Gantzer’s muscle an accessory muscle of forearm – Its Anatomical Variations and Clinical Insight
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**Abstract**: Muscles of forearm play an important role in moments of wrist and hand. Marked variations of the flexor group of forearm muscles are rarely seen. Muscular variations in the forearm region are clinically significant in operative procedure like tendon transfer and correction of hand deformities. Accordingly the present study was designed to evaluate the anatomical variations such as origin, insertion and clinical insight of the Gantzer’s muscle. In an anatomical study of 54 upper limb specimens of irrespective of age and sex, the incidence, origin, insertion, nerve supply and relations of Gantzer’s muscle have been documented. The Gantzer’s muscle was found in 39 [72%] of the 54 upper limb specimens. It arose from the medial humeral epicondyle in 18 [33%] specimens and from the flexor digitorum superficialis in 21 [38%] specimens. Its insertion was to the flexor digitorum profundus in 16 [29%] specimens and to the flexor pollicis longus tendon in 23 [42%] specimens. It was innervated by the trunk of the median nerve in 13 [24%] specimens and by the anterior interosseous nerve in 26 [48%] specimens. In addition an unusual course of median nerve, radial and ulnar arteries were noted in relation to the Gantzer’s muscle. Such muscular variations may influence the biomechanics of wrist and hand. However, they may simulate soft tissue tumors and can result in nerve or vascular compressions. The knowledge of such variant Gantzer’s muscle and its relation to the median nerve and anterior interosseous nerve facilitates determination of the exact cause of median nerve or anterior interosseous nerve entrapment and allows a safe surgery or appropriate treatment for compressive neuropathies. Unusual course of ulnar and radial arteries noted in this study should be borne in mind by clinicians, surgeons and academicians who manipulate this particular anatomical site.

**Keywords**: Gantzer’s muscle, Kiloh-Nevin syndrome, median nerve, radial artery, ulnar artery.

**Introduction**
Muscles of forearm play an important role in moments of forearm and wrist. The force developed by a muscle depends on both its length and its velocity, and moments of forearm and wrist determine the change in musculotendon length and musculotendon velocity during joint rotation. Muscular variations in the forearm region are clinically significant in operative procedure like tendon transfer and correction of hand deformities.

Flexor digitorum superficialis (FDS) belongs to the intermediate layer of flexor compartment of the forearm, it produces flexion of the middle phalanges of the fingers at the proximal interphalangeal joints and prolonged contraction leads to the flexion of the metacarpophalangeal joints and wrist joint.

Flexor digitorum profundus (FDP) and flexor pollicis longus (FPL) belongs to the deep layer of flexor compartment of the forearm. The FDP is the bulkiest muscle which arises mainly from the upper three- forths of the anterior and medial surfaces of the shaft of the ulna, medial surface of the coronoid and olecranon processes and from the adjacent interosseous membrane. The FPL is absent in primates such as gorilla and chimpanzee in whom a well-developed flexor hallucis longus perform the same function as that of flexor pollicis longus performs in man. The FPL chiefly arises from the anterior surface of the shaft of the radius intervening between radial tuberosity and to the upper attachment of pronator quadratus muscle and from the adjacent interosseous membrane. In addition the FDP or FPL muscles may have additional head which arises from the medial border of the coronoid process of the ulna or from the medial epicondyle of the humerus, such accessory head is known as Gantzer’s muscle. Such muscular variations may influence the biomechanics of wrist and hand at the same time may cause entrapment neuropathy or may simulate soft tissue tumors.

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Accordingly the present was designed to study the variant anatomical origin, insertion and clinical insight of the Gantzer's muscle.

Materials and Methods
For this anatomical study 54 upper limb specimens of human cadavers irrespective of age and sex were used at Santhiram Medical College - Nandyal and an attempt was made to trace the accessory muscle [Gantzer's muscle] to its origin, insertion and its near relation with neurovascular structures were likewise analyzed, and representative anatomy was photographed.

Results
The following types of anatomical variations of Gantzer's muscle and its relation with other structures of the forearm were observed.

- The Gantzer's muscle was found in 39 [72%] of the 54 upper limb specimens.
- It arose from the medial humeral epicondyle in 18 [33%] specimens and from the flexor digitorum superficialis in 21 [38%] specimens.
- It was connected to the flexor digitorum profundus in 16 [29%] specimens [6 cases in the right side and 10 cases in the left upper limb specimens]. [Fig-1 and Fig-2]
- The Gantzer's muscle (accessory belly of the flexor pollicis longus muscle) was connected to the flexor pollicis longus tendon in 23 [42%] specimens [10 cases in the right side and 13 cases in the left upper limb specimens]. [Fig-3, 4 and Fig-5]
- It was supplied by the trunk of the median nerve in 13 [24%] specimens [6 cases in the right side and 7 cases in the left upper limb specimens] and by the anterior interosseous nerve in 26 [48%] specimens [10 cases in the right side and 16 cases in the left upper limb specimens].
- An unusual course of median nerve, radial and ulnar arteries was noted in relation to the Gantzer's muscle. [Fig-1,2,3, 4 and Fig-5]

To the best of our knowledge, such variant Gantzer's muscle in relation to the median nerve, radial and ulnar arteries has not been cited in the recent medical literature.

Figure 1: Showing Gantzer's muscle [an accessory head of flexor digitorum profundus muscle] and its relation to the ulnar artery in the left upper limb.

Figure 2: Showing Gantzer's muscle [an accessory head of flexor digitorum profundus muscle] and its relation to the median nerve and radial artery in the right upper limb.

Figure 3: Showing Gantzer's muscle [an accessory head of flexor pollicis longus muscle] and its relation to the median nerve in the left upper limb.

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Figure 4: Showing Gantzer's muscle [an accessory head of flexor pollicis longus muscle] and its relation to the median nerve in the right upper limb.

FPL- Flexor Pollicis Longus; FDS- Flexor Digitorum Superficialis; 1- Gantzer’s Muscle Gantzer’s Muscle inserted to the Flexor Pollicis Longus Muscle; 2- Median Nerve;

Figure 5: Showing Gantzer’s muscle [an accessory head of flexor pollicis longus muscle] and its relation to the median nerve and anterior interosseous nerve in the right upper limb.

FPL- Flexor Pollicis Longus; FDS- Flexor Digitorum Superficialis; 1- Gantzer’s Muscle Gantzer’s Muscle Inserted To The Flexor Pollicis Longus Muscle; 2- Anterior Interosseous Nerve; 3- Median Nerve;

Discussion

Accessory muscles or tendons in the forearm may lead to confusion during surgical procedures such muscular variations may lead to error in both diagnosis and treatment. [4] The Gantzer’s muscle mostly originated from the medial epicondyle of the humerus or from the under surface of FDS muscle, the presence of Gantzer’s muscle has been noted to be around 50-60% [5], 10.4% [6], 74.5% [7] and 85% [8]. The incidence of Gantzer's muscle is lowest in European Caucasians (33%) and highest in the Blacks (89.5%) with the Asian Japanese being midways and in Indian population (46.03%) it lays between the European Caucasians and the Asian 2 Japanese. [9] Whereas the overall incidence of presence of the Gantzer’s muscle observed in this study was 72%.

The prevalence’s of the additional head of flexor pollicis longus ranged from 75 %, 5.3 %, 54.2%, 55%, 66.66%, and 62%. [10, 11, 12, 13, 14] But in this study Gantzer's muscle was connected to the flexor digitorum profundus in 16 [29%] specimens and to the flexor pollicis longus tendon in 23 [42%] specimens. Such additional head of flexor pollicis longus may leads to flexion deformity (long flexion contracture of the inter-phalangeal joint) of the thumb.[15]

The architecture of the whole muscle may be important in determining muscle function, structural variations affect not only the overall shape and size of the muscle but also function of the skeletal muscle especially range of motion. [16] The Gantzer's muscle is made of fusiform muscle fibers whereas the flexor pollicis longus is made of unipennate muscle fibres. The function of fusiform muscle fiber is in direct opposition to unipennate fibres. This could in turn lead to loss of precise and skilful movements. [17]

Such additional heads or accessory muscles variations in muscle arise primarily due to [18, 19]

- An inheritance carried over from ancient origins.
- Some are errors of embryologic developmental timing.
- Persistence of an embryologic condition.
- Incomplete cleavage of the muscles during development.

The Gantzer’s muscle in relation to the median and anterior interosseous nerves:

Compression of the median nerve is most common in the carpal tunnel, the pronator teres muscle or any muscular variations or aberrant muscle slips at pronator teres muscle level may leads to entrapment neuropathy of the medial nerve which is known as pronator teres syndrome. In the front of the forearm median nerve crosses the ulnar artery from medial to lateral side and is separated by the artery by the ulnar head of pronator teres, where as in this study variant Gantzer’s muscle separated the median nerve from the ulnar artery. Hemmady reported that an accessory muscle was sandwiched between the median nerve and anterior interosseous nerve. [14] In this study emerging of median nerve between the Gantzer’s muscle and deep surface of the FDS muscle noted in 12 specimens, such unusual course of the median nerve may leads to median nerve compressive neuropathies or vascular compressions. Such neuromuscular variations are clinically important because symptoms of median nerve compression arising from similar variations are often confused
with more common causes, such as radiculopathy and carpal tunnel syndrome. [20]

A large number of accessory muscles or aberrant muscle slips and relation to the surrounding neurovascular structures have been chronicled in surgical and radiological literature, but the number of case reports is limited. The Gantzer’s muscle relationship with the anterior interosseous nerve has been described by several authors. [21, 22, 23] Dellon and Mackinnon stated that Gantzer’s muscle always lies posterior to the median nerve or anterior interosseous nerve (AIN) [23], where as in this study anterior interosseous nerve lies deep to the Gantzer’s muscle in 12 specimens and in 16 specimens passed between the Gantzer’s muscle and deep surface of the FDS. Cicatricial contraction of the accessory belly (Gantzer’s muscle) of the flexor pollicis longus as seen in Volkman’s ischaemic contracture may lead to entrapment of the median and anterior interosseous nerves, in such cases accessory belly (Gantzer's muscle) may have to be lengthened/released along with the principle belly of flexor pollicis longus.

Such unique course of anterior interosseous nerve in relation to the Gantzer’s muscle noted in this study may cause entrapment neuropathy of the anterior interosseous nerve (Kiloh-Nevin syndrome). [24] Such muscular variations should be kept in mind for surgeons during anterior approaches to the proximal radius and the elbow joint, as also during a decompressive fasciotomy for compartment syndrome of the forearm.

The Gantzer’s muscle in relation to the ulnar artery:

Ulnar artery is the larger terminal branch of brachial artery and arises from in the cubital fossa, an unusual course or variant ulnar artery or superficial course of ulnar artery may complicate intravenous drug administration, venipuncture, and percutaneous brachial catheterization. In this study the Gantzer’s muscle runs distally and obliquely across the ulnar artery from medial to lateral side underneath the flexor digitorum superficialis to join the FDP muscle and its tendon in 6 specimens were noted, as per our knowledge such unusual course of ulnar artery in relation to the Gantzer’s muscle has not been reported in modern literature. [Fig-1] Knowledge of this variation is very important to surgeons in appropriately planning the operative procedures.

The Gantzer’s muscle relation to the radial artery:

Radial artery is the smaller terminal branch of the brachial artery and begins the cubital fossa it extends down words in the forearm intervening between the tendons of brachioradialis and flexor carpi radialis. But in this study the Gantzer’s muscle runs distally and obliquely across the median nerve and radial artery from lateral to medial side underneath the flexor digitorum superficialis to join the FDP muscle and its tendon. [Fig-2] The knowledge of such variations is very important for radiologists, surgeons, orthopedic surgeons, plastic surgeons and nurses.

Conclusion

Variant accessory muscle [Gantzer's muscle] to its origin, insertion and its unusual relation with adjacent neurovascular structures reported in this study has not been reported in modern literature. The knowledge of variant course of the median nerve and anterior interosseous nerve in relation to the Gantzer's muscle facilitates determination of the exact cause of median nerve or anterior interosseous nerve entrapment and allows a safe surgery or appropriate treatment for compressive neuropathies. [25] Unusual course of ulnar and radial arteries in relation to the Gantzer’s muscle noted in this study should be borne in mind by clinicians, surgeons and academicians who manipulate this particular anatomical site.

References


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