believe that there may be a distal medial head tendon that joins the lateral and long head tendons; however, it is not clearly visible on MRI because it may simply be too small. Indeed, Barco et al. [15] indicated that the main tendon of the medial head was inconsistent or too small to measure. Another possible explanation for the differing results of MRI and histology in our analysis is that the histologic sections displayed the tip of the insertion where the central tendon is very close to the short medial head tendon and, likely, there may be merging of the fibers of the three heads. The rolled edge, representing a deep medial thickening of the central tendon, receives contributions from the medial head [12], but a survey of the integrity of all of the attachment sites of the medial head also requires identification of the olecranon insertion of the deep muscular component.

Using the Play-doh® models, the deep layer (consisting of the muscle belly and muscular attachment of the medial head triceps and its tendon) was first displayed, and then, the superficial layer, consisting of the long and lateral heads, their central tendon, and lateral expansion, was added. Although the models were not precisely correct with regard to size and orientation of some of the components of the tendinous apparatus, they provided a three-dimensional display of the major relationships which are the characteristics of this complex anatomy. There are several other examples of the use of Play-doh® models in medicine in order to supply presurgical information, and the technique has been employed successfully as a learning tool for the undergraduate students. Agius

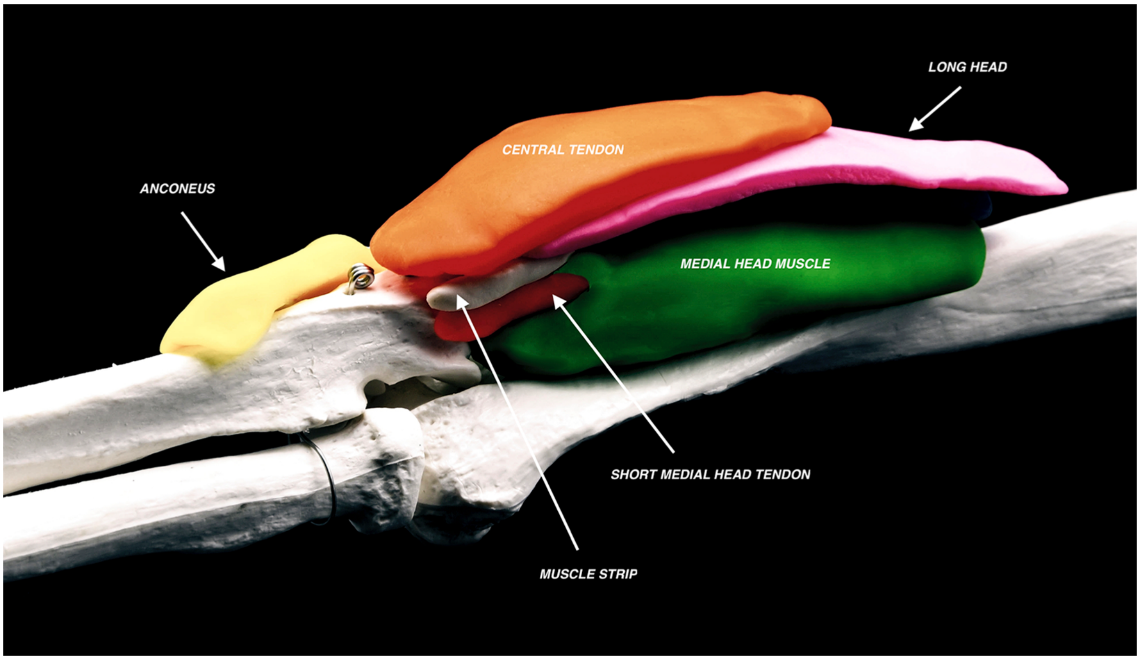

Fig. 11 Medial sagittal view of a Play-doh® model of the second layer of the tendinous apparatus with the long head (pink) and its central tendon (orange) located superiorly. Also indicated is the short medial head tendon (red) insertion next to the muscle strip (white) that separates it from the central tendon. The anconeus muscle (yellow) is partially seen distally

et al. used Play-doh® models of the eyelid in order to train surgeons on the anatomy of this region. [27]. Herur et al. studied the anatomy of various nerves with conventional tools like videos as well as Play-dohs® [28]. Eftekhar et al. reported the advantages of using Play-doh® models with a group of neurosurgery residents to study presurgical anatomy of complicated cerebral aneurysms [27–29].

Complete tears of the tendinous apparatus of the triceps brachii muscle are extremely rare, accounting for less than 1% of all tendinous ruptures. The most frequent location of these tears is the site of insertion into the olecranon. In most of these instances, the lateral expansion is left intact, partially masking the loss of elbow flexion on clinical examination. Isolated tears of the muscular and tendinous attachments of the medial head are also rare.

Tearing of portions of the distal triceps tendinous apparatus is more common, typically involving part or the entire central tendon. The distinction between an incomplete or complete tear is very important with regard to treatment, as acute complete tears are treated surgically [8, 17, 18, 24, 26, 30, 31]. Both MRI and US represent important diagnostic techniques in the assessment of the degree of violation of the injured tendons [7–9, 12, 13, 15, 18].

There are certain limitations of this study. Perhaps most significant is the small number of elbow specimens ($n = 12$) that were used. Furthermore, all of these elbow specimens were obtained from persons who were elderly at the time of death, increasing the likelihood of degenerative changes in the

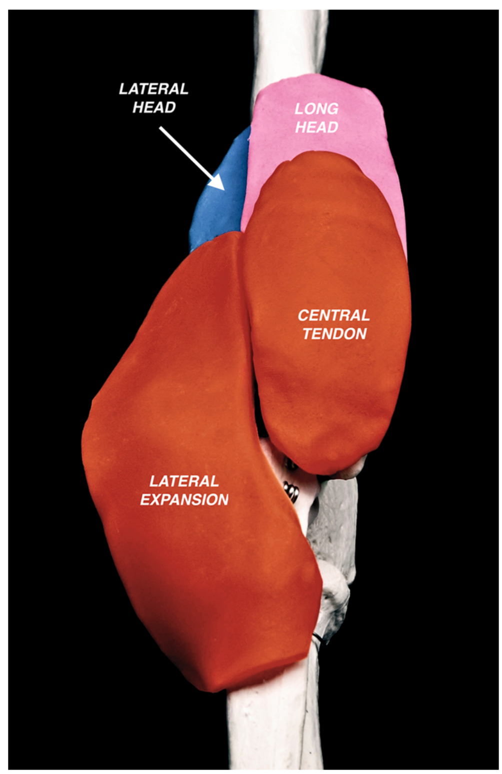

Fig. 12 Frontal view of a Play-doh® model of the second layer of the distal triceps tendinous apparatus showing the long (pink) and lateral (blue) heads, central tendon (orange), and lateral expansion (orange). The anconeus muscle is hidden beneath the lateral expansion

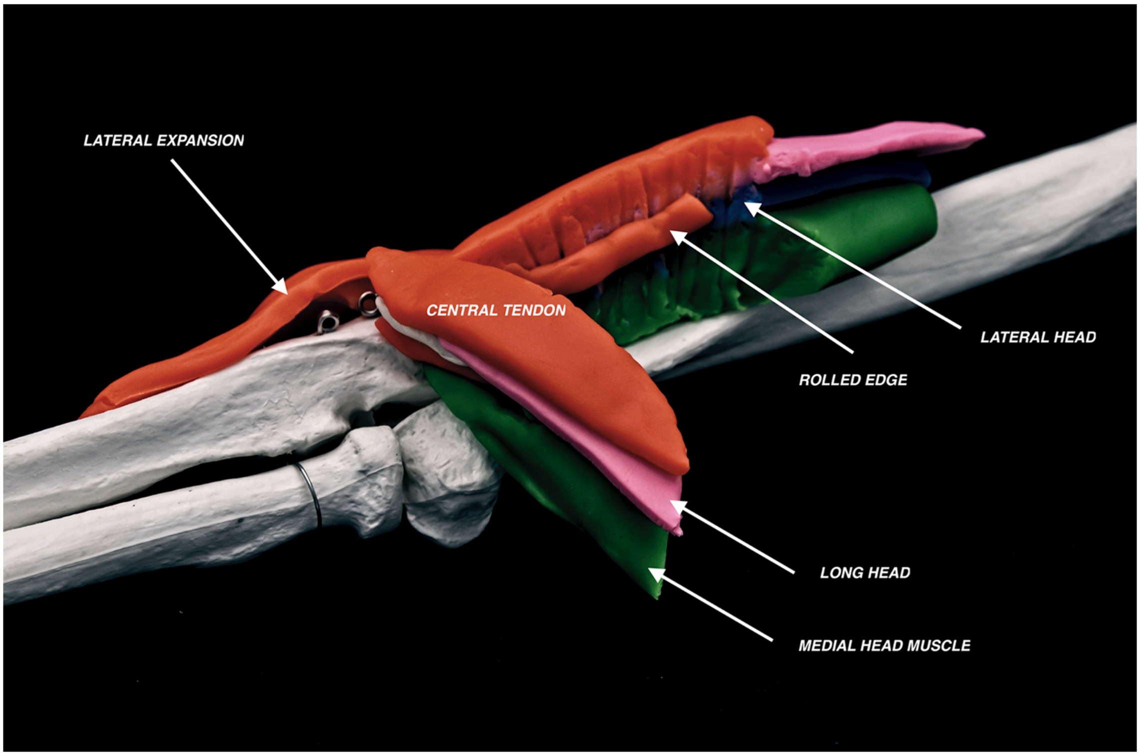

Fig. 13 Play-doh® model. Medial sagittal view through the sectioned central tendon (orange). It is possible to identify the rolled edge (orange, thickened region), internally, contiguous with the central tendon. The medial (green) and long head (pink) muscles are partially opened and seen

very tissues we were studying. These degenerative changes, however, did not significantly influence the relationships among the components of the distal tendinous apparatus, which was the point of interest of this investigation. We used only T1-weighted images, which seemed to be a logical choice as we were more interested in anatomic data than visualizing alterations in signal intensity. We did not study the modifications of tendinous anatomy that might occur with different degrees of flexion and extension of the elbow. Finally, we restricted our investigation to cadavers and did not study a group of patients with injuries of the distal tendinous apparatus to determine the clinical utility of understanding this complex anatomy. We leave that to other investigations.

In conclusion, our main purpose was to better understand the location of each component of the triceps mechanism due to the limited and controversial information of this complicated anatomy that is available in current literature. We have defined the complex anatomic features of the distal tendinous apparatus of the triceps brachii muscle using MRI. We have confirmed these features through careful inspection of cadaveric specimens, supplemented with histologic analysis. Finally, we have prepared Play-doh® models to vividly illustrate the relationships among the various components of this apparatus.

Knowledge of this regional anatomy should improve our diagnostic abilities in the imaging assessment of patients with injuries to the triceps brachii muscle, allowing a more accurate appraisal of the presence and extent of injury. This information should better promote the choice of the most appropriate treatment strategy in cases of these injuries.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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CORRECTION

Correction to: Distal insertional anatomy of the triceps brachii muscle: MRI assessment in cadaveric specimens employing histologic correlation and Play-doh® models of the anatomic findings

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"The authors of the paper would like to apologise to the readers of this prestigious journal, but we noticed a problem with the position of the anatomic structures represented in the play-doh models. The long head of triceps, short medial head tendon and muscle strip were positioned on the lateral side and the anconeus, lateral head and lateral expansion fascia were positioned on the medial side. We rebuilt the play-doh models and presented them with their correct positions (medial: long of triceps, short medial head tendon and muscle strip; lateral: anconeus, lateral head and lateral expansion fascia)."

The correct Figures 9, 10, 11, 12 and 15 are shown below.

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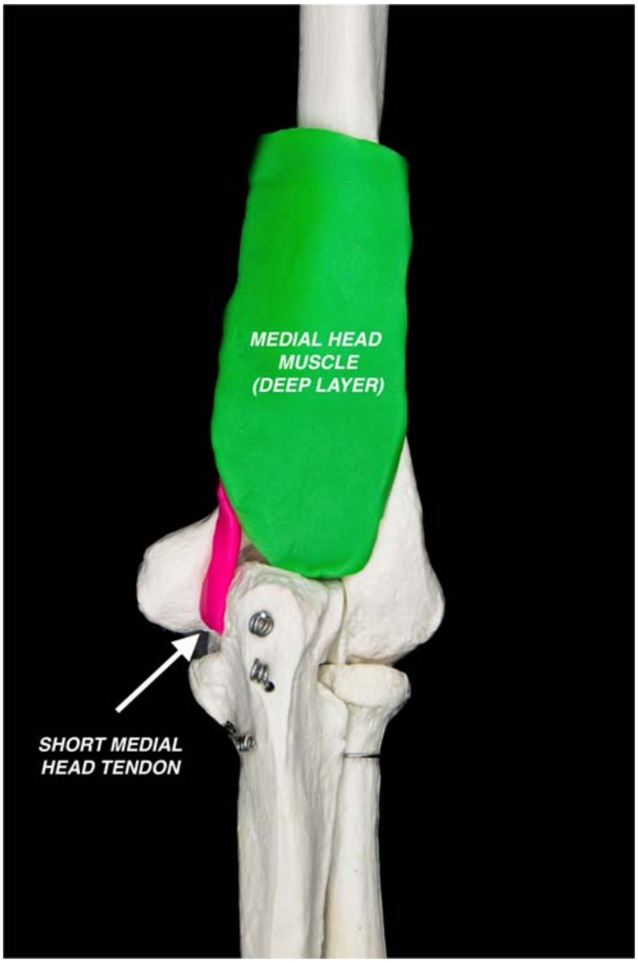
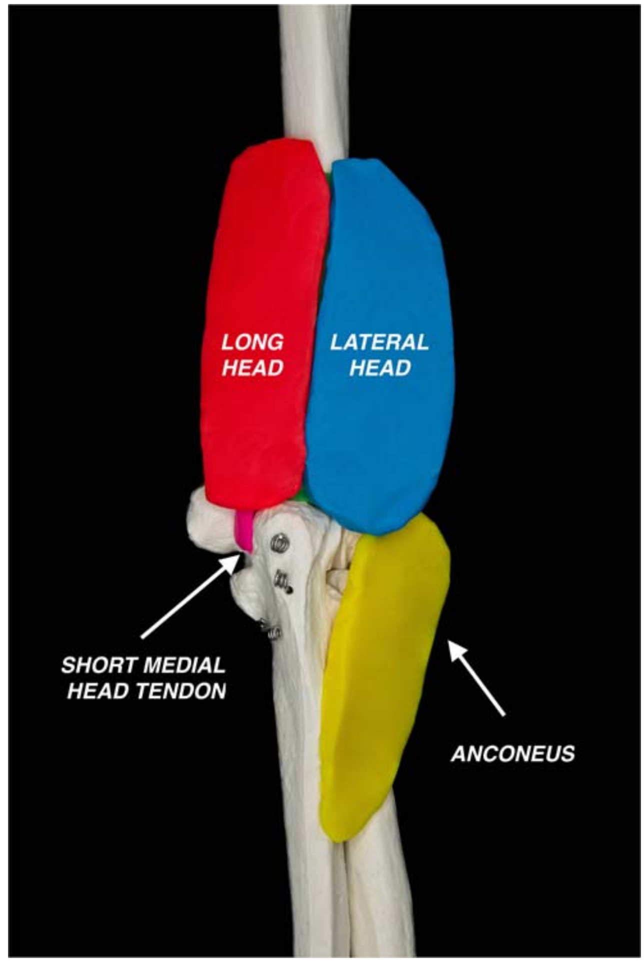
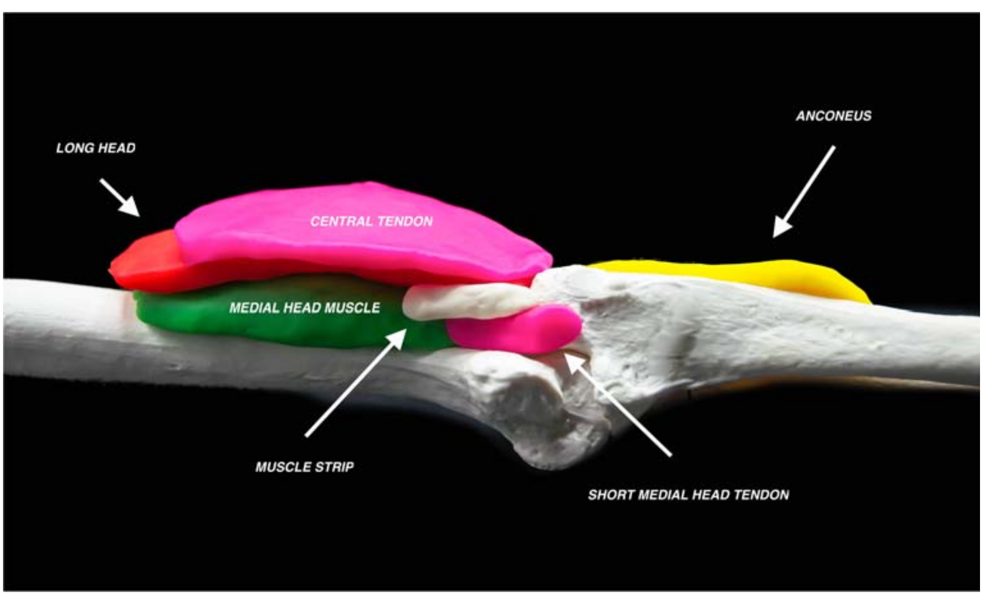

MEDIAL HEAD
MUSCLE
(DEEP LAYER)
SHORT MEDIAL
HEAD TENDON


LONG
HEAD
LATERAL
HEAD
SHORT MEDIAL
HEAD TENDON
ANCONEUS


LONG HEAD
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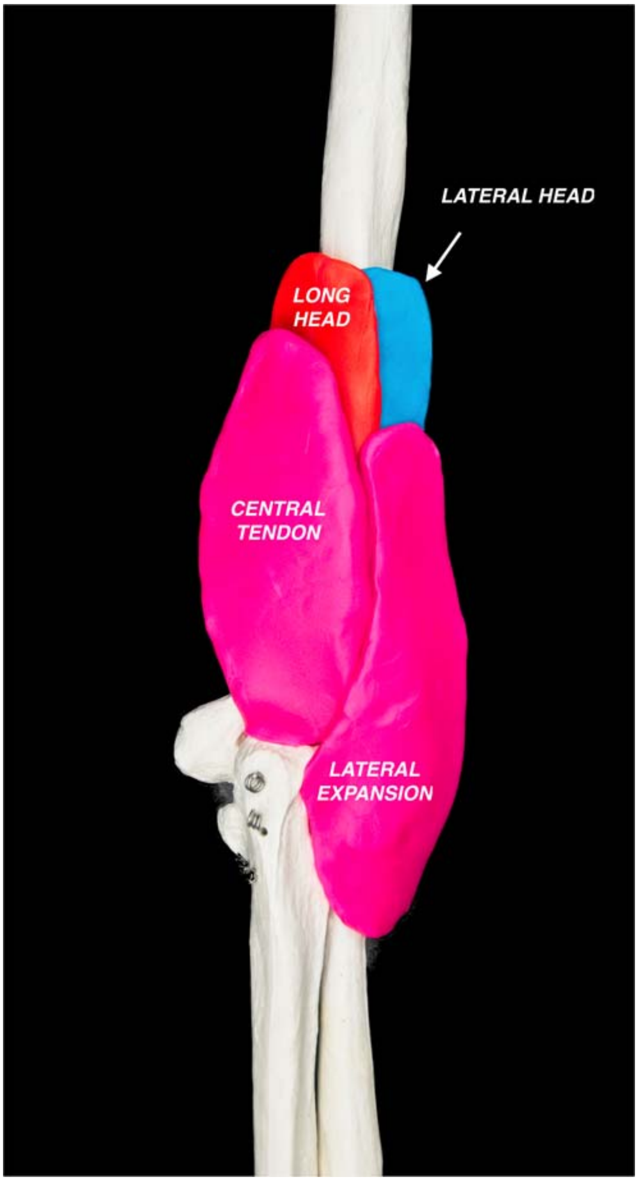
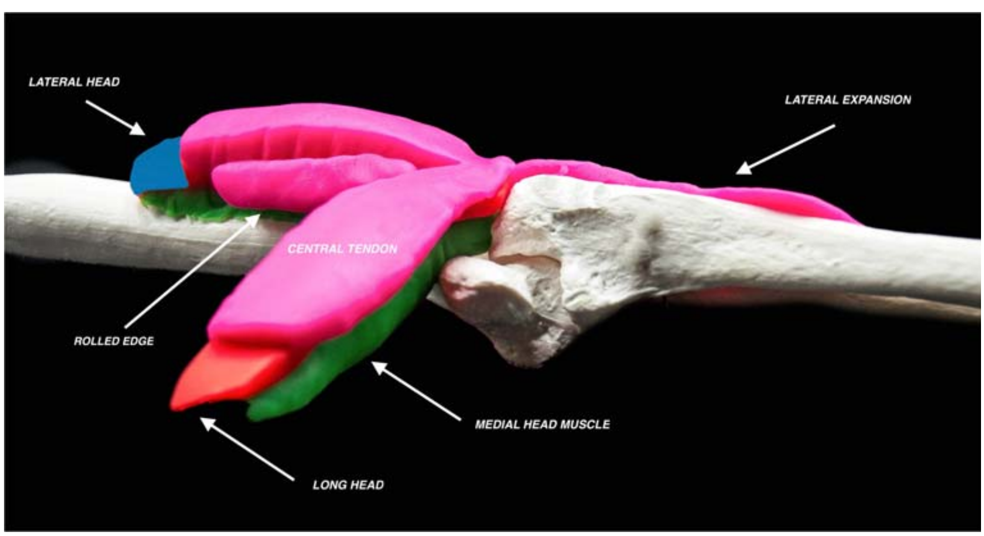
CENTRAL TENDON
MEDIAL HEAD MUSCLE
MUSCLE STRIP
SHORT MEDIAL HEAD TENDON


LATERAL HEAD
LONG HEAD
CENTRAL TENDON
LATERAL EXPANSION


LATERAL HEAD
LATERAL EXPANSION
CENTRAL TENDON
ROLLED EDGE
MEDIAL HEAD MUSCLE
LONG HEAD