

AGENESIS AND VARIATIONS OF THE PALMARIS AND THE PLANTARIS MUSCLE AND TENDON: A CADAVERIC STUDY

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ABSTRACT

Introduction: Palmaris longus (PL) is one of the most variable and most superficial flexor muscles of the forearm. Plantaris muscle has also been observed to present frequent variations in terms of its occurrence, origin, course, relation with surrounding neurovascular structures and insertion.

Materials and Methods: The study consisted of a total of 100 upper limbs and 100 lower limbs out of the total 50 bodies. The origin, insertion, nerve and blood supply were noted. The length, circumference of the muscle belly and the tendon were also noted for both the muscles.

Results: The length of the forearm, Palmaris longus muscle and the tendon was also more in the males than in the females. &% of the cases had agenesis of the Palmaris longus muscle. High aponeurosis, twin bellies of the muscle, extra origin of the Palmaris longus muscle from the inter muscular septum and flexor digitorum superficialis muscle were some of the variations observed. In case of the Plantaris muscle, the length was more in the females than in the males, though the circumference of the belly and the length of the tendon was far higher in the males than in the females.

Conclusion: The knowledge of the approximate length and breadth of the Palmaris and the plantaris muscle, including the various variations that may be associated with it is very important to the surgeons in various reconstructive surgeries and physiotherapies

KEY WORDS: Palmaris Longus, Plantaris, Cadavers, Variations, Agenesis.

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INTRODUCTION

Palmaris longus (PL) is one of the most variable and most superficial flexor muscles of the forearm. It is a slender, fusiform muscle which lies medial to flexor carpi radialis. Arising from the medial epicondyle of humerus by the common tendon, and from adjacent intermuscular septa and deep fascia of the arm, it converges to form a long tendon, which passes superficial to the flexor retinaculum. As the tendon crosses

the retinaculum it broadens out to become a flat sheet and gets incorporated into the palmar aponeurosis. It is supplied by the median nerve [1].

The PL muscle flexes the wrist weakly as an accessory flexor muscle. Its main function is to serve as an anchor of the fascia, as it tenses the skin and the palmar fascia of the hand, shearing the forces to the palmar aponeurosis in a distal direction [2-5].

As it is considered an accessory muscle and not essential for normal function, as its absence has not been associated with loss of grip and pinch strengths [6] this tendon is used as a graft in a large number of surgical procedures, such as: chronic injuries of the flexor tendons [7,8], ligament reconstructions [9], pulley reconstruction [10], ocular defects, reconstructions and ligaments of the thumb and elbow, blepharoptosis [6] and other surgical reconstructions [9,10].

Plantaris is the largest muscle in the human beings. It runs alongside the gastrosoleus complex, and continues along the medial aspect of the Achilles tendon (AT) before inserting onto the greater tuberosity of the calcaneus. The muscle belly is fusiform in shape passes inferomedially posterior to the knee joint and ends as a long slender tendon. It gets inserted into the tendon calcaneus or occasionally separately inserting into the medial side of the calcaneus bone. It is innervated by the tibial nerve (S1, S2). Plantaris acts as a weak plantar flexor of the ankle joint and flexor of the knee joint. Plantaris may also provide proprioceptive feedback information to the central nervous system regarding the position of the foot [11]. The muscle is also reported to merge with the flexor retinaculum or with the superficial fascia of the leg.

Plantaris muscle has been observed to present frequent variations in terms of its occurrence, origin, course, relation with surrounding neurovascular structures and insertion. MRI study was compared to cadaveric study to evaluate the incidence of the muscle [12].

MATERIALS AND METHODS

This study was conducted by the department of anatomy at Mamatha Medical College during the period of Two years. 50 adult cadavers were considered for this study. All the cadavers were injected with preservative fluids by body injectors and placed in a tank solution till the dissections were performed on them. The dissections were performed by the students of the medical college as per the regular guidelines and according to the procedures as described by the standard anatomical dissection textbooks.

The study consisted of a total of 100 upper limbs and 100 lower limbs out of the total 50 bodies. The muscles were identified and carefully traced so as to not to disturb the nerve and blood supply of the muscles. The first blunt dissection was followed by the fine dissection. The origin, insertion, nerve and blood supply were noted. The length of the forearm were measured for all the cases (Fig. 1). The length of the muscle belly and the circumference was also noted with the Vernier's caliper, divider, measuring scale and cotton thread (Fig. 2). The length, width and the intramuscular wall of the tendon were also evaluated. The variations in the origin, insertion, length and breadth of each muscle belly and tendon of both Palmaris longus and plantaris (Fig. 3) were carefully documented.

Fig. 1: Measurement of length of forearm.



Fig. 2: Measurement of circumference of belly.



Fig. 3: Length of the tendon of plantaris.



RESULTS

Out of the 50 adult cadavers used for study, 37(74%) were males and 13 (26%) were females. As a result, the number of limbs taken into consideration were 100 each. The average length of the forearm among the males was 272mm and it was 253mm in females. The length of the Palmaris longus muscle was also more on the males than in the females (124.08mm vs 119.96mm). The length of the tendon in males (15.02 mm) was only slightly more than in the females(152.2mm) (Table: 1).

Table 1: Length and circumference details of Palmaris longus muscle and tendon.

| Parameter | Males | | Females | |
|--|-------------------|---------------|----------------|---------------|
| | Length in mm (SD) | Range in mm | Length (SD) | Range |
| Length of forearm | 271.97 (±8.52) | 269.39-274.55 | 253.33 (±8.88) | 249.02-257.64 |
| Length of Palmaris longus muscle | 124.08 (13.58) | 119.96-128.2 | 86.2 (8.78) | 81.94-90.46 |
| Circumference of muscle belly | 30.53(6.39) | 28.59-32.47 | 25.48 (5.67) | 22.73-28.23 |
| Length of the tendon | 153.02 (12.2) | 149.32-156.72 | 152.2(15.81) | 144.83-160.17 |
| Width of the tendon | 3.4(0.69) | 3.19-3.61 | 3.85(0.62) | 3.55-4.15 |
| Length of Intramuscular part of tendon | 24.97 (3.77) | 23.83-26.11 | 22.37(3.52) | 20.67-24.07 |

In case of the Plantaris muscle, The length was more in the females than in the males, with the length being 74.49 in females and 73.17 in males, though the circumference of the belly and the length of the tendon was far higher in the males than in the females (Table 2).

Table 2: Length and circumference details of Plantaris longus muscle and tendon.

| Parameter | Males | | Females | |
|-----------------------------------|-------------------|-----------------|--------------|-----------------|
| | Length in mm (SD) | Range in mm | Length (SD) | Range |
| Length of Plantaris longus muscle | 73.17 (6.17) | 71.32 - 75.06 | 74.49 (3.03) | 72.02 - 75.96 |
| Circumference of muscle belly | 45.60 (3.18) | 44.64 - 46.56 | 37.66 (2.47) | 36.46 - 38.86 |
| Length of the tendon | 376.02 (17.61) | 370.67 - 381.37 | 342.4 (3.90) | 340.51 - 344.29 |

Absence of the palmaris longus muscle was seen in 7 (7%) cases out of which 5 were males and 2 were females. 1 of the males had bilateral absence while the other 5 cases were unilateral. Plantaris muscle was absent only in 3 cases in the study, and all the three cases were unilateral. None of the females showed the

absence of the muscles, with all the unilateral absence of the muscles being seen in the males only.

Variations observed in the Palmaris longus muscle: Among the variations found in our study, the most common one was the presence of an high aponeurosis, which was seen in 5 (5%)limbs . Distal 1/4th part of the forearm or 3.2 inches above the palm showed aponrotic expansion, which measured 5.2 x 3.1cm. This sheath formed a protective layer to the median nerve which lay underneath (Fig: 4)

Fig. 4: Median nerve under the protection of high aponeurosis (Arrow showing the median nerve under the aponeurosis).



In one of the limbs, there was an extra origin of the Palmaris longus muscle from the inter muscular septum and flexor digitorum superficialis muscle (Fig:5).

Fig. 5: Extra origin of Palmaris longus muscle from the intermuscular septum between it and flexor digitorum superficialis muscle (Arrow showing the origin).



Another variation observed by us was the fusion of the Palmaris longus belly with the flexor digitorum superficialis muscle, though out its extent (Fig: 6).

Fig. 6: Fusion of Palmaris longus muscle belly with flexor digitorum superficial muscle (Arrow showing the fusion).



In one case, a presence of two similar Palmaris longus muscles arising from the same site was observed. Both these muscles were very slender with short bellies and long slender, rounded tendons, which were parallel to each other. These tendons joined with the tendon of flexor digitorum superficialis anteriorly and on the lateral side, with the tendon of flexor pollicis longus (Fig. 7).

Fig. 7: Palmaris longus. Twins (Arrows showing the two bellies).



A very slender and rounded Palmaris longus tendon, almost threadlike was observed in one of the limbs. In this case, the muscle was also very short and slender. There were no variations seen in the Plantaris muscle or tendon in any of the 100 lower limbs.

DISCUSSION

Palmaris longus muscle is considered as a phylogenetically degenerate metacarpophalangeal joint flexor. Although it plays a role in carpal flexion, its main function appears to be as an anchor for the skin and fascia of the hand, in resisting horizontal shearing forces in a distal direction, as in holding a golf club [13]. It also takes part in thumb abduction [14].

The palmaris longus muscle is one of the most variable muscles in the human body and it belongs in the class of retrogressive muscles.

In 1559, the absence of Palmaris longus muscle was described for the first time in Columbus' book, which was published soon after his death [15]. Several clinical trials and studies have been conducted since by many authors [16-20]. The absence of this muscle and tendon has also been reported in different ethnic groups, with wide variation [16-18,21-23]. In several textbooks, the absence has been reported to range from 11.2% to 15% in Caucasians, and was found to be more common in bilateral than unilateral in women with the left side being more affected than the right [21]. It has a high prevalence in Caucasians (22.4%) and Turks (63.9%), and a low prevalence in blacks (3%), Asians (4.8%), and Koreans (0.6%) [19].

In our study, the prevalence of the absence of Palmaris longus muscle was 7% among the cadavers of which 5 were males and 2 were females.

With the palmar aponeurosis the muscle represents the most superficial part of the primitive common flexor muscle of the fingers. Palmaris longus is restricted to the mammals and among primates it is found in the lower groups. The reason for this retrogression is considered to be due to the gradual development of prehension, achieved by diversion of muscular power for the independent motion of parts of the hand.

Other variations are also very common with this muscle and tendon. In our study, we had observed Extra origin of Palmaris longus muscle from the intermuscular septum, high aponeurosis protecting the median nerve, Fusion of Palmaris longus muscle belly with flexor digitorum superficialis muscle and twins arising from the same site.

It has been reported that the variations in this muscle are common with an incidence of 4.3%. All phases of muscular development are encountered from a type completely muscular from origin to insertion, to a form in which only a fibrous vestige remains. The muscle belly may be centrally placed, entirely distal or double, forming a digastric muscle. In addition the

muscle belly or its tendon may be bifid or both parts may be split [24].

Variations in form are the most commonly seen and constitute 50% of them. Their incidence is about 4.3%. The muscle belly is normally short, fusiform and proximal in position and it is toggled into a long tendon. However, all phases of muscular development are encountered from a type completely muscular from origin to insertion, to a form in which only a fibrous vestige remains. The muscle belly may be centrally placed, entirely distal or double, forming a digastric muscle. In addition the muscle belly or its tendon may be bifid or both parts may be split [24].

Duplicate muscle belly was also found by Takanashi et al in both arms [25], which was similar to Kimura et al [26]. Most of the studies showed a unilateral duplication of muscle bellies, similar to our study [24,27].

The variations in Plantaris muscle is not uncommon. Variations in terms of its distinct interdigitations with lateral head of gastrocnemius or having a strong fibrous extension to patella may be responsible for patellofemoral pain syndrome [28].

During the surgical procedures, injuries to the muscle is common, because of its superficial attachment with the fascia of the leg and its long tendon resembling to nerve [29]. Hemorrhage and edema in this area may be associated with the tendinous injury of the plantaris muscle [30]. The plantaris muscle has been used as an excellent graft. Studies have described anatomical procedure of using a free plantaris tendon graft for reconstruction of the anterior talofibular and calcaneofibular ligaments. In the presence of other flexors like gastrocnemius and soleus muscles, the removal of plantaris muscle may not have an effect on the normal limb function [31].

Although the variations in plantaris muscle is not uncommon, we did not find any variations in our study, though the knowledge of anatomical variations of the plantaris muscle is important for physiotherapists, plastic surgeons performing tendon transfer operations, clinicians diagnosing muscle tears and radiologists interpreting MRI scans.

CONCLUSION

The knowledge of the approximate length and breadth of the Palmaris and the plantaris muscle, including the various variations that may be associated with it is very important to the surgeons in various reconstructive surgeries and physiotherapies. Therefore, regular updation of the variation of both these muscles is of utmost importance

Conflicts of Interests: None

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