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Study on Morphological Variations in Fibers of Pronator Quadratus Muscle

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A B S T R A C T

In standard textbook of Anatomy describes pronator quadratus (PQ) muscle fibers variations are not well documented. In 16 specimens (30.76%) we found superficial fibers with medial aponeurosis and deep fibers. Both this fibers were running parallel to each other directing downwards and laterally from ulna towards the radius. In 34 specimens (65.38%) we found superficial fibers in distal part of muscle were directing downwards and laterally from ulna towards the radius while the middle part fibers were more horizontally placed and the proximal muscle fibers were directing upwards and laterally. Deep fibers of the muscle were seen extending downward and laterally toward the radius more oblique to the direction of superficial fibers. In one specimen we found superficial fibers were directing downwards and laterally, but proximal and distal to the superficial fibers, deep fibers were seen originating about 2 cms proximal to the superficial fibers from the shaft of the ulna while the distal to the aponeurotic superficial fibers, deep fibers again appears as fleshy muscle from ulna extending downward toward the distal part of radius and also some of the fibers extend distally toward the capsule of wrist joint and get attached to it. In another specimen we found aponeurotic superficial fibers in distal part of muscle were directing downwards and laterally from ulna towards the radius while the middle part fibers were more horizontally placed and the proximal muscle fibers were directing upwards and laterally. Proximal to the superficial part of the muscle two separate superficial muscle fiber slips were seen extending toward the radius. Both muscle slips were having origin from ulna in continuation with superficial fibers of pronator quadrates muscle. Proximal muscle slip was quadrangular in shape and get inserted on anterior ridge of lower end of radius while distal triangular muscle slip get inserted on medial triangular surface of lower end of radius. So the detailed evaluation of pronator quadratus muscle is needed for knowledge to anatomist and during hand, orthopedic and plastic surgery.

Keywords: pronator quadratus, anterior interosseus syndrome, myofascial pain syndrome, anterior interosseus nerve.

INTRODUCTION:

Pronator quadratus (PQ) is a flat, quadrilateral muscle which extends across the front of the distal part of the radius and ulna. It arises from the oblique ridge on the anterior surface of the shaft of the ulna and adjoining area on the medial part of this surface, and a strong aponeurosis which covers the medial third of the muscle. The fibers pass laterally and slightly downwards to the distal quarter of the anterior border and surface of the shaft of the radius. Deeper fibers insert into the triangular area above the ulnar notch of the radius. Anterior interosseus branch of median nerve which is motor

branch supplied the muscle.[1,2] Standard textbook of anatomy describes pronator quadratus muscle has single head and its variations are not well documented.

But few researchers stated about variations in head of pronator quadratus muscle like dual headed nature (superficial and deep heads) of this muscle, absence of muscle, three headed muscle. Variations of pronator quadratus may be the cause of anterior interosseus syndrome (KilohNevin syndrome) or pronator quadratus myofascial pain syndrome.[3]

Material and methods:
Dissection done over 52 forearms from adult cadavers excluding deformed upper extremity. Careful dissection performed over flexor aspect of forearm, then superficial and deep flexor muscle were dissected and their tendons were cut distally for better exposure of pronator quadratus (PQ) muscle. Nerve supply of the muscle was also seen. Then superficial fibers was dissected from anterior surface of the radius and reflected medially to observe deep fibers of pronator quadratus muscle. Presence of additional head and its nerve innervations was seen during dissection.

Observations:
In present study we studied 52 pronator quadratus muscle and found muscle originate from ulna and inserts on radius in different fashion.

In 16 specimens (30.76%) we found superficial fibers with medial aponeurosis and deep fibers. Both this fibers runs parallel to each other directing downwards and laterally from ulna towards the radius (Figure 1).

In 34 specimens (65.38%) we found superficial fibers in distal part of muscle were directing downwards and laterally from ulna towards the radius while the middle part fibers were more horizontally placed and the proximal muscle fibers were directing upwards and laterally. Deep fibers of the muscle were seen extending downward and laterally toward the radius more oblique to the direction of superficial fibers (Figure 2).

In one specimen we found superficial fibers were directing downwards and laterally, but proximal and distal to the superficial fibers, deep fibers were seen originating about 2 cms proximal to the superficial fibers from the shaft of the ulna while the distal to the aponeurotic superficial fibers, deep fibers again appears as fleshy muscle from ulna extending downward toward the distal part of radius and also some of the fibers extend distally toward the capsule of wrist joint and get attached to it (Figure 3).

In another specimen we found aponeurotic superficial fibers in distal part of muscle were directing downwards and laterally from ulna towards the radius while the middle part fibers were more horizontally placed and the proximal muscle fibers were directing upwards and laterally. Proximal to the superficial part of the muscle two separate superficial muscle fiber slips were seen extending toward the radius. Both muscle slips were having origin from ulna in continuation with superficial fibers of pronator quadrates muscle Proximal muscle slip was quadrangular in shape and get inserted on anterior ridge of lower end of radius while distal triangular muscle slip get inserted on medial triangular surface of lower end of radius (Figure 4). In all specimens muscle was supplied by anterior interosseus branch of median nerve which supplies from the deeper aspect of the muscle.

Figure 1: Parallel running superficial and deep fibers of pronator quadratus muscle

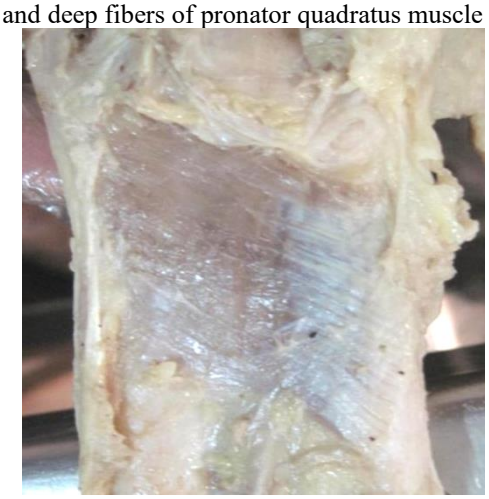

Figure 1

Figure 2: In figure A we can see superficial fibers in distal part of muscle are directing downwards and laterally from ulna towards the radius while the middle part fibers were more horizontally placed and the proximal muscle fibers are

directing upwards and laterally. In figure B deep fibers of the muscle were seen extending downward and laterally toward the radius more oblique to the direction of superficial fibers

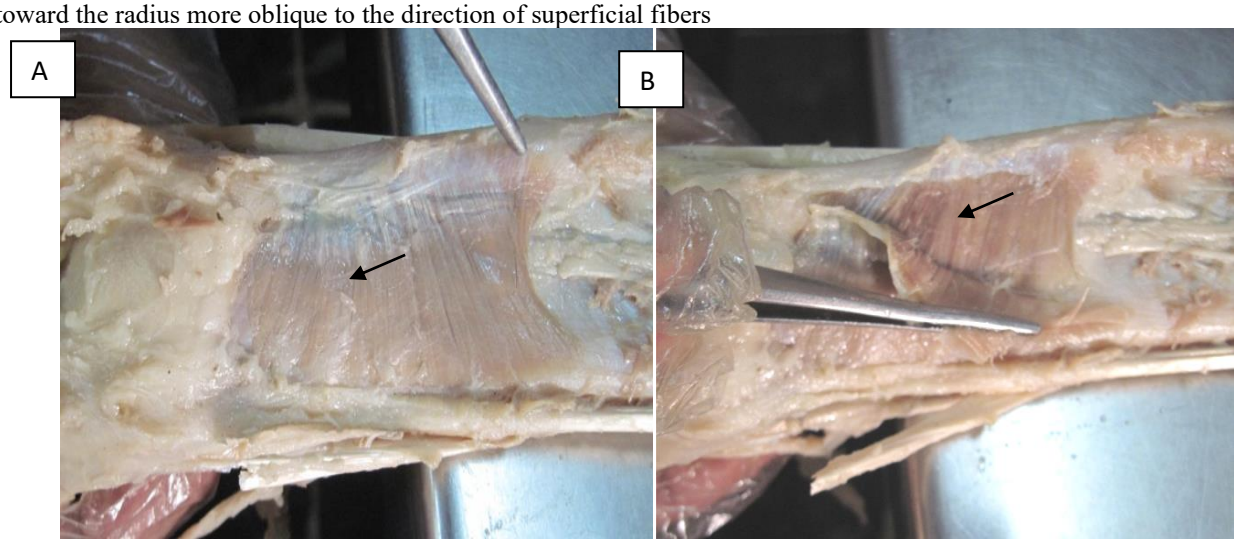

Figure 2

Figure 3: In this figure superficial fibers are seen directing downwards and laterally, but proximal and distal to the superficial fibers, deep fibers are seen originating about 2 cms proximal to the superficial fibers from the shaft of the ulna. Distal to the aponeurotic superficial fibers deep fibers again appears as fleshy muscle from ulna extending downward toward the distal part of radius and also some of the fibers extend distally toward the capsule of wrist joint and get attached to it.

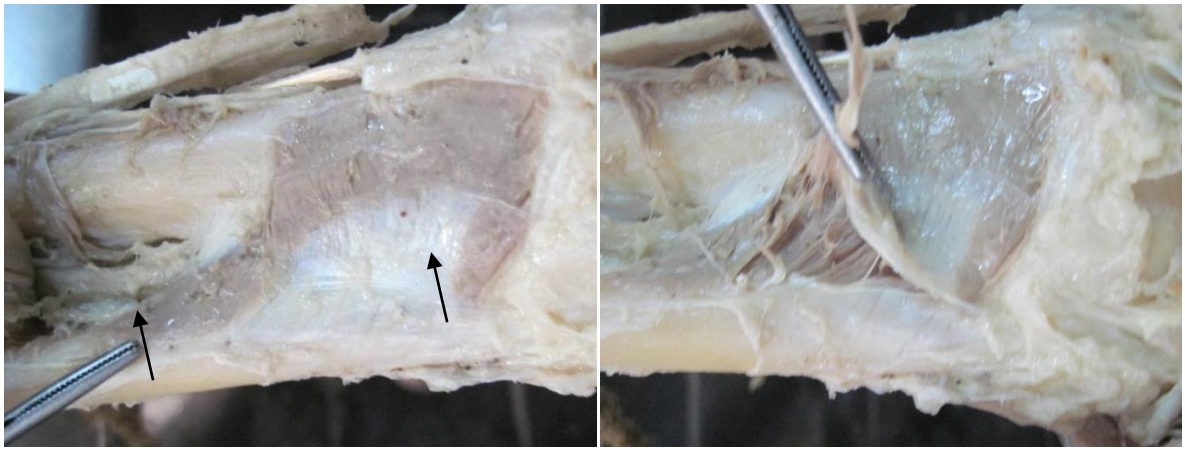

Figure 3

Figure 4: In this specimen we can see proximal to the superficial fibers of the muscle two separate superficial muscle fiber slips extending toward the radius. Both muscle slips are having origin from ulna in continuation with superficial fibers of pronator quadrates muscle Proximal muscle slip is quadrangular in shape and get inserted on anterior ridge of lower end of radius while distal triangular muscle slip get inserted on medial triangular surface of lower end of radius..

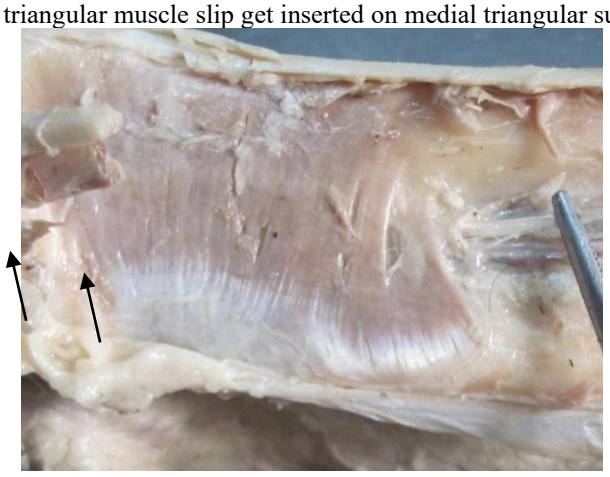

Figure 4

DISCUSSION:

In previous studies superficial and deep fibers of the pronator quadratus muscle are mentioned as superficial head and deep heads. Study done by Jadhav et al[4] (2014) has observed different types of additional heads of pronator quadratus muscle in 36 specimens out of 60 specimens studied and classified them as follows:

Type I: Deep head of PQ was extending proximally in triangular shape which had more attachment on ulna (n=11).

Type II: Deep head of PQ which was extending proximally in triangular shape which had more attachment on radius (n=02).

Type III: Deep head of PQ was covered by superficial head of it (n=14).

Type IV: Distally superficial head of PQ which had tendinous insertion on radius and proximally its deep head with more attachment on radius (n=01).

Type V: Two separate rectangular heads of PQ (n=04).

Type VI: Superficial head of PQ was taking origin from lower part of ulna and inserted on carpal bones (scaphoid, lunate) and few fibers on brachioradialis muscle(n=01).

Type VII: Type I and distally separate slip arising from ulnar side of superficial head of PQ which was attached on capsule of distal radio-ulnar joint (n=01).

Type VIII: Distal triangular superficial head of PQ with tendinous apex at ulna and deep head of PQ extended proximally (n=01).

Type IX: Distal rectangular superficial head of PQ and proximally triangular deep head of pronator quadratus with apex at radius (n=01).

In our study we found 34 specimens (65.38%) having type I fiber pattern. And type VII fibers was seen in one specimen. Das et al[5] (2008) quoted that absence of pronator quadratus muscle was reported by Braus et al (1960) and Kahle et al (1985) in their studies. However present study did not reported absence of pronator quadratus muscle. Stuart[6] (1996) study confirms the consistent presence of two distinct heads to the muscle. The functional significance of these heads were also been studied using in vitro and in vivo techniques to demonstrate that the superficial head is the prime mover in forearm pronation, and that the deep head is a dynamic stabilizer of the distal radioulnar joint. Ahamad et al[7] (2018) observed on gross inspection the presence of two portions of the muscle with different location. 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 fibers. These fleshy fibers passed laterally and converged on white shinny 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 fibers which coursed medially across the anterior aspect of ulna and radius. Tufts et al[9] (2015) report a bilateral aberrant pronator quadratus muscle in a single cadaver, whose features suggest its role as a wrist flexor. The aberrant pronator quadratus was having both superficial and deep bellies originating on the lateral surfaces of these bones with the muscle fascicles oriented obliquely (pennation=80° for radial bellies, bilaterally; 60° for left, 48° for right ulnar bellies). Each pronator quadratus was having tendons from the radial (1 from right, 2 from left) and ulnar bellies (2 from right, 1 from left). In both forearms, these form a common tendon that travels distally across the radioulnar joint, through the carpal tunnel floor, and inserts on the capitate. Collectively, these features suggest an additional function of wrist flexion, similar to a rare flexor carpi radialis brevis.Double, triple heads of pronator quadratus muscle may compress anterior interosseous nerve and produce symptoms and this condition is called as anterior interosseous syndrome or pronator quadratus myofacial pain syndrome.[3] In study done by Schaardenburgh (2022) mentioned that pronator quadratus consist of three parts; superficial, deep proximal and deep distal.[10] Cross-sectional observational study was conducted on 22 cadaveric upper extremities by Zeybek et al[11] (2024). Significant differences were found in pronator quadratus of right and left upper extremities, particularly in the vertical distance between the proximal and distal attachment points. Additionally, significant differences were observed between male and female cadaver for radius and ulna attachment, width of muscle, and the vertical distance between pronator quadratus attachment points on both the radius and ulna. Extra heads may be used for the graft which is used to restore vascularity to proximal carpal row after aseptic necrosis and as a vascularised tissue flaps in the traumatic injuries of distal forearm. Study done by Lee et al[8] (1984) suggests that the pronator quadratus muscle graft is very useful in distal forearm traumatic injuries and also for providing bed for skin graft. Since the incidence of double head is more than the single head as found in present study and some previous study further evaluation is needed to revise the normal anatomy of pronator quadratus muscle.

CONCLUSION:

Incidence of superficial and deep fibers of pronator quadratus running in different direction is more than running in same direction as per present study and previous research report. So the detailed evaluation of pronator quadratus muscle and its variations is needed for knowledge to anatomist and during hand, orthopedic and plastic surgery.

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