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# Morphological Variations of Muscles of the Forearm - Gantzer Muscle

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**Abstract:** ***Introduction: The muscular variations like accessory muscles are not uncommon in upper limbs. In majority of the cases, these accessory muscles are asymptomatic. They become clinically important when they produce clinical symptoms like neurovascular compression and also during various surgical approaches. Method: The present study was conducted in 30 disarticulated upper limbs of unknown age and gender in the Department of Anatomy, Osmania Medical College, Hyderabad, Telangana, India. Result: In 6 upper limbs, accessory belly of Flexor pollicis longus (FPLah) was found. Conclusion: Gantzer muscle is clinically important as it compresses median nerve or anterior interosseous nerve. The proper knowledge of these variations is important not only for anatomists, but also for surgeons and radiologists to avoid complications during surgeries and errors in diagnosis during radio diagnostic procedures.***

**Keywords:** Gantzer's muscle, Flexor pollicis longus, Flexor digitorum profundus, Flexor digitorum superficialis, Kiloh-Nevin Syndrome

## 1. Introduction

Accessory muscles are anatomic variants representing additional distinct muscles that are encountered along with the normal complement of muscles [1]. They usually found as an incidental finding as in most of the cases they remain asymptomatic.In1813, German anatomist Carol F. L.Gantzer described accessory muscles in flexors compartment of the forearm which insert either into Flexor Pollicis Longus (FPL) or Flexor Digiotorum Profundus (FDP) [2, 3, 4] which are named after him as Gantzer's muscle or occasional heads [5]. Of these two, FPLah (accessory head of FPL) is more frequent and FDPah (accessory head of FDP) is less frequent. [5, 6, 7, 8]. The incidence of the accessory head of the FPL has been reported to range from 39±2% to 73±7% and that for the accessory head of the FDP from 2±9% to 35±2 % [3, 8]. According to literature, Albinus described this muscle almost a century before [4, 9].

The muscles of anterior or flexor or volar compartment of the forearm are arranged in 2 layers. The superficial layer contains Pronator teres (PT), Flexor carpi radialis (FCR), Palmaris longus (PL), Flexor digitorum superficialis (FDS) and The Flexor carpi ulnaris (FCU). Deep layer contains Flexor digitorum profunuds (FDS), Flexor pollicis longus (FPL) and Pronator quadratus (PQ) [10]. The FDS muscle has been grouped as a retrogressive muscle as it represents remnants of connections between two sheets of muscles [11].

**Embryology:** Gantzer muscle is defined as accessory muscle connecting superficial and deep flexors [2]. Somatic mesoderm invades limb sprouts during the fourth week of embryonic life, forming ventral and dorsal condensation [5].

The flexor muscles develop from the ventral condensation (flexor mass) which subsequently divides into superficial and deep layer of muscles. The existence of accessory muscles which connect these flexor muscles could be explained by the incomplete cleavage of the flexor mass during development in foetal life [2-3, 6, 11-13].

In majority of the cases the accessory muscles are asymptomatic and found as an incidental finding. An accessory muscle may simulate as a ganglion or a soft tissue tumor. If present in close proximity to a neurovascular structures, it may cause compression of these structures due to their mass effect. The gantzer muscle is clinically important as it compresses the median nerve or its branch anterior interosseous nerve causing compressive neuropathy like carpal tunnel syndrome, Kiloh-Nevin Syndrome or Anterior interosseous nerve syndrome. The knowledge of this muscle is necessary for proper diagnosis and to avoid errors in treatment.

## 2. Materials and Methods

The present study conducted in the department of anatomy in the Osmania Medical College, Koti, Hyderabad, Telangana, India. It includes 30 disarticulated upper limbs of unknown age and sex which are partially dissected during undergraduate dissection and are further dissected to check for presence of gantzer muscle. The parameters like shape, origin, insertion, length, width, nerve supply and relation to anterior interosseous nerve are observed and recorded.

## 3. Results

The following findings are encountered – FPLah is observed in 6 upper limbs. Of these, in 5 upper limbs the accessory heads are taking origin from medial epicondyle (83.3%) and in 1 upper limb taking origin from undersurface of Flexor digitorum superficialis (16.4%). All are inseted into ulnar side of FPL. In all cases median nerve is anterior and anterior interosseous nerve is posterior to muscle bellies.

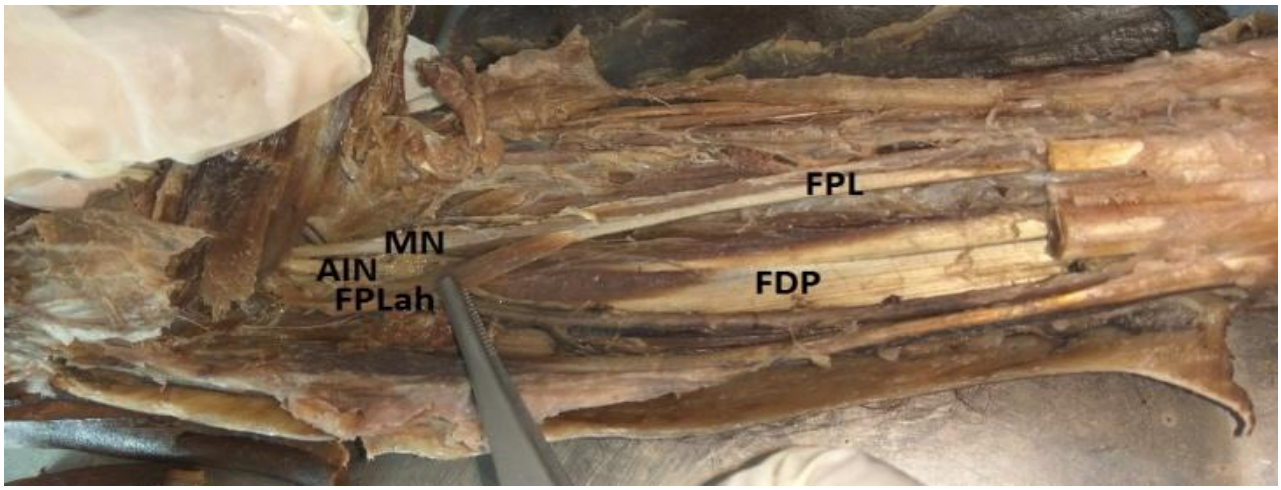



**Figure 1:** FPLah (accessory head of flexor Pollicis Longus) originating from medial epicondyle with AIN (Anterior Interosseous Nerve), MN- median nerve.

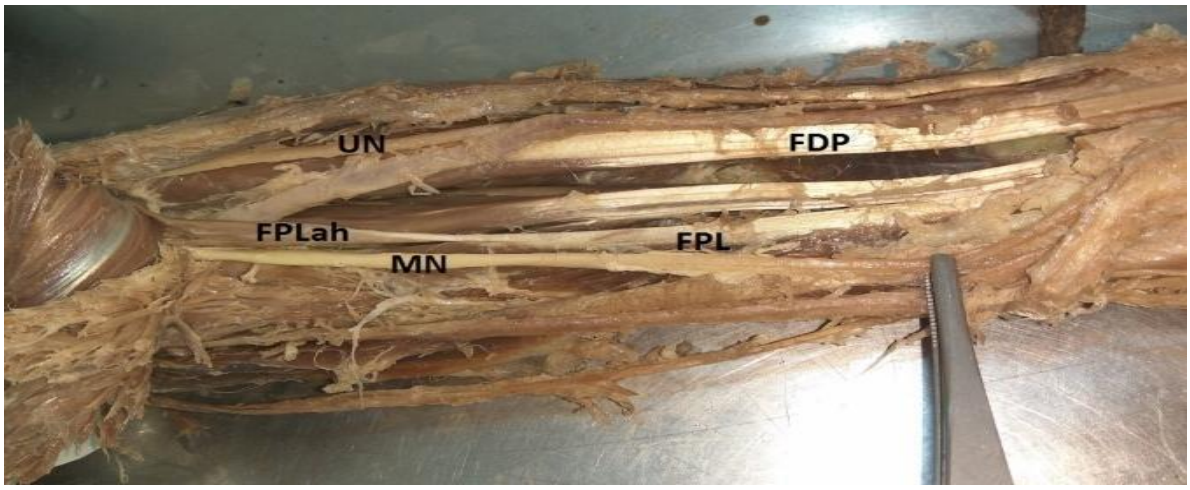



**Figure 2:** FPLah (accessory head of flexor Pollicis Longus) originating from undersurface of FDS

## 4. Discussion

The occurrence of Gantzer's muscle is lowest in European Caucasians (33%) and highest in the Blacks (89.3%) with the Asian Japanese being midways and in Indian population (46.03%) it lies between the European Caucasians and the Asian Japanese [4, 12]. According to previous studies the incidence of gantzer muscle ranges from 50%-66% [14].

According to literature, the various sites of origin for Gantzer muscle are the medial epicondyle of the humerus as reported by sudhakaran [2], Vasavi Rakesh [3], Mustafa [9] or coroniod process of ulna as reported by Mustafa [9] Degreef [15] or from the under surface of flexor digitorum superficialis muscle (FDS) as reported by Shalom [6] or from tendon of brachialis as reported by Soubhagya [12]. In present study accessory heads are taking origin from the medial epicondyle (83.3%) and undersurface of Flexor Digitorum superficialis (16.7%) which was similar to previous studies.

The following are the average measurements of accessory heads of FPL - muscle length was 5.85cm, muscle width was 0.8cm, tendon length was 3.2cm and tendon width was 0.2cm. The comparison of these measurements with other studies is tabulated in Table.1.

The parameters are slightly higher than Vasavi rakesh et al [3] and lower than Potu B.K. et al [17], thus inermadiate between these 2 studies.

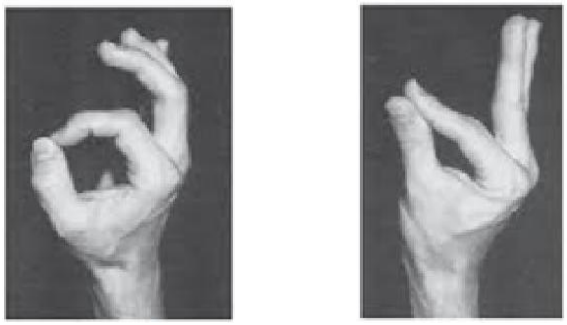
**Table 1:** Comparison of muscle measurements

| Author | ML OF AHFPL | MW OF AHFPL | TL OF AHFPL | TW OF AHFPL |
|---|---|---|---|---|
| Bharathi rani et al [16] | 6.05 | - | 3.12 | |
| Potu B. K et al [17] | 6.2 | 1.2 | 2.6 | 0.35 |
| Ravi prasanna et al [4] | 3.8 | - | 7.4 | 1.2 |
| Vasavi rakesh et al [3] | 5.9 | 0.6 | 3.2 | 0.2 |
| Mustafa [9] | 11.022 | 0.55 | - | - |
| **Present Case** | **5.85** | **0.8** | **3.5** | **0.3** |

**ML** - Muscle length, **MW** - Muscle width, **TL** - Tendon length, **TW** - Tendon width

Soubhagya et al [12] reported a case of triple gantzer and Si-Wook Lee et al [7] reported a case of double gantzer muscle with four bellies. Ilse Degreef [15] reported a case of older female patient with paralysis of the anterior interosseous nerve caused due to compression by an accessory muscle slip arising from the coronoid process of the ulna towards the flexor pollicis longus (Gantzer's muscle). Umapathy et al [13] and Raviprasanna et al [4] stated that the FPLah (Gantzer's) is made up of fusiform muscle fibres has an opposite function to that of the unipennate muscle FPL proper leading to an extra strain on the normal function of the FPL proper, in turn, leading to the loss of precise and skillful movements of the thumb.

The common effects of these accessory heads are nerve compressions and tenosynovitis and they may also cause restricted movement of the hand resulting in burning pain in the lower third of the forearm via a muscle-tendon shearing action. Compression of the anterior interosseous nerve (AIN) in the forearm is called Kiloh- Nevin syndrome or Anterior Interosseous Nerve syndrome (AINS). It was first described by Parsonage and Turner in 1948 and further elucidated by Kiloh and Nevin in 1952 [2]. The AIN innervates the FPL, PQ and FDP to the index (sometimes also the FDP to the medius). Even though AIN is sensory to the radiocarpal, midcarpal and carpometacarpal joints, the syndrome is not associated with sensory loss. It presents as purely motor deprivation affecting the FPL, lateral half of the FDP and PQ causing square pinch deformity [9, 13, 18]. Weakness may present as clumsiness with fine motor activities like writing and sewing. It can be clinically tested by asking the patient to make the 'Ok' sign which is also called the Spinner's test [5].



**Normal** **AIN palsy**

**Figure 3:** Patient asked to make 'OK' sign

The following 4 types of relationships of FPLah to AIN were noted [1, 13, 16]

Type I - AIN running anterior to FPLah (13.4%),
Type II - AIN running lateral to FPLah (65.8%),
Type III - AIN running posterior to FPLah (8.1%) and
Type IV - AIN running lateral and posterior to FPLah (12.8%)

A complete AINS occur in Type III relationship where the whole nerve passes posterior underneath the belly causing weakness in the FPL, FDP and the pronator quadratus muscles. Incomplete type is likely to occur in Type IV relationship where only the medial branch of the AIN to FDP of index and middle fingers passing underneath the belly is compressed, whereas the lateral branch to FPL running alongside the belly is spared [6, 17].

The causes of AIN compression have been listed as abnormal muscles and tendons, vascular arcades and intrinsic compression, micro trauma. Differential diagnosis includes rupture of the FPL or a locked trigger thumb or flexor tendonadhesions. The EMG study is useful for diagnosis of AINS.

During anterior surgical approach to the proximal radius and the elbow joint and decompressive fasciotomy for compartment syndrome of the forearm these muscle variants should be kept in mind by surgeons. These anatomical variants can be detected by the imaging techniques like computed tomography (CT) and magnetic resonance imaging (MRI).The knowledge of these muscles which help for clinical diagnosis and for proper planning of any surgical procedures in that region.

## 5. Abbreviations

AIN - Anterior Interosseous Nerve
AINS - Anterior Interosseous Nerve Syndrome
FDP - Flexor Digitorum Profundus
FDS - Flexor Digitorum Superficialis
FPDah - Accessory Head of Flexor Digitorum Profundus
FPL - Flexor Pollicis Longus
FPLah - Accessory Head of Flexor Pollicis Longus

## 6. Conclusion

The gantzer muscle is one of the causes of neurovascular compression in forearm by their mass effect. Therefore proper knowledge of these gantzer muscles is necessary for making a differential diagnosis of the causes and sites of nerve compression in the forearm and also for proper planning of surgical intervention for relieving pain in compartment syndrome and during tendon transfers for restoring function in multiple nerve palsies as in Hansen's disease and severe traumatic loss of muscle in crush injuries.

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