

A Study of the Accessory Muscles in the Flexor Compartment of the Forearm

UMAPATHY SEMBIAN, SRIMATHI T., MUHIL M., NALINA KUMARI S.D., THIRUMALAIKOLUNDU SUBRAMANIAN

ABSTRACT

Aim: To ascertain the prevalence of the accessory muscles in the flexor (anterior) compartment of the forearm.

A wide array of the supernumerary muscles has been described in the anatomical, surgical and radiological literatures.

In a vast majority of the cases, the accessory muscles are asymptomatic and they represent incidental findings at surgery or imaging.

Hence, this study was taken up to access the occurrence of the accessory muscles in the flexor compartment of the forearm.

Materials and Methods: This descriptive study was conducted in the Department of Anatomy, Chennai Medical College Hospital and Research Centre, Trichy and in the Sri Ramachandra University, Chennai, India.

This study was conducted from 2006 to 2012 for a period of seven years in the Department of Anatomy.

During the routine cadaveric dissection for undergraduate teaching in one hundred cadavers for a period of seven years, we studied the presence of abnormal variations in the muscular pattern of the anterior compartment of the forearm.

All the upper limbs were dis-articulated and were tagged for their respective sexes and numbers.

Among the 100 cadavers, 90 belonged to the male sex, whereas 10 belonged to the female sex. In a total of 200 upper limbs: 100 limbs to the right side and 100 limbs to the left side.

Upper limbs which exhibited fractures both pre mortem as well post mortem, those with an obscuring pathology, previous

surgical scars, and congenital deformities and partially amputated limbs were excluded from our study.

Methods: During the routine undergraduate dissection, we studied the muscular pattern in all the upper limbs.

After making an incision in the skin, the superficial fascia and the deep fascia were reflected, thus exposing the flexor muscle compartment. A thorough investigation was carried out to verify all the two layers of muscles, both the superficial layer and the deep layer.

The investigation included the questions (a) whether the muscles for that compartment were present or not (absence), and if present its both proximal and distal attachments, (b) if there is any accessory muscles present, its attachments.

Results: In our study, we found that only in two different limbs, unilaterally, there was a presence of (a) an Additional Head of the Flexor Pollicis Longus (AHFPL-Gantzer's muscle) and in another limb (b) an Accessory Palmaris Longus was found and both belonged to the male sex.

Conclusion: Only 2% of the limbs in our study exhibited an abnormal pattern of the muscles.

This study will supplement our knowledge on the possible variations of the muscles in this region, which would be useful for hand surgeons, orthopaedic surgeons, general surgeons, physicians and plastic surgeons, as it would probably compress the neuro-vascular bundle because of its close relationship, leading to both vascular and neural symptoms.

Key Words: Gantzer's muscle (AHFPL), Carpel tunnel syndrome, Accessory Palmaris Longus, Guyon's canal

INTRODUCTION

A wide array of supernumerary and accessory musculature has been described in the anatomical, surgical and radiological literatures. In most of the cases, the accessory muscles are asymptomatic and they are found incidentally during surgery or imaging. However, in some cases, the accessory muscles may produce clinical symptoms due to the compression of the neurovascular structures, especially in the fibro osseus tunnels.

In some cases, if an obvious cause of the neurological symptoms is not evident, the recognition and the careful evaluation of the accessory muscles may aid in the diagnosis and treatment of these cases.

Variations in the extensor compartment of the forearm are quite common. However, in the flexor compartment, not many variations

are noted and the occurrence of an additional muscle is very uncommon.

In case of the Carpel Tunnel Syndrome, it is said to be because of the inflammation with subsequent oedema, which leads to compression in the carpel tunnel, but in certain cases, these accessory muscles can also produce the Carpel Tunnel Syndrome due to overcrowding in the fibro osseus tunnels.

Hence, this study was taken to rule out the prevalence of the muscles which are encountered in our population.

AIM

The aim of this study was to ascertain the prevalence of the accessory muscles in the flexor compartment of forearm to help the physicians, the general surgeons and the hand surgeons, to

keep this in mind for the diagnosis as well as for the treatment of such conditions, which involves compression of the neuro vascular structures.

MATERIALS AND METHODS

The present study was conducted in the Department of Anatomy, Chennai Medical College Hospital and Research Centre, Trichy and in the Department of Anatomy, Sri Ramachandra University, Chennai, India.

This study was done from 2006-2012, for a total of seven years, and it consisted of 100 cadavers which were used for the routine undergraduate teaching program.

All the cadavers belonged to the adult category and they were without any obvious pathological deformities. The cadavers were preserved by the injection of formalin based preservative (10% formalin) and they were stored in tanks. Before taking photographs, the dissected region was rinsed with water.

From all the cadavers, the upper limbs on both the sides were disarticulated after the dissection, with the subsequent tagging of sex and the identification number for that particular cadaver from which the limb was disarticulated.

Both the sexes were included in our study. There were 90 male cadavers and 10 female cadavers. The disarticulated limbs were in a total of 200 (100-right side and 100-left side).

Meticulous care was taken to exclude the limbs which exhibited obscuring pathologies, fractures (both pre- and post-mortem), deformities, congenital anomalies and previous surgery in this region and amputations.

METHODS

The dissections were carried out in all the limbs on the right and left sides as per the instructions which were given by Cunningham's Manual of Practical Anatomy.

The skin was reflected to expose the superficial fascia, and it was examined for its contents: cutaneous nerves and vessels and if any abnormality was noted, it was recorded in detail. Then the superficial fascia was incised and it was reflected to expose the deep fascia. Then the deep fascia was incised and it was reflected to expose the muscles of the superficial compartment of the forearm.

All the muscles were examined for their presence, position, and their attachments, and then the superficial compartment was cut to expose the deep compartment muscles; again, the routine investigation was carried out.

If any abnormality was found in the muscular pattern, it was recorded in detail and photographed.

OBSERVATION

In our study, we came across two variations of accessory muscles in two different limbs unilaterally, which belonged to the male sex.

- AHFPL-Additional Head of the Flexor Pollicis Longus (GANTZER'S muscle) on the left side forearm, (unilateral) of a male cadaver.
- An Accessory Palmaris longus on the right side forearm (unilateral) of a male cadaver.

The GANTZER'S muscle (AHFPL) originated from the undersurface of the Flexor Digitorum Superficialis muscle, just distal to its origin from the medial epicondyle. On further dissection, the accessory belly was found to run downwards to the medial aspect of the Flexor Pollicis Longus tendon proper for its insertion at the junction between the proximal and the middle thirds of the forearm.

The accessory Palmaris Longus originated from different areas, namely few fibers from the deep fascia of the forearm, passing through the GUYON'S canal over the ulnar vessels and the nerves and merging with the hypothenar muscles, few fibres from the tendon of the Palmaris Longus proper and at last, few fibres from the flexor retinaculum.

The tendon of the accessory Palmaris longus muscle got inserted into the medial epicondyle.

DISCUSSION

In the forearm, the muscles can be classified into a superficial set of muscles and a deep set of muscles.

The superficial set of the muscles are the Pronator teres (PT), the Flexor carpi radialis (FCR), the Palmaris longus (PL), the Flexor digitorum superficialis (FDS) and the Flexor carpi ulnaris (FCU). The deep set of the muscles are the Flexor digitorum profundus(FDP), the Flexor pollicis longus(FPL) and the Pronator quadrates(PQ).

The Flexor pollicis longus is one of the deep flexors of the forearm and it originates from the grooved anterior surface of the radius and from the adjacent interosseous membrane and gets inserted into the base of the distal phalanx of thumb [1].

It has been noted that it can arise from the lateral border of the coronoid process or from the medial epicondyle of the humerus. This variable slip of the muscle is called as the GANTZER'S muscle [2].



[Table/Fig-1,2,3]: AHFPL (Gantzer's muscle)



[Table/Fig-4,5,6]: ACCESSORY Palmaris longus

The prevalence of the Gantzer's muscle has been noted to be around 50-60% by Al-Quattan [3], and Oh [4]. There has been various reports from different studies regarding the prevalence of this Gantzer's muscle, which was found to range from 75% [2], to 5.3% [5], to 54.2% [6], to 55% [7], to 66.66% [8], to 62% [9]. It has also been reported to occur unilaterally or bilaterally and the chances for it to occur bilaterally than unilaterally is more [3,4,8,10,11,12,13]. There has been reports of its variable origin too [2,3,6,7,9].

Normally, the Flexor pollicis is supplied by the Anterior Interosseus nerve which descends on the interosseus membrane between the FPL and the FDP. Further, it runs downwards between the FPL and the PQ.

This additional head (the Gantzer's muscle) is said to be one of the structures which may compress the anterior interosseus nerve, thus leading to a relatively rare clinical condition which is called as the anterior interosseus nerve syndrome, which produces the square pinch deformity.

This condition is said to interfere with the functions of precision handling (finger-thumb prehension) and a powerful grip (full hand prehension) as the FPL acts as a stabilizer of the flexed phalanx of the thumb. As has been said by Levangie and Norkin [14], the architecture of this muscle is important to determine its function and so, abnormalities in its shape affects not only its function but also its range of movements.

In contrast to the Flexor pollicis longus proper which is made up of unipennate muscle fibres, the additional head of the FPL (Gantzer's) is made up of fusiform muscle fibres which have an opposite function to that of the unipennate muscle. So, it could lead 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.

According to a study which was done on 240 limbs, the prevalence of the accessory head of the flexor pollicis longus was observed in 149 specimens. In these 149 specimens, four basic patterns of the relationship of AHFPL with the anterior interosseus nerve (AIN) were found. (a) AIN was found to pass anterior to the AHFPL in 13.4% specimens (b) AIN passed lateral to the AHFPL in 65.8% specimens (c) AIN passed posterior to the AHFPL in 8.1% specimens and (d) AIN passed both lateral and posterior to the AHFPL in 12.8% specimens [9].

The palsy of the AIN is frequently reported to be due to the entrapment by soft tissue, and vascular and bony structures and it may be associated with other causes like neuralgic amyotrophy, entrapment neuropathy [15], and repetitive trauma to the forearm. It may also be due to anatomical abnormalities.

We would like to conclude that the chances for AIN to get entrapped is more likely when the nerve passes posteriorly or laterally to the AHFPL, based on anatomical considerations.

Developmentally, the occurrence of AHFPL is due to incomplete differentiation. Initially, a common flexor mass is formed in the embryo, which further differentiates into a superficial layer and a deep layer. The deep layer further develops into the FDP, FPL and the PQ muscles. In case an incomplete differentiation occurs, then such type of accessory muscles are formed [16,17].

Hemmandy has stated that the accessory muscles are to be borne in mind during decompression fasciotomy for the compartment syndrome of the forearm, and during anterior surgical approaches to the proximal radius and the elbow joint.

The next finding was the presence of an accessory Palmaris longus on the right side forearm in a male cadaver unilaterally.

In hand reconstructive surgeries, the Palmaris longus muscle is one of the most utilized donor site for tendon reconstruction procedures. However, its anatomical position is variable and its anatomical variations may be responsible for the median nerve compression.

In our study, the accessory Palmaris longus originated from different areas ie few fibres arose from the tendon of the Palmaris longus proper, few fibres arose from the deep fascia of the forearm, passing through the GUYON'S canal over the ulnar vessels and merging with the hypothenar muscles and at last, a few fibres arose from the flexor retinaculum whereas its insertion was into the medial epicondyle. The muscle had a long tendon and a short muscular belly.

The accessory muscles are the most frequently described anatomical variations at the Guyon's canal, whose occurrence is about 22.4% in cadaver specimens and which occur bilaterally in 46.2% specimens [18].

The most common anatomical accessory muscle variations were the accessory abductor digiti minimi with a prevalence of 61.5% (Dodd's et al.,1990) [18] and the accessory Palmaris longus with a prevalence of 8.6%.

The Guyon's canal syndrome can be classified as occurring due to a primary cause and a secondary cause. The primary is idiopathic with symptoms of Guyon's canal syndrome, with no identifiable lesion [19].

The secondary causes can be subdivided into (a) Traumatic, (b) Inflammatory, (c) Structural and (d) Vascular. The structural causes may be of a tumorous or a non tumorous nature. The tumours may be due to ganglions, lipomas and giant cell tumours.

The non-tumorous causes may be due to anomalous muscles like the unusual thickening of the Palmaris brevis, and the accessory Palmaris longus, or the complete reversal of the Palmaris longus.

The presence of an accessory Palmaris longus can be attributed to an unusual migration of myoblasts during the morphogenesis.

Although it is rare, an accessory Palmaris longus is worth bearing in mind as a possible cause for median nerve compression.

CONCLUSION

We would like to conclude by stating that the observations which were made by us in this study will supplement our knowledge on the possible variation of the muscles in this region, which would be useful for orthopedic surgeons, plastic surgeons, hand surgeons and general surgeons, as it would compress the neuro-vascular structures because of its close relationship, thus causing both vascular and neuronal symptoms.

The presence of the Gantzer's muscle (AHFPL) may compress the AIN, thus leading to the AIN syndrome (Kiloh-Nevin syndrome) and thus causing a square pinch deformity and difficulty in precision handling.

The accessory Palmaris longus which arises from the deep fascia and crosses the Guyon's canal could be the cause for the development of the Guyon's canal syndrome.

Even though the literature review has quoted that the frequency of the accessory muscles which are encountered are more, in our study, we came across only two cases which constituted only 2% of the population.

The authors frankly accept that the sample size was too small and that the female cadavers (limbs) constituted only 10% of the total number of the specimens. So, to come to a definitive conclusion, these type of studies should be conducted in different regions of India and also on good numbers of specimens.

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AUTHOR(S):

1. Dr. Umapathy Sembian
2. Dr. Srimathi T.
3. Dr. Muhil M.
4. Dr. Nalina Kumari S.D.
5. Dr. Thirumalaikolundu Subramanian

PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Dept of Anatomy, Chennai Medical College Hospital and Research Centre, Trichy, India.
2. Assistant Professor, Dept of Anatomy, Sri Ramachandra University, Chennai, India.
3. Associate Professor, Chennai Medical College Hospital & Research Centre, Trichy, India.
4. Professor & H.O.D (Anatomy), Chennai Medical College Hospital & Research Centre, Trichy, India.

5. Professor & H.O.D (Gen Medicine), Chennai Medical College Hospital & Research Centre, Trichy, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Umapathy Sembian
G-1, Staff Quarters, Chennai Medical College Hospital & Research Centre, Irungalur, Trichy, India -621105.
Phone: 9789832616
E-mail: umapathysembian@yahoo.in

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