Research Square

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Mesoscopic variability of the Brachioradialis insertion

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Abstract

Purpose: The brachioradialis muscle attaches to the lateral aspect of the 1st extensor channel, forms its floor and integrates to with its walls, strengthening them in the process. The main goals was to explore if it is possible to detect mesoscopic variation in tendon insertion. Since the brachioradialis muscle is well defined, easily accessible and easy to preserve in prosection material we focused on it for our research.

Methods: To explore the mesoscopic anatomy of the brachioradialis muscle, we performed a microdissection of the tendon's insertion under a dissection stereomicroscope. Several unreported anatomical patterns emerged.

Results: First, the brachioradialis tendon often had an oblique superficial bundle spanning from its dorsal edge and attaching to the most ventral aspect of the styloid process, possibly proving advantageous in bringing the arm in the position between pronation and supination. We also visualized small tendinous slips originating from the dorsal part of the tendon, often interfacing with the soft tissues of the wall between the first and second carpal extensor channels, or the dorsal and lateral walls of the 1st and 2nd extensor channels respectively. In some specimen the brachioradialis tendon was located under the synovial membrane of the floor of the 2nd extensor channel. And lastly, we observed several cases, where fibers of the pronator quadratus muscle interfaced with the tendon of the brachioradialis muscle. One specimen had an unusually dorsal attachment over a smaller than normal surface area.

Conclusions: Our findings expand on the already described anatomy of the insertion of the brachioradialis tendon and are a proof of principle that the anatomical microvariability in the tendon insertions is still not fully explored. The oblique bundles could provide an advantage when bringing the arm in the position between pronation and supination. Some of these additional fibers could serve to strengthen the corresponding extensor channels walls. And lastly, variation that result in smaller surface area of attachment of the tendon could be a risk factor to the very rare brachioradialis avulsion fracture.

Introduction

The brachioradialis muscle is a flat, single-belly muscle that originates from the proximal two-thirds of the anterior lateral supracondylar crest and surface of the humerus , and inserts onto the base of the styloid process of the radius [1]. Variations in the brachioradialis muscle body are well-documented. Fusions between the brachioradialis muscle and the lateral head of m. triceps brachii muscle, m. deltoideus, or m. brachialis are possible [1–3]. Two to four additional muscle heads can be present [4, 5]. When running along the main body without joining it, the extra head is called m. brachioradialis accessorius [3, 6]. The additional heads of the brachialis muscle can sometimes start from m. triceps brachii, m. brachialis, or even m. deltoideus [3, 7, 8]. Often, these additional muscle heads can be partially joined by bundles of interconnecting muscle bridges, and can entrap aberrant accessory branches of the superficial radial nerve [4, 9]. Alternatively, the superficial radial nerve or its accessory branches can pierce the body of the brachioradialis muscle, which would also result in an entrapment [4]. Tendons are

also variable. They can be pierced or split by the superficial branch of the radial nerve [10, 11]. The tendon of m. brachioradialis accessorius can insert onto atypical targets like os metacarpale III (OM III) along with m. extensor carpi radialis brevis [12].

Results

Our goal was to explore the tendon of the brachioradialis muscle at the mesoscopic level. To perform the dissection, we first retracted the oblique muscles of the thumb, which covered the area. The epitendineum was then carefully removed with microsurgical instruments in a proximal-to-distal direction. During this process we could visualise small bundles ending at the epitendineum, which we did not document, since it is a common occurrence amongst muscle tendons. The floor of the first extensor channel was covered by the brachioradialis muscle. Our findings can be summarized in two major groups: 1. Variable structures inserting onto the ventral aspect of the main tendon, and 2. Variable bundles inserting dorsal to the main tendon.

Two major variations were observed at the ventral aspect of the tendon. First, an oblique bundle would often arise over a larger surface area, accounting for most of its lateral surface (Fig. 1 a) or from the dorsal edge of the brachioradialis tendon (Fig. 1 b). It inserts over the ventral aspect of the styloid process of the radius, while the main tendon continues over its lateral surface. In total, 7 out of 20 limbs had this oblique bundle. Second, at the ventral aspect of the tendon, near its distal portion, we observed in 3 out of 20 cases that several fibers of the pronator quadratus muscle attached to the tendon of the brachioradialis muscle (Fig. 1 c).

Next, we investigated the anatomical variations in the region dorsal to the main tendon. We would occasionally visualize a rather sizable bundle, forming on the dorsal edge of the brachioradialis tendon, that could project to different attachments targets. Most often a small part of the tendon inserts in the area between the first and second extensor compartment at various depths and can integrate with the lateral wall of the second extensor channel (observed in 10 out of 20 cases) (Fig. 2 a and a 1). In 4 out of 20 cases, we observed a portion of the brachioradialis tendon travelling under the synovia of the second extensor channel and forming part of its ventral wall (Fig. 2 b and b 1). The least common pattern was the brachioradialis tendon attaching to the dorsal wall of the first extensor channel (Fig. 3 a and a 1). In one specimen, the bundle bifurcated, encircling the wall of the first extensor channel, and continued in the soft tissues of the adjacent second extensor channel (Fig. 3 b and b 1).

On a more macroscopic level, we also found one case of a dorsally displaced insertion of the brachioradialis muscle. The tendon inserted onto the crest between the first and second extensor groove and did not have any relations to the medial wall of the first extensor channel (Fig. 4).

Discussion

The relation between the superficial branch of the radial nerve and the brachioradialis tendon is one of the more clinically relevant variations in the region. The nerve can be compressed if it pierces the tendon,

or is located between two bundles of additional tendons, leading to sensory symptoms, a condition known as cheiralgia paresthetica or Wartenberg's syndrome [9, 10, 13]. Many variations of the muscle body have been reported, and all appear to be linked to either supernumerary muscles or muscle heads [1, 3, 5, 9], or fusion with adjacent muscle bodies [1, 3, 7]. The insertion of the muscle is often described as heart-shaped or tear-shaped, and it is part of the floor of the first extensor channel [14]. In order to further investigate its relation to the extensor channels we performed microdissection of the tendon using a dissection stereomicroscope and the appropriate microdissection tools. A very common observation was an oblique bundle, running superficially from the dorsal to the ventral edge of the tendon. The position and trajectory of the oblique bundle suggest that it should apply force upon contraction in such a manner that it would bring the arm in a position between pronation and supination – one of the main movements executed by the muscle. This variation might be beneficial to the physiological function of the muscle, when the bundle is of appropriate size. We also observed microbundles, delaminating from the main tendon and inserting onto the lateral wall of the first extensor channel. Koh et al. describe that the brachioradialis tendon extends to the wall of the first extensor compartment, however, they do not report any bundles that integrate with it [14]. The authors also speculate that the brachioradialis tenon can reinforce the walls of the retinaculum. Here we show that the dorsal side of the 1st extensor channel as well the medial wall of the 2nd can be reinforced by integrating bundles of the brachioradialis tendon. We also found that in 3 out of the 20 cases, fibers from the pronator quadratus muscle inserted onto the most distal part of the brachioradialis tendon. Our observations are confirming previous reports that the brachioradialis tendon spans the space between the two walls of the first extensor channel and is part of its floor (medial wall) [14, 15]. We did observe additional patterns, namely bundles located in the region between the first and second extensor channels, integration with the external surface of the second extensor channel, or extension of bundles into the floor of the second extensor channel. If we could not properly visualize a well-formed bundle reaching the described targets, it was counted as a normal tendon anatomy. Although we report the exact number of observed cases, we would like to disclose that the microdissection of the fibers was rather challenging, therefore, some of the variable groups we describe can be understated as borderline, or uncertain cases are reported as negative. The dorsally displaced tendon was the rarest variation by far, observed only in one specimen. This smaller area of attachment, located just over the crest between the first and second extensor groove, could predispose to the rather rare distal brachioradial avulsion fracture [16, 17]. One major drawback of the study is that the dissection of cadaveric material does not allow for functional studies, and no clinical information was available. Any functional and clinical implications are therefore just speculative. In conclusion, our current reports shows that the mesoscopic variability in tendons insertions remains to be fully explored and we show that in principle it is not technically challenging. Further characterisation may lead to better understanding in the genesis of the medical condition concerning the tendon insertion.

Methods

Human cadaveric donor materials were fixed in an aqueous solution containing formalin, ethanol, glycerine, and salicylic acid. The initial dissections were performed as a routine part of the education of medical students in the course of human anatomy. The tendon dissection was done under a dissection stereomicroscope. The instruments used were standard microdissection forceps and scalpels.

Declarations

Funding:

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Competing Interests:

The authors have no relevant financial or non-financial interests to disclose.

Compliance with Ethical Standards

Dissections are done under the permission of the Bulgarian Ministry of Health Regulation No. 2 of 18.05.2012. Standard dissection techniques and materials were used.

Author contributions

Protocol development and study conceptualisation: D. Stoyanov, S. Pavlov, K. Bratoeva. Data collection (dissection and photography): D. Stoyanov, I. Ivanov. Data analysis: D. Stoyanov, L. Veleva, S. Pavlov, M. Ivanov. Manuscript writing/editing: all authors. Funding acquisition: K. Bratoeva

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Figures

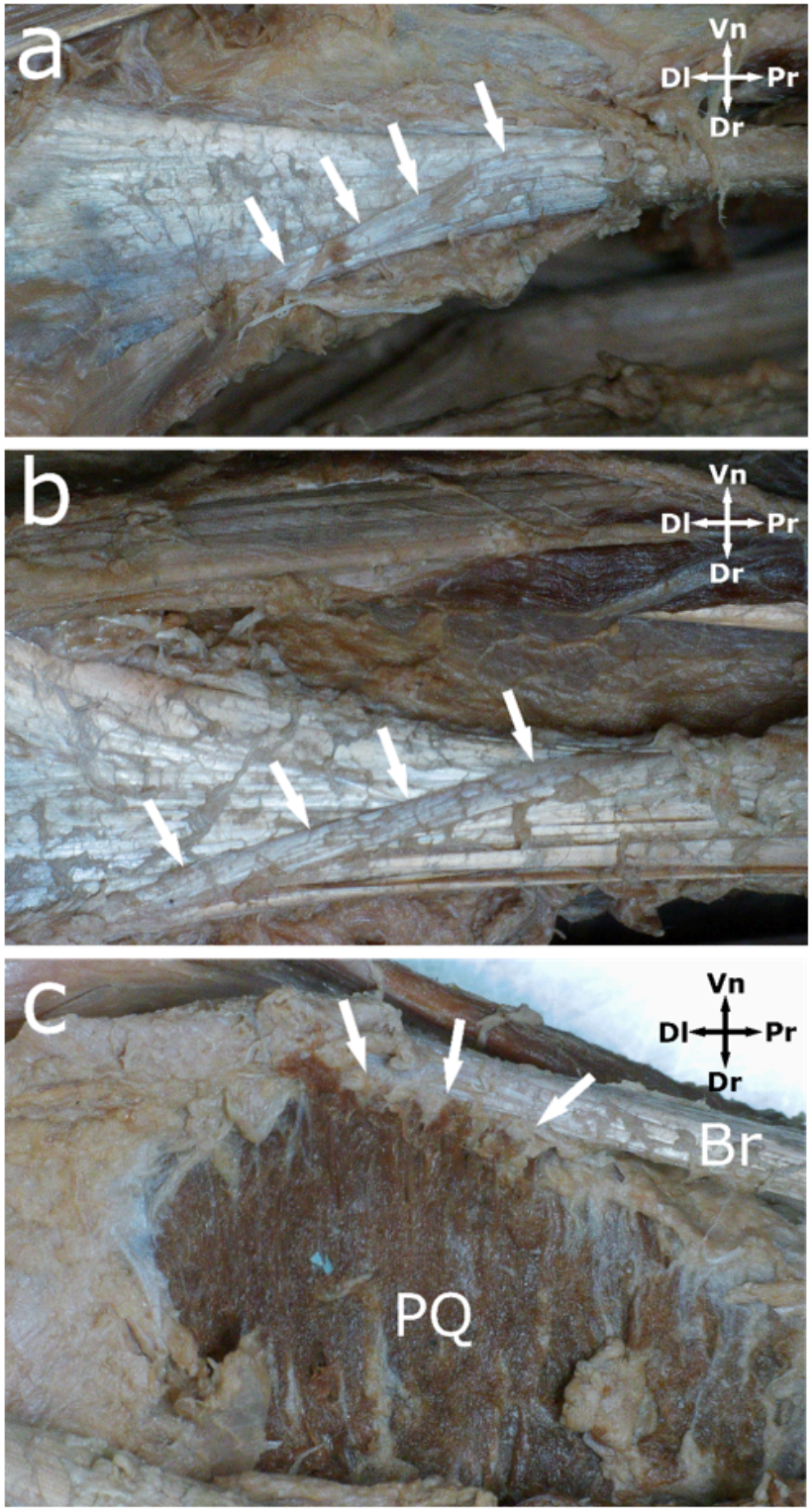


Figure 1

Mesoscopic variation with insertion onto the ventral edge of the brachioradialis tendon. A and B. A small oblique bundle arises from the entire lateral surface or the dorsal edge of the brachioradialis tendon and attaches to the proximo-ventral part of the styloid process along with the main tendon (arrows). C. Part of the pronator quadratus muscle is anchored to the brachioradialis tendon (arrows).

Abbreviations: Br – m. brachioradialis, PQ – m. pronator quadratus, Dr – dorsal, Vn – ventral, Dl – distal, Pr – proximal

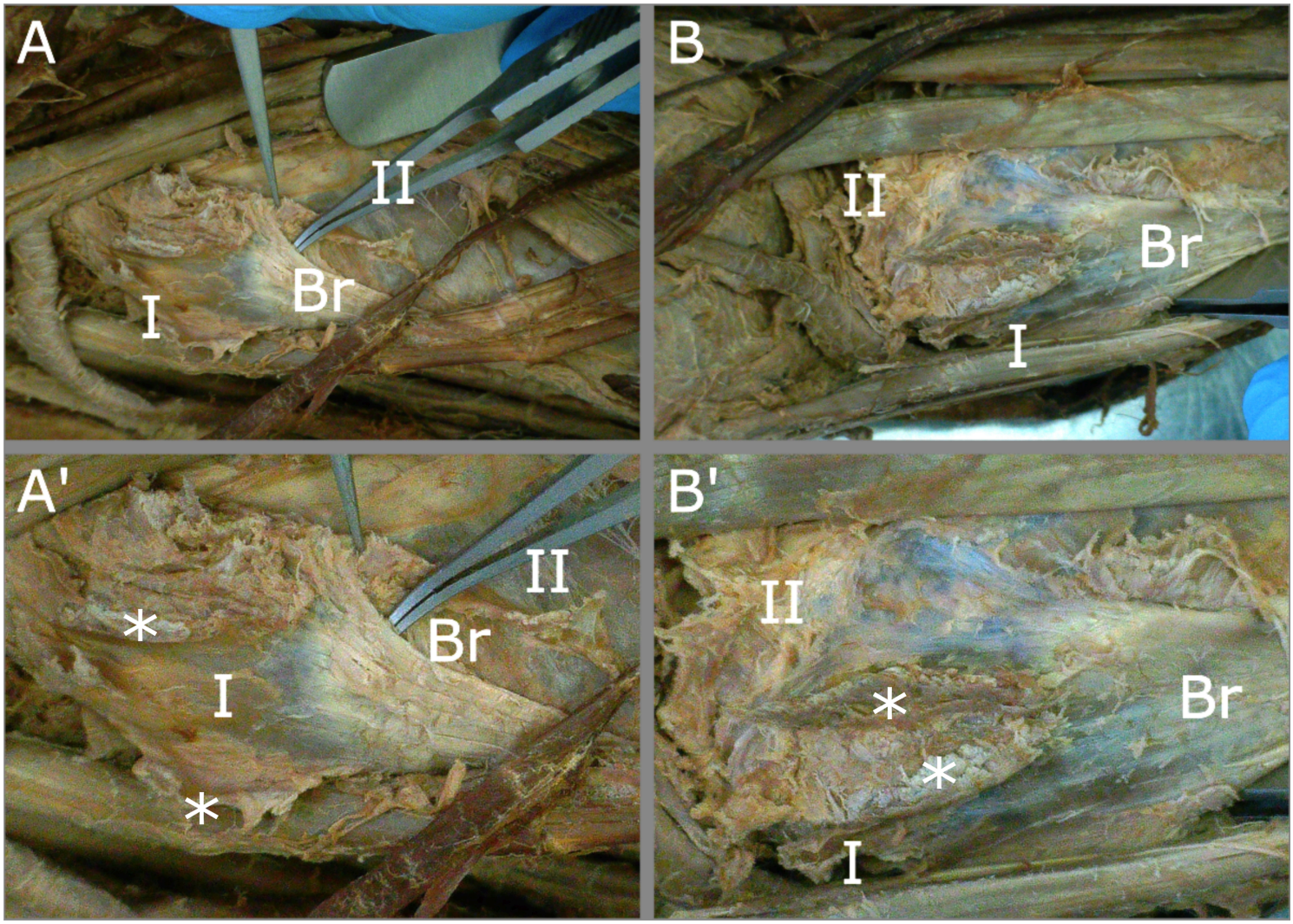


Figure 2

Mesoscopic variation with dorsal insertion to the brachioradialis tendon. A and A': A portion of the brachioradialis tendon is located in the soft tissue between the first and second extensor channels. A small bundle of this portion of the tendon can integrate with the wall of the second extensor channel (forceps). Asterisk mark the malls of the 1st extensor channel. B and B': A part of the brachioradialis tendon can enter the second extensor channel and be incorporated in the ventral wall. The asterisks mark the juxtaposed walls of the 1st and 2nd extensor channel. Abbreviations: Br – m. brachioradialis, I – first extensor channel, II – second extensor channel, Dr – dorsal, Vn – ventral, Dl – distal, Pr – proximal

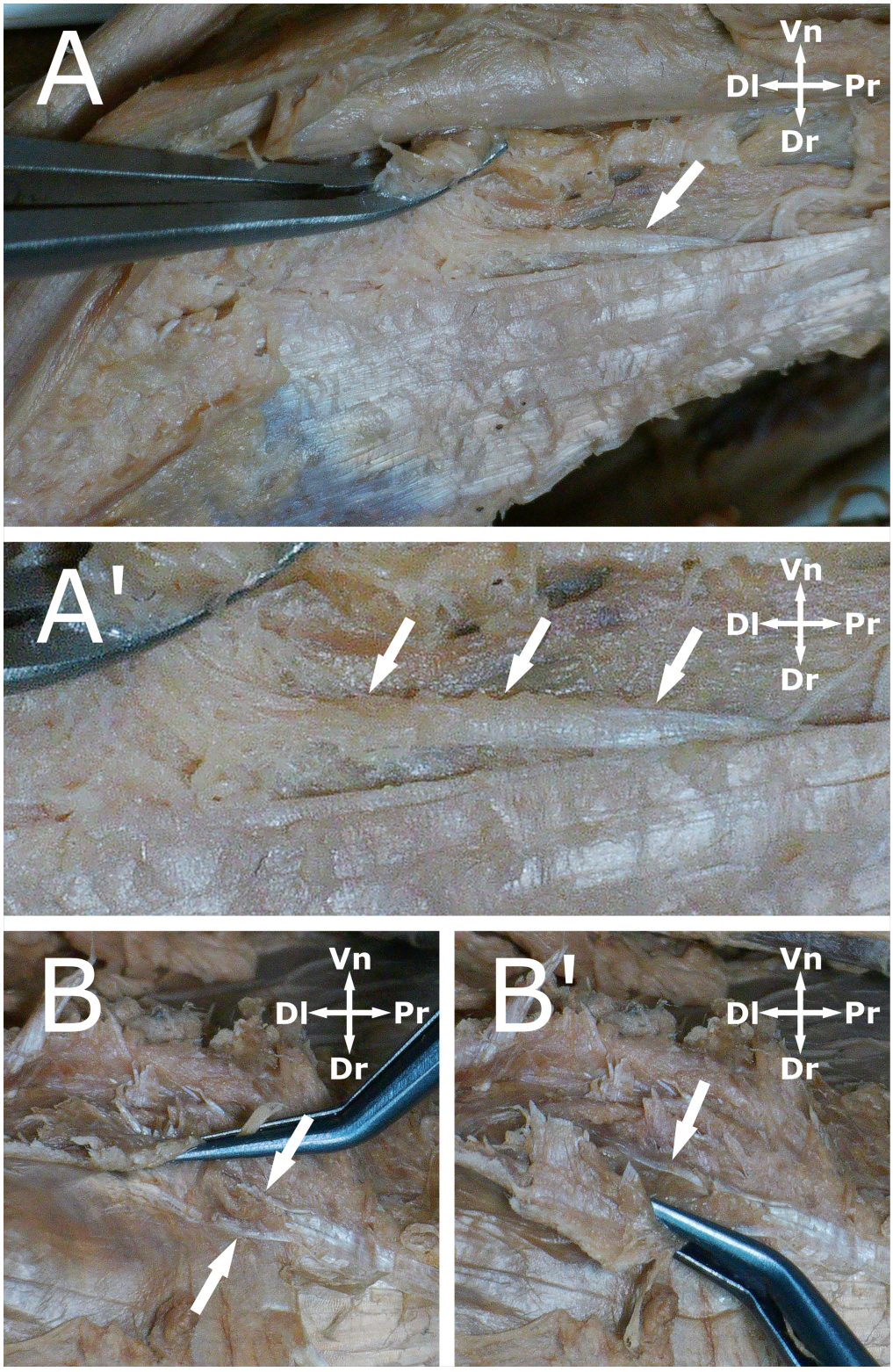


Figure 3

Mesoscopic variation: dorsal insertion with integration into the dorsal wall of the first extensor channel. A and A': A small tendinous bundle emerges from the medio-dorsal portion of the tendon (arrow) and integrates into the lateral wall of the first extensor channel. The forceps hold the transacted wall of the first extensor channel. B: A small bundle is derived from the dorsal edge of the brachioradialis tendon. The tendon bifurcates (arrows) and encircles the wall of the first extensor channel. B' The dorsal

part of the bundle runs through the soft tissues on the floor of the second extensor compartment. Abbreviations: Dr – dorsal, Vn – ventral, Dl – distal, Pr – proximal

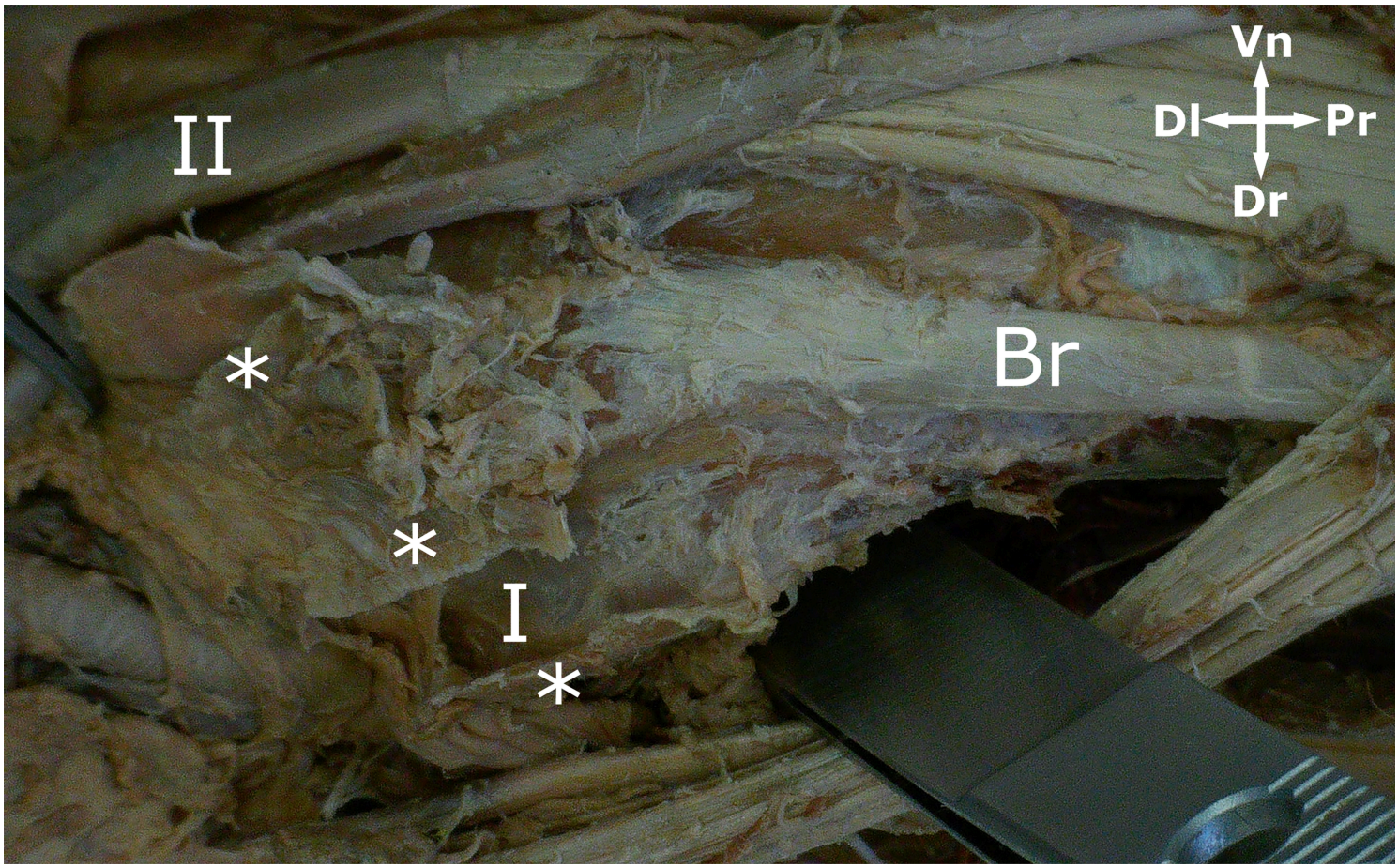


Figure 4

Dorsalized insertion of the brachioradialis muscle. The brachioradialis muscle inserts onto the extensor crest between the first and second extensor channels, and does not send fibers to the medial wall of the first extensor channel. The tendon insertion appeared smaller than normal. Abbreviations: BR – m. brachioradialis, I – first extensor channel, II – second extensor channel; * - shows the transected walls of the first and second extensor channels, Dr – dorsal, Vn – ventral, Dl – distal, Pr – proximal