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Research article

MORPHOLOGY OF PRONATOR QUADRATUS MUSCLE: A CADAVERIC STUDY

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ABSTRACT

Objective: Pronator quadratus plays an important role in movement and stabilization of radius and ulna in distal radio-ulnar joint and used as a flap in traumatic injuries of the distal part of the forearm. **Aim:** The aim of this study was to delineate the morphology of pronator quadratus muscle. **Material and methods:** A total of 60 forearms (Rt- 30; Lt-30) from 30 Indian cadavers were evaluated. Careful dissection of each forearm was done and extent of radial and ulnar attachments of pronator quadratus, width of proximal and distal borders of it was taken. Also, observed additional heads, attachment of origin and insertion of pronator quadratus muscle. **Results:** Width of proximal and distal borders of pronator quadratus were 28.6mm and 30.2mm respectively on right side and on left it was 28.7mm and 30.1 mm respectively. It had a single head in 33.33%, double heads in 60.00% and three heads in 06.66%. Extents of its radial and ulnar attachments were 45.1 mm and 45.4 mm on right side and 45 mm and 45.5mm on left side respectively. **Conclusion:** These observations have significant value and are applicable to plastic surgeons, clinicians, anatomists and this study will provide additional information for them.

Keywords: Pronator quadratus, Radius, Ulna, Variations.

INTRODUCTION

Pronator quadrates (PQ) is a flat and quadrangular muscle, which lies in a deep flexor compartment of the forearm. It takes origin from the oblique ridge on distal part of the anterior surface of the shaft of the ulna, its adjoining medial area and a strong aponeurosis which covers the medial third of the muscle. Fibers of PQ muscle are directed laterally and slightly downwards and inserted into the distal fourth of anterior border and palmar surface of the lower one fourth of the shaft of the radius. Deepest fibers of PQ are inserted into the triangular area which is present above the ulnar notch of the radius. [1] It is a prime mover for pronation in all positions of elbow flexion and extension and deeper fibers oppose the separation of distal ends of radius and ulna. It is innervated by the anterior interosseous nerve, which is the branch of the median nerve. [2, 3]

Standard textbook of anatomy describes PQ muscle has a single head and its variations are not well documented in textbooks. There are few research reports which reported the variations of heads of PQ muscle. Annis [4] quoted in his paper that, Stuart studied the anatomy of PQ and described dual headed nature (superficial and deep heads) of this muscle. PQ plays an important role in stabilization of the radius and ulna in the distal radio- ulnar joint.[2] Grafts of PQ are used to restore vascularity to proximal carpal row after aseptic necrosis [5] and as a vascularized tissue flaps in the traumatic injuries of distal forearm.[6] Also, pedicle bone grafting of it can be used to treat

pseudoarthrosis of scaphoid bone.[7] Variations of PQ may be the cause of anterior interosseus syndrome (KilohNevin syndrome) or PQ myofascial pain syndrome.[4] Very few prior studies have investigated the PQ muscle but the anatomical information was limited. In this reason, the aim of this study was to delineate the morphology of PQ muscle.

MATERIAL & METHODS

Sixty embalmed (right-30; left- 30) upper limbs from 30 Indian adult cadavers (age range of 50–72 years) of male gender were analysed for this study. The study was conducted in the Department of Anatomy, PDVVPF'S Medical College, Ahmednagar, India. All upper limbs were free from any deformity, fracture and pathology. Also, upper limbs with previous surgical scars and congenital deformities and partially amputated limbs were excluded from our study. Careful dissection of the anterior compartment of each forearm was done and PQ was cleaned meticulously. The proximal and distal attachments and additional attachments of the PQ muscles were carefully analysed. Anatomical variations in the number of heads of the PQ muscle were recorded and photographed. Extent of radial and ulnar attachments, width of proximal and distal borders of PQ was taken with the help of digital Vernier calliper accuracy up to 0.01 mm. Nerve supply and blood supply of PQ muscle were observed.

RESULTS

We observed the different heads of pronator quadratus muscle (Table 1). Variations of PQ were more common on left side.

Table 1- Showing the incidence of number of heads of pronator quadratus [n=60]

Pronator quadratus	Single head (Fig.1a)	Double head (Fig. 1b)	Triple head (Fig.1c)
Number	20 (rt: 7; lt: 13)	36 (rt:12 ; lt:24)	04 (rt:1;t:3)
%	33.33	60.00	06.66

We observed different types of double heads (i.e. superficial and deep) of PQ and classified as follows-

Type I: Deep head of PQ was extending proximally in triangular shape which had more attachment on ulna(n=11); [Fig. 2a].

Type II: Deep head of PQ which was extending proximally in triangular shape which had more attachment on radius (n=02); [Fig.2b].

Type III: Deep head of PQ was covered by superficial head of it (n=14); [Fig.2c].

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); [Fig 3a].

Type V: Two separate rectangular heads of PQ (n= 04); [Fig.3b].

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); [Fig.3c].

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); [Fig.4a].

Type VIII: Distal triangular superficial head of PQ with tendinous apex at ulna and deep head of PQ extended proximally (n=01); [Fig. 4b].

Type IX: Distal rectangular superficial head of PQ and proximally triangular deep head of pronator quadratus with apex at radius (n= 1); [Fig. 4c].

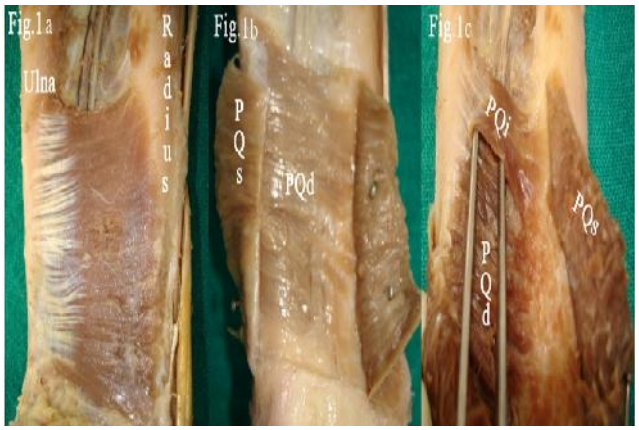

Fig.1a- Showing single head of pronator quadratus. **1b:** Showing double head of pronatorquadratus. **1c:** Showing three head of pronator quadratus

PQS- Superficial head ofpronator quadratus, PQd – Deep head of pronator quadratus

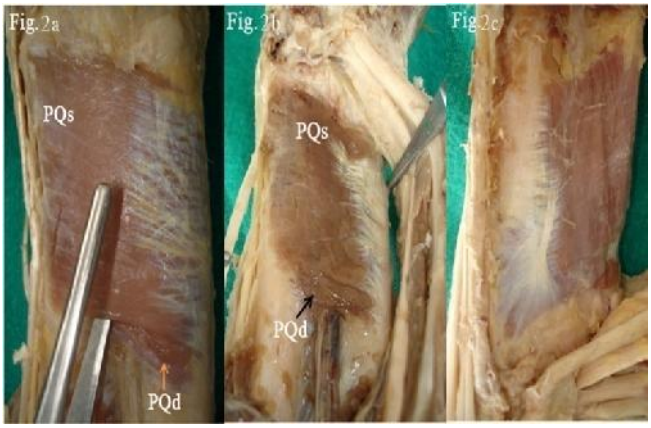

Fig. 2a: Showing Type I pronator quadratus muscle. **2b**: Showing Type II pronator quadratus. **2c:** Showing Type III pronator quadratus.

PQs- Superficial head of pronator quadratus, PQd – Deep head of pronator quadratus

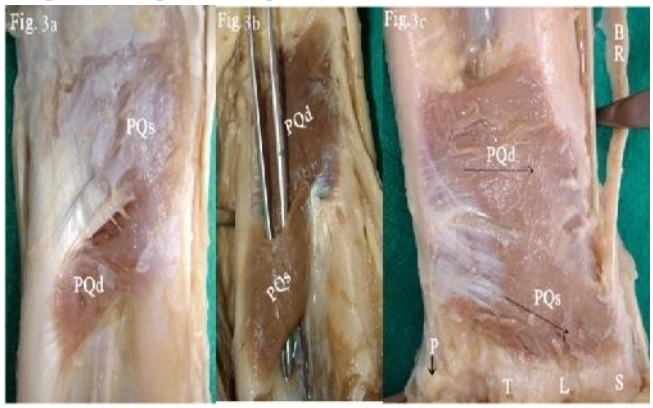

Fig. **3a**: Showing Type IV pronator quadratus. **3b:** Showing Type V pronator quadratus. **3c:** Showing Type VI pronator quadratus

PQs- Superficial head of pronator quadratus, PQd – Deep head of pronator quadrates BR- Brachioradialis, PQs- Superficial head of pronator quadratus, PQd – Deep head of pronatorquadratus, S- Scaphoid, L- Lunate, T- Triquetral, P- Pisiform. Black arrows are showing different direction of fibers of both heads of PQ.

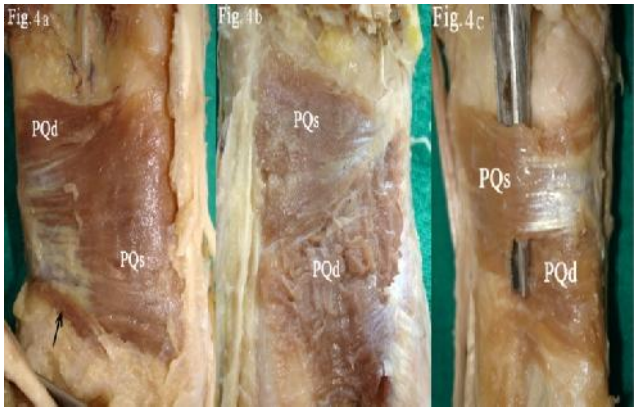

Fig 4a: Showing Type VII pronator quadratus. **4b:** Showing Type VIII pronator quadratus (PQs) **4c**: Showing Type IX pronator quadratus.

PQs- Superficial head of pronator quadratus, PQd – Deep head of pronator quadrates, Black arrow is showing separate slip of pronator quadratus.

We observed, additional attachment of fibers of PQ on bracheoradialis muscle in 2 (Fig. 3c), on carpal bones in 4 (Fig.3c) and on capsule of DRUJ (Fig. 4a) in 2 cadavers.

Radial and ulnar attachments of PQ (Table-2) in 48.50% of cases were at the same level. In remaining cases i.e. 51.50%, ulnar attachment exceeds radial attachment by 3 to 7 mm or radial attachment exceeds ulnar attachment by 2 to 5 mm.

Table 2: Showing the mean of various attachments and width of PQ

Mean of various attachments of PQ	Rt	Lt
Extent of radial attachment of PQ	45.1mm	45.0mm
Extent of ulnar attachment of PQ	45.4mm	45.5mm
Width of proximal border of PQ	28.6mm	28.7mm
Width of distal border of PQ	30.2mm	30.1mm

In all specimens, the PQ muscle was supplied by anterior interossious nerve and anterior interossious blood vessels. These structures were passing in a plane deep to the deep head of PQ muscle.

DISCUSSION

Precise knowledge of anatomical variations is very important because it may influence clinical diagnosis, investigations and interventional performance such as laparoscopy, endoscopy, magnetic resonance imaging and computerized tomography.[8] Pronator quadratus is the deep muscle of flexor compartment of forearm which is considered to be free from variations. [1] Das et al [9] quoted that, absence of PQ muscle was reported by Kahle et al and Barus and Elze. However, present study did not reported absence of PQ muscle. Johnson and Shrewsbury[10] and Koebkeet al.[11] reported double heads of PQ. They described that, deep head of PQ was completely covered by superficial head of PQ. Present study also reported same type of PQ in 23.33% (Fig. 6). Macalister[12] described nine varieties of PQ muscle having double and triple heads. He quoted that, suppressed PQ was reported by Otto and Meckel and bi-triangular form of PQ observed by Barton. In present study, we observed double heads PQ in 60% and triple heads in 6.66 % of cadavers (Table 1; Fig. 1b, 1c). Representation of double heads PQ showed wide variations, as mentioned above. We observed two

separate rectangular heads of PQ muscle while Macalister[12] observed triangular heads of PQ muscle. Variations described by Macalister[12]were different when we compared with our findings.

We observed additional attachment of insertion of PQ muscle into carpal bones and the capsule of distal radio- ulnar joint (Fig. 3c, 4a). A similar observation was made by Macalister [12]and in addition, he observed attachment into the anterior annular ligament, metacarpal bone of the thumb. In two cadavers we observed that, few fibers of PQ muscle were attached to brachioradialis muscle (Fig.3c). We did not find any report of such attachment of PQ muscle in literature. Demir et al[13] reported, a case of double heads of PQ in which an aponeurotic structure coming from superficial head joined to the anterior surface of lower part of the radius.

Fontanic et al [14] studied the anatomic basis of PQ flap and reported the radial and ulnar attachments were at the same level in 50% of cases. In our study, we noted the radial and ulnar extent of PQ muscle (Table 2) and it was at the same level in 47.50% of cases. We observed slightly lower values than Fontanic et al[14] which may be because of racial variations or number of sample size which is more in our study. In all cases, including with extra heads of PQ muscle, the anterior interossious nerve was running on a plane deep to the deep head of PQ muscle. All heads were supplied from deep to superficial surface. Branches to the superficial head were reaching after piercing the deep head of PQ muscle.

CONCLUSION

Pronator quadratus muscle is not free from variations. This study reported that, PQ muscle may have single, double and triple heads. Double or triple heads of it may compress the branches of anterior interossious nerve and produce symptoms. However, extra heads may be used for transplant surgeries. Therefore, precise knowledge of variations of it may be helpful for hand surgeons while planning transplant surgeries, to prevent iatrogenic trauma and to diagnose KilohNevin syndrome. Our study reported high incidence of variations of PQ muscle further studies should be performed with the help of new techniques which will throw more light on anatomy of this muscle.

Conflict of interest: Nil

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