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CASE REPORT

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Accessory part of the deltoid muscle

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The shoulder and arm region has numerous morphological variations. The deltoid muscle usually consists of three parts: anterior, middle and posterior. This case report describes a very rare deltoid muscle variant, an addition to the spinal part that is attached proximally at the infraspinatus fascia and the spine of the scapula. The distal attachment transforms directly into the brachialis muscle. Additional parts can affect the biomechanics and function of the joints significantly. (Folia Morphol 2024; 83, 1: 226–230)

Keywords: deltoid muscle, deltoid tendon, anatomical variation, shoulder

INTRODUCTION

The deltoid region of the shoulder is important functionally because of its powerful abductor mechanism. It has a triangular shape due to the outline of the deltoid muscle (DM). The DM arises from an extensive V-shaped attachment from the anterior margin of the lateral third of the clavicle (clavicular or anterior part), the lateral border of the acromion (acromial or middle part) and from almost the whole of the spine of the scapula (spinal or posterior part). All fibres of the DM converge to insert into the deltoid tuberosity of the lateral surface of the shaft of the humerus [17]. The DM is innervated by the axillary nerve [17].

It continues and maintains the abduction of the humerus initiated by the supraspinatus muscle. At complete abduction, the arm is raised to an angle about 180 degrees, the first 15 degrees of which are affected by the supraspinatus muscle and the next 75 by the DM. The clavicular part comprises the flexors and mesial rotators of the arm. The posterior fibres have the opposite action.

The DM demonstrates variations with regard to the number of its segments and parts, its proximal attachment, distal attachment, fusion with surrounding muscles and innervation [2, 12, 14, 27, 31].

The different variants of the deltoid muscle are not only interesting from an anatomical point of view, but also from a clinical one, especially for orthopaedic surgeons. These variations could impede approaches to the proximal humerus, and allow the use of the deltoid in treating irreparable rotator cuffs,

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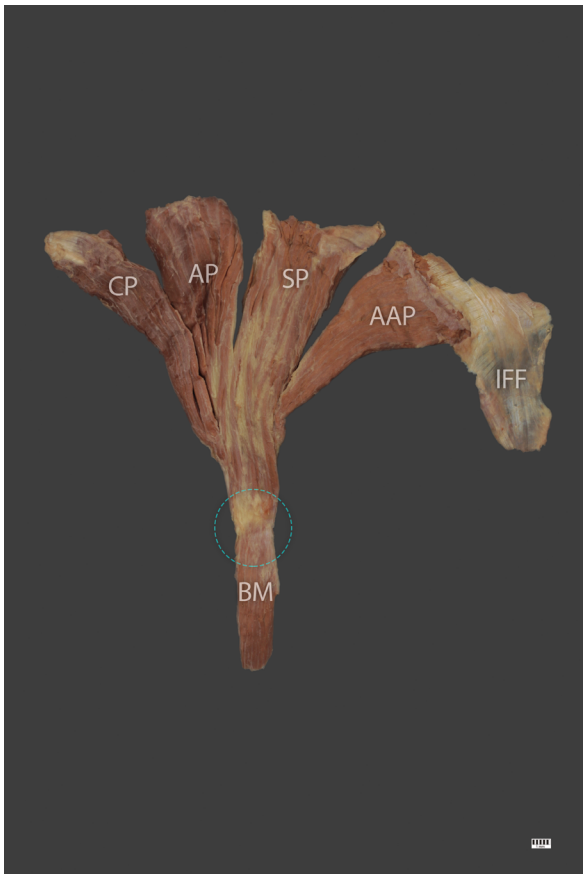

Figure 1. Anterior view of the deltoid muscle; CP — clavicular part; AP — acromial part; SP — spinal part; AAP — accessory spinal part; IFF — infraspinatus fascia; BM — brachialis muscle; turquoise circle show fusion between deltoid muscle and brachialis muscle.

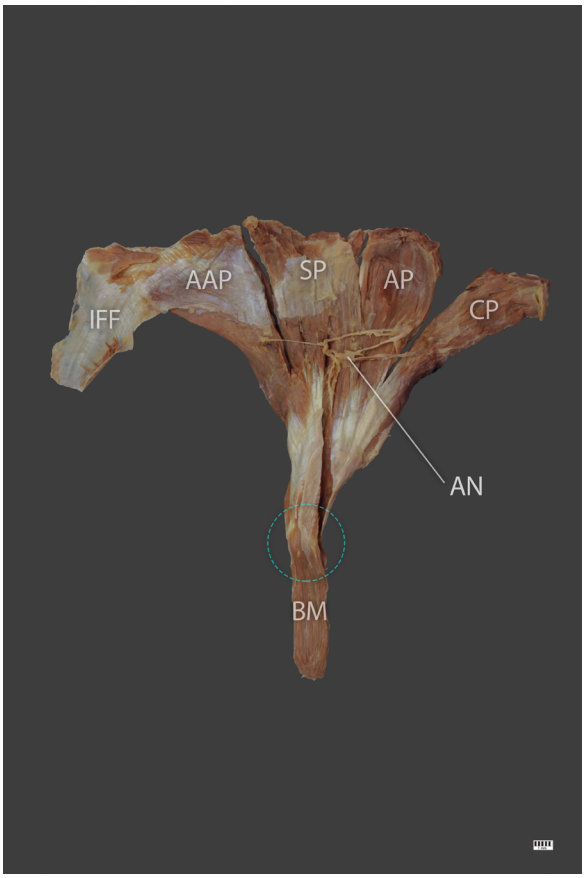

Figure 2. Posterior view of the deltoid muscle; CP — clavicular part; AP — acromial part; SP — spinal part; AAP — accessory spinal part; IFF — infraspinatus fascia; BM — brachialis muscle; AN — axillary nerve; turquoise circle show fusion between deltoid muscle and brachialis muscle.

Table 1. Morphometric measurements of parts of the deltoid muscle [mm]

	Clavicular part	Acromial part	Spinal part	Accessory part
Proximal attachment — width	26.96	50.32	70.40	69.14
Proximal attachment — thickness	5.91	6.23	7.84	4.67
The belly length up to the point where all parts connect and pass into the tendon	164.29	139.35	107.94	121.46

with or without acromioplasty or acromionectomy, or facilitate posterior deltoid-to-triceps tendon transfer [6, 15, 26].

This case report focuses on a very rare variant of the DM with an accessory segment (accessory spinal part), and the distal part passes directly into the brachialis muscle (BM) (fusion).

CASE REPORT

A male cadaver, 79 years old at death, was subjected to routine anatomical dissection for research and teaching purposes at the Department of Anatomical Dissection and Donation, Medical University of Lodz, Poland. The right upper limb underwent traditional anatomical dissection and a morphological variant of the DM was found [25, 34]. This structure was subjected to a detailed assessment. The DM consisted of four parts (clavicular, acromial, spinal and accessory spinal; Figs. 1, 2). The clavicular part originated from the lateral third of the clavicle; the acromial part originated from the lateral border of the acromion; the spinal part originated from part of the spine of the scapula. The accessory spinal part originated from the other part of the spine and from the infraspinatus fascia (Figs. 1, 2). The measurements of the individual parts are shown in Table 1.

All the parts then interconnect to form a common muscle mass 48.54 mm wide and 13.45 mm thick. The length of this common muscle mass to the myotendinous junction point is 38.98 mm. The width of the myotendinous junction is 24.56 mm and its thickness is 4.16 mm.

The tendon is 18.97 mm long; it is attached to the deltoid tuberosity and provides an origin for the BM. At the site of transition of the tendon into the muscular part of the brachialis, it is 23.73 mm wide and 4.19 mm thick (Figs. 1, 2).

In the other upper limb, the DM comprised three segments (anterior, middle and posterior) and the BM demonstrated standard proximal and distal attachments.

DISCUSSION

The area of the shoulder girdle and the arm has numerous morphological variations. Older publications show only the numerous morphological variants within the biceps or triceps brachii [28], while newer scientific studies also show many variants in the shoulder area [13, 22, 23, 32–34].

In order to understand such morphological variations, one needs to know their embryological basis. The DM, teres minor, infraspinatus and supraspinatus muscles arise from a common premuscle mass continuous with the pectoral mass and the common arm sheath. In an 11 mm embryo the DM has partially split off from this mass towards its origin from the acromion and clavicula. In 14 to 16 mm embryos it has much of the adult form, with usually a distinct slip arising from the fascia over the infraspinatus muscle. In a 20 mm embryo, it has practically the adult form and attachments.

Many articles have examined the morphological variability of the musculoskeletal system in recent years [19–21, 24]. Previously, vascular variations seemed to be the most widespread, although muscle and tendon variations are also relatively common.

The DM has been classically divided into clavicular, acromial and spinal parts [17]. It also has morphological variants, which have been the focus of many studies over the years. Familiarity with them is a challenge for both scientists and clinicians. MacAlister [16] noted that the acromial part of the DM can be absent, and that its spinal part can be separated from both the acromial and clavicular parts. Mori [18] also described the possibility of separating the individual parts and analysed the types of separation. For the acromial part of the DM, complete separation was observed in 24% of tested shoulders, incomplete separation in 38%, and no separation in 38% [18]. For the clavicular part, there was complete separation in 4%, incomplete separation in 4%, and no separation in 92% [18].

Fusion between the clavicular part of the DM and the pectoralis major (clavicular part) has often been reported [7, 8, 16, 28, 31]. Other possible fusions are between the DM and the trapezius, infraspinatus and teres minor or latissimus dorsi muscles [5, 16]. Calori [7] described another head, the 'costodeltoideus', which can originate from the lateral edge of the scapula between the teres minor and infraspinatus, or between the teres major and minor. Gruber [9] described an 'acromioclavicularis lateralis', which originates from the acromion and inserts into the clavicular head of the deltoideus.

Calori [7] report the presence of accessory slips of the DM originating from the spine of the scapula or the infraspinatus fascia and inserting into the humerus between the deltoid and triceps or into the fascia of the arm, while MacAlister [16] found a small muscle arising from the infraspinatus fascia near the inferior angle of the scapula, forming a small second head. The present case report differs in that a complete independent part, herein labelled the accessory spinal part, originates from the other part of the spine and from the infraspinatus fascia. This accessory part was completely separated from the second spinal part. Interestingly, each part was also separately innervated by branches of the axillary nerve.

Improved understanding of the origin and parts of the DM can help to optimise procedures and minimize functional deltoid comorbidity. The scapular spinal fibres of the DM act with the latissimus dorsi to generate extension of the arm during ambulation. These fibres also assist in external (or lateral) rotation of the humerus [1]. This is functionally important because strengthening the posterior fibres of the DM can help to offset the tendency of the shoulder to become internally rotated owing to poor posture [1].

Hence, having an accessory spinal part can result in better prevention of poor posture. Biomechanical research will be needed to confirm this thesis. Furthermore, the reported accessory spinal part could also impede posterior deltoid transfer to allow restoration of elbow extension in patients with tetraplegia and posterior approach to the shoulder [6]. In addition,

a portion of the BM can become interposed between the fragments, thus causing nonunion in fracture of the shaft of the humerus; this would represent another variation in the distal part of the deltoid.

Another variation observed herein involved a connection between the DM and the BM (proximal attachment of the BM) after all the parts had joined to became a tendon. Although this has been previously noted by MacAlister [16] on one male limb, it has not been identified in any other study [8, 18, 28–30]; only fusion of the acromial portion with the brachioradialis has been reported [5]. This type of fusion could seriously affect function because the BM is the 'workhorse' of the elbow. It is a major flexor of the forearm at the elbow joint, flexing the elbow in all positions. It is the only pure flexor of the elbow joint, producing most of the force during flexion. As such, it is unclear whether this type of fusion increases or decreases the bending strength of the elbow joint.

Such variation in anatomical spaces or the reference points for incisions is an important consideration in surgical interventions as it can be a source of complications [19, 24] . For example, neurovascular structures are particularly vulnerable to iatrogenic injury. Therefore, correct diagnosis and surgical treatment of the shoulder requires an accurate understanding of its anatomy in situ, and the presence of anatomical variations can hinder surgery.

CONCLUSIONS

The deltoid muscle is characterized by complex morphological variations. Additional parts of the DM can have a significant effect on the biomechanics, function of the joints and surgery.

Ethical approval and consent to participate

The study protocol was accepted by the Bioethics Committee of the Medical University of Lodz. The cadavers were the property of the Department of Anatomical Dissection and Donation, Medical University of Lodz. Informed consent had been obtained from all participants before they died.

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Conflict of interest: None declared

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