

## CASE REPORT

## Morphological Variant of Pronator Quadratus Muscle: A Case Report

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### ABSTRAK

*Dibentangkan di sini adalah satu kes anomali morfologi berbeza bagi otot pronator quadratus (PQ). Di sini, bentuk PQ tidak sama dengan morfologi normal otot tersebut di mana otot PQ kelihatan berbentuk segi tiga dan bukan bentuk segi empat. Di samping itu, bentuk segi tiga ini terdapat di dua tempat, iaitu proksimal dan distal. Dengan ketara, otot PQ ini terdiri daripada dua serat-serat merah berisi dan aponeurosis putih. Bahagian proksimal mempunyai asas yang luas dan puncak yang lebih sempit. Asas yang lebih besar itu tersisip dengan tulang ulna dan membentuk serat merah berisi yang berkumpul di sisi dan berterusan dengan aponeurosis berakhir pada tulang radius. Sebaliknya, bahagian segi tiga distal mempunyai serat berisi dilampirkan dengan tulang radius dan tertumpu di bahagian medial menjadi berterusan dengan bahagian aponeurotik pada tulang ulna tersebut. Setiap bahagian dirujuk sebagai pronator triangularis proximalis dan pronator triangularis distalis. Perbezaan-perbezaan ini mungkin memberi kesan kepada kes-kes atipikal pronasi lengan. Maklumat variasi ini adalah penting dalam pembedahan tangan dan memberi pengetahuan tambahan kepada hubungan antara morfologi otot PQ dan had atau kekuatan dalam tindakannya.*

*Kata kunci: aponeurosis, morfologi, pronator quadratus, variasi*

### ABSTRACT

Presented herein is a case of one different morphological anomaly of pronator quadratus (PQ) muscle. Here, the shape of PQ was not similar to the normal morphology of the muscle. The PQ muscle appeared to be in distinct triangular-shaped instead of quadrangular-shaped. In addition, this triangular-shaped was found in two sites i.e. proximal and distal. Significantly, the PQ muscle consisted of

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two fleshy red fibres and white aponeurosis. Proximally placed portion had a wide base and a narrower apex. The larger base was attached to the ulna and formed of fleshy red fibres which converged laterally to be continuous with aponeurosis ending on the radius. In contrast, the distal triangular portion had the fleshy fibres attached to the radius and converged medially to be continuous with aponeurotic portions on the ulna. Each portion were referred as pronator triangularis proximalis and pronator triangularis distalis. These variations might affect atypically in cases of forearm pronation. Information of these variations is important in hand surgeries and provide an additional knowledge on the relationship between morphology of PQ muscle and the limitation or the strength in the action of it.

Keywords: aponeurosis, morphology, pronator quadratus, variation

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## INTRODUCTION

Variation of muscle morphology was described by Leonardo da Vinci as early as 16<sup>th</sup> century (Mosconi & Kamath 2003). Despite years of study, anatomical variations on pronator quadratus muscle in terms of its shape and size were not adequately reported. Hollinshead described that the common variation among this flexor group of forearm muscles was the absence of palmaris longus (Hollinshead 1962). This muscle can be completely duplicated or has two tendons. The flexor digitorum profundus was said to have an accessory origin from the coronoid process and the flexor pollicis longus an accessory origin from medial epicondyle of the ulna (Kapoor et al. 2008). The ulnar head of the pronator teres was reported to be absent in almost 9% of limbs (Loukas et al. 2008). Among all the forearm muscles, pronator quadratus (PQ) is important to be highlighted as the muscle is known to have unique morphological variations (Mochizuki et al. 2013).

Several variations of PQ were reported in the literature (Wang et al. 1997). The PQ is a muscle that has been virtually forgotten since it was first documented four centuries ago. Standing described the muscle having superficial and deep divisions (Standing 2005). It contains strong aponeurotic attachment on the medial third of the muscle. The pronator quadratus is said to be split into two laminae by the anterior interosseous nerve, instead of being entirely anteriorly to the nerve (Lee & Idler 1996). Presence of double head of PQ muscle was reported by Jadhve et al. in 2014. Absence of PQ in Madelung's deformity of the wrist was reported by Haugstvedt et al. in 2017. Anomalous variations of PQ muscle is widely appreciated as the diagnosis and treatment of pronator quadratus myofascial pain syndrome associated with the variations (Lee & Idler 1996).

## CASE REPORT

During routine anatomy practical

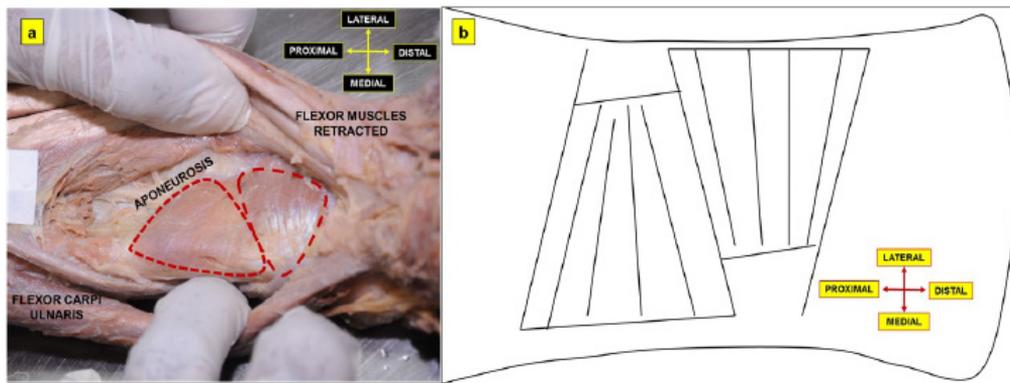


Figure 1: (a) Variation in morphology of left pronator quadratus muscle; (b) schematic diagram showing the variation of left pronator quadratus muscle

section for medical students at the Faculty of Medicine, Universiti Teknologi MARA, Malaysia, we observed a case of unique features of PQ muscle in the left upper extremity of a cadaver. Here, the gross appearance of the whole muscle was composed of two distinctly triangular shaped-sheets at proximal and distal portions. These portions were situated anterior to the lower parts of the radius and the ulna superior to wrist joint. It was covered by the tendons of flexor digitorum profundus, flexor digitorum sublimis, palmaris longus and median nerve. PQ is one of the forearm muscles whose fibres run across the flexor aspect and it produces pronation action.

In this case report, the presence of two portions of the muscle with different location was observed on gross inspection. Each muscle has a large red fleshy muscular portion and a little smaller white aponeurotic portion. Base of the proximal triangular shaped portion was located on the ulna and it was formed by red fleshy fibres. These fleshy fibres passed laterally and converged on white

shiny aponeurosis which attached to the radius. On the other hand, base of the distal triangular shaped portion was attached to the radius and its muscle fibres which coursed medially across the anterior aspect of ulna and radius. These fibres became continuous with the only aponeurotic portion on the ulna (Figure 1a and 1b).

Here also a natural demarcating line, a sort of cleavage line is appeared, dividing the two portions. In contrast, the commonly found usual pattern consists of a single quadrangular shaped PQ muscle with a single aponeurosis on the medial side and large fleshy red portion on the lateral side (Figure 2). The anterior interosseous nerve and vessels were found running towards the upper proximal portion of PQ muscle. We compared our findings with the common pattern of pronator quadratus (Figure 3).

## DISCUSSION

Interestingly, many flexor muscles in the upper limb exhibit anomalies and cause compression of neurovascular

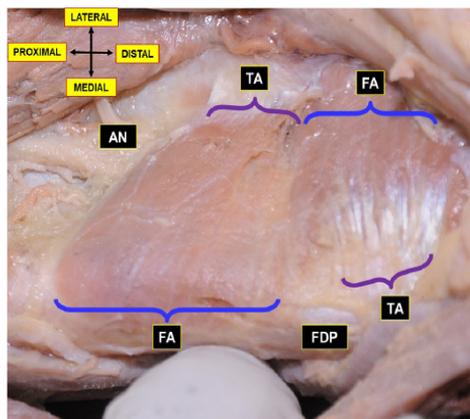


Figure 2: Close up view of the new morphological form of left pronator quadratus. AN=Anterior interosseous nerve; FDP=Flexor digitorum profundus retracted; FA=Fleshy attachment of pronator profundus; TA=Tendinous attachment of pronator quadratus

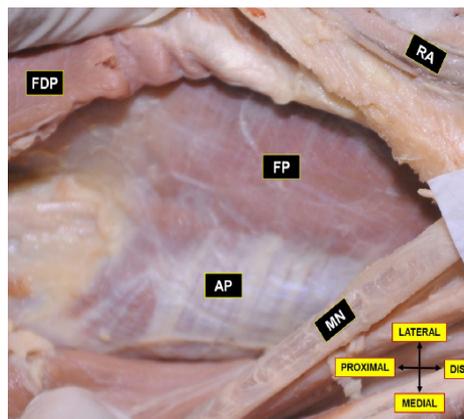


Figure 3: Common pattern of left pronator quadratus muscle. AP=Aponeurotic portion of pronator quadratus; FP=Fleshy portion of pronator quadratus; FDP=Flexor digitorum profundus retracted; MN=Median nerve; RA=Radial artery

structures (Zar Chi et al. 2017). In the present case report, we identified the unique morphology of PQ muscle which was variant from normal anatomical appearance. Here, the whole PQ muscle was found to have two distinctly triangular shaped at proximal and distal portions. The muscle composed of two fleshy fibres and two aponeuroses. Standingg (2005) described that PQ is a flat quadrilateral muscle which has deep fibres inserted to the ulna and one strong aponeurosis on its medial side. Moore & Dally (2006) and Hollinshead (1962) demonstrated that PQ, a single quadrangular shaped muscle, arises from distal fourth of ulna, especially from sinuous ridge on its anteromedial aspect, and inserted into the ridge on the anterolateral border of the radius above the styloid process, most deeply into the triangular interosseous area above the ulnar notch. This type of morphology of PQ muscle is

considered to be a normal anatomical feature of the muscle. In contrast, the present of two aponeuroses in our case report was relatively different from its normal anatomical feature. Hollinshead (1962) described one fleshy fibre arises approximately from the distal fourth of the anterior surface of the ulna and runs transversely but slightly anterior to insert into the distal fourth of the anterior surface of the radius. There is no detail description of fleshy fibres and aponeurosis. In this variant pattern, superficial portion of the muscle appeared to consist of two distinct triangular shaped at proximal and distal portions which entirely are separate in origin, course and insertion. Thus, the muscle was divided into fleshy and aponeurotic parts. Moore & Dally (2006) and O'rahilly (1986), defined that all skeletal muscles have fleshy, reddish, contractile portions but most have white non-contractile portion (namely; tendons).

There are many ways in which developmental anomalies can occur such as genetic, environmental (teratogens) and unknown aetiology. Among them, genetic factor is the most answerable caused since it depends on the factors like maternal age and ethnicity. In the present case report, the variation in the shape of pronator quadratus muscle was most likely due to the birth defects in which foetus was affected by certain chemical agent or chromosomal defect. Although most of the assumption on anatomical variation could be explained, the detailed concept on the causes of malformation is still under debate.

Accordingly, each portion of PQ muscle in proximal and distal was assumed to be a separate muscle and named as pronator triangularis proximalis and pronator triangularis distalis, respectively. PQ with dual-headed nature of the muscle was reported by Jadhav et al. in 2014. In his study, the muscle was classified into four types following the arrangement of superficial and deep heads without aponeurosis. In his report, he introduced different types of PQ muscles, a large quadrangular shaped fleshy superficial portion, a small triangular shaped fleshy portion which is deep head in nature, and the type was presented with large triangular superficial portion and small triangular portion. These types of PQ muscle were obviously different from the present findings which had superficial portion divided into two equal portions with two distinct aponeuroses. The above evidence showed that even though PQ was a small muscle; it was subjected

to have several unique variations in its morphology.

Regarding functional role of PQ, it is a powerful prime mover for pronation. (Moore & Dally 2006; Standring 2005). Choung et al. (2016) described that the muscle with tendinous fibres arising from pronator ridge and fleshy fibres inserted into the anterior surface of lower fourth of the radius rotates the radius in pronation. The ulnar is not entirely stationary during pronation and supination. The distal end of the ulna moves posterolaterally in pronation. The report by Tuttle et al. (1992) showed that electromyography (EMG) analysis verified the major contribution of both heads of PQ muscle to pronation torque and the deep head of PQ was active during both pronation and supination. It supports the theory that it acts primarily as a dynamic distal radioulnar joint stabilizer. This information is helpful in upper extremity modeling surgical treatment, and rehabilitation strategies. It is speculative that PQ involves in varieties of pronation action involved in living style activities, such as door knob releasing, handling variety of devices, and playing games like tennis and golf. These kinds of physical activities require early or late pronation to have a popular top spin ball action. Therefore, the anomalous variation of PQ may play a crucial in significant pronation action. Furthermore, it is important for the clinicians to be aware of the existence of such a unique morphological variant of pronator quadratus to avoid injuries when performing operations in the lower part of the forearm.

## CONCLUSION

This case report revealed the anomalous morphology of pronator quadratus muscle which was found in the left forearm of the cadaver. The muscle was found to be prominently triangular shaped at both proximal and distal portions which were named as pronator triangularis proximalis and distalis, respectively. Since PQ muscle acts a prime mover in pronation, knowledge on the variation of this muscle pates further impacts on its action. Additionally, the existence of this type of variation is helpful in upper extremity modeling surgical treatment, and rehabilitation strategies.

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