Morphological Study of *Palmaris Longus* Muscle

**Abstract**

**Background:** The *palmaris longus* is one of the most variable muscle in the human body, this variations are important not only for the anatomist but also radiologist, orthopaedic, plastic surgeons, clinicians, therapists. In view of this significance is performed this study with the purpose to determine the morphological variations of *palmaris longus* muscle.

**Methods and Findings:** A total of 17 cadavers with different age groups were used for this study. The upper limbs region (34 sides) were dissected carefully and photographed in the Morphology Laboratory at the University of Pamplona. Of the 34 limbs studied, 30 showed normal morphology of the *palmaris longus* muscle (PL) (88.2%); PL was absent in 3 subjects (8.85% of all examined forearm). Unilateral absence was found in 1 male subject (2.95% of all examined forearm); bilateral agenesis was found in 2 female subjects (5.9% of all examined forearm). Duplicated *palmaris longus* muscle was found in 1 male subject (2.95 % of all examined forearm). The *palmaris longus* muscle was innervated by branches of the *median* nerve. The accessory *palmaris longus* muscle was supplied by the deep branch of the *ulnar* nerve. *Palmaris longus* is a muscle located in the superficial layer of the anterior compartment of the forearm. It has a small belly arising from the medial epicondyle of the *humerus*, and its long thin tendon inserts into the *palmar aponeurosis* in the hand, the muscle has importance in medical clinic, surgery, radiological analysis, in studies about high-performance athletes, in genetics and anthropologic studies.

**Conclusions:** The anatomical variations of the *palmaris longus* muscle must be documented of their clinical significance and their potential use in orthopaedic and reconstructive surgery.

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**Keywords**

Introduction
The Palmaris longus muscle (PL) belongs to the superficial flexor muscles of the forearm. The muscles of the forearm are: 1) the anterior or flexors; 2) the posterior or abductors; and 3) the muscles of the radial area. All these muscles are muscular at the upper end and they are toggled into long thin tendons that extend at the apex of the fingers. The PL muscle belongs to the anterior muscles of the forearm. The anterior muscles form three layers, two superficial and one deep. This muscle belongs to the first superficial layer along with the flexor carpi ulnaris, the flexor carpi radialis and the pronator teres muscles [1]. The PL muscle is a thin spindle shaped long slender and fusiform muscle that is found between the flexor carpi ulnaris and flexor carpi radialis. It arises from the medial epicondyle and epicondylar ridge of the humerus. It runs downwards and terminates in a long, slender tendon which passes anterior to the transverse carpal ligament, crosses the retinaculum, becomes flat and enters the palmar aponeurosis of the hand, anterior to the flexor retinaculum. Its innervation comes from branches of the median nerve [2].

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. Another use of the muscle is to abduct the thumb. This role is due to its slender move over the long adaptor of the thumb. Generally, its role is negligible and this is the reason why it is lost in many operations without cost to the function of the forearm or the wrist [1-3].

A wide range of anatomical variations of the muscles, vascular and nervous in the upper limb has been reported in anatomical, clinical and radiological studies [4-7]. Numerous variations of the PL muscle have been reported in both morphology and number. It may have a proximal tendon or a distal tendon, or have a fleshy central belly with proximal and distal tendons, it may be digastic or fleshy throughout or its tendon may be split and sometimes it may be degenerated to such an extent it that may be simply represented by a tendinous band. When it is tendinous proximally and has a fleshy distal belly it is called reverse PL or PL inversus [8]. The objectives of the present study were to determine the morphological variations of palmaris longus muscle and clinical significance.

Methods
This work was previously approved by the Ethics Committee in Research and Environmental Impact of the University of Pamplona, conformed by resolution 030 of January 16, 2014 and Resolution No. 008430 of October 4 of 1993, issued by the Ministry of Health of Republic of Colombia by which regulates the scientific, technical and administrative norms for health research. This descriptive cross-sectional study was designed to determine the prevalence and morphologic features of the anatomical variations of the Palmaris Longus muscle in 34 upper extremities of 15 male and 2 females embalmed adults cadavers in the laboratory of Morphology of the University of Pamplona. The flexor compartment of the upper limb were studied serially during the years 2014-2016. The anatomical variation described was found during routine dissection performed by medical students of second semester in a 47-year-old male cadaver. Measurements were taken with assistance of a sliding Vernier caliper, accurate to 1 mm during the course of the anatomical dissection. The data thus obtained were recorded in a physical matrix and were consigned in digital media using Excel tables. Topographic details of the variations were examined, recorded and photographed.

Results
Of the 34 limbs studied, 30 showed normal morphology of the Palmaris longus muscle (PL) (88.2%);
PL was absent in 3 subjects (8.85% of all examined forearm), of which: unilateral absence was found in 1 male subject (2.95% of all examined forearm); bilateral agenesis was found in 2 female subjects (5.9% of all examined forearm). Duplicated PL muscle was found in 1 male subject (2.95 % of all examined forearm).

**Plamaris longus and accessory palmaris longus muscle in the left forearm**

The Accessory Palmaris Longus muscle (Acc PL) was found ulnar to the Palmaris longus muscle (PL). The bellies of both the Acc PL and PL were closely apposed with each other towards proximal; the tendons of both the Acc PL and PL were separated towards distal in 102 mm. The duplicate PL arose from a common tendinous origin of flexor muscles [PL, flexor carpi radialis muscle (FCR), flexor carpi ulnaris muscle (FCU), pronator teres muscle (PT) and a part of the flexor digitorum superficialis muscle (FDS)] at the medial epicondyle of the humerus. In the PL, the muscle belly measuring 125 mm in length and 12.6 mm in width was followed by a long tendon distally at the middle of the forearm. The tendon coursed over the flexor retinaculum, finally inserting into the palmar aponeurosis. The morphology of the Acc PL was quite similar to that of the PL (Figure 1).

The muscle belly measuring 110 mm in length and 11 mm in width was followed by the tendon distally at the middle of forearm, and finally inserting into the flexor retinaculum (Table 1).

**Table 1.** Summary of Plamaris longus and Accessory palmaris longus muscle in the left forearm

<table>
<thead>
<tr>
<th>Morphology</th>
<th>Palmaris longus muscle</th>
<th>Accessory palmaris longus muscle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle belly</td>
<td>Length 125 mm</td>
<td>Length 110 mm</td>
</tr>
<tr>
<td></td>
<td>Width 12.6 mm</td>
<td>Width 11 mm</td>
</tr>
<tr>
<td>Tendon</td>
<td>Length 145 mm</td>
<td>Length 125 mm</td>
</tr>
<tr>
<td></td>
<td>Width 6.2 mm</td>
<td>Width 4.8 mm</td>
</tr>
<tr>
<td></td>
<td>Thickness 1.3 mm</td>
<td>Thickness 0.8 mm</td>
</tr>
<tr>
<td>Origin</td>
<td>Medial epicondyle</td>
<td>Medial epicondyle</td>
</tr>
<tr>
<td>Innervation</td>
<td>Palmar aponeurosis</td>
<td>Flexor retinaculum</td>
</tr>
<tr>
<td></td>
<td>Median nerve</td>
<td>Ulnar nerve</td>
</tr>
</tbody>
</table>
The PL was innervated by branches of the median nerve in the proximal third of the forearm. The Acc PL muscle passed superficial to the ulnar artery and ulnar nerve, and was supplied by the deep branch of the ulnar nerve. The branches to the FCR, PL and FDS arose as a common trunk from the median nerve, whereas those to the Acc PL and FDS arose as another common trunk which branched distally.

Discussions
The PL muscle has great clinical importance and is classified phylogenetically as a retrogressive muscle. The reasons for its importance are: 1) its tendon is a great landmark to identify the median nerve during operations; 2) the PL tendon is used as an alternative transplant for various cosmetic and reconstructive plastic surgery, hand procedures and as a tendon graft in various positions in otolaryngology and ophthalmology (e.g. lip augmentation, ptosis correction, management of facial paralysis, restoration of lip and chin defects, urinary incontinence, opponensplasty for severe carpal tunnel syndrome and excisional arthroplasty for management of Keinbock’s disease), repair of tendon calcanei, collapsed lunate replacement, auto graft for ruptured extensor tendons, acute thenar injury–Camitz opponensplasty [3]. PL muscle variations cause a variety of clinical syndromes such as carpal tunnel syndrome, Guyon’s syndrome or compartment syndrome of the forearm or the wrist, may be associated with the symptoms of Dupuytren's contracture, accessory palmaris longus muscle that appeared to compress the ulnar nerve during repeated contractions and hypertrophy of the palmaris longus muscle seen as a pseudomass of the forearm; and 4) research of the PL muscle helps the understanding of the hereditary of genes responsible for the muscles and their functions [3, 8].

The frequent use of the palmaris longus tendon by surgeons brings to mind the question of whether the removal of the tendon of this muscle would affect the hand functions or not. Palmaris longus was reported to play an important role in thumb abduction through an extension onto the thenar eminence [9-11]. It is also believed that a weak flexor of the wrist and divided palmaris longus is of little importance and need not to be repaired. It has been determined that grip strength of the hand wrist was not affected in the absence of PL. It has been reported that patients requiring a palmaris longus tendon graft could be divided into two main groups depending on the functional status of the donor’s upper extremity [10, 11]. In the first group, the donor’s upper extremity was normal and the palmaris longus was needed for reconstruction elsewhere, e.g., lip augmentation, ptosis correction, management of facial paralysis, tendon reconstruction in the opposite extremity, etc. The second group of patients was those in whom the donor’s upper extremity was not normal. This group could further be subdivided into two subgroups: one where the primary pathology did not involve the wrist flexors or thumb abductor muscles, e.g., ulnar collateral ligament reconstruction, interposition tendon grafts, and carpometacarpal (CMC) joint arthroplasty and the other subgroup included those patients where the primary pathology involved the wrist flexors or thumb abductor muscles, e.g., high ulnar and low median nerve palsies. The probable effects of the palmaris longus muscle on hand functions have been studied and no clinically significant difference was observed [10,11]. Answer the question of whether the functional value of the palmaris longus muscle bears a statistical value and significance in healthy subjects or not. To this end, reviewing both grip and pinch strengths. As for the grip strength, the presence or absence of the palmaris longus muscle did not create a difference in general. In both sexes, the palmaris longus muscle increased pinch strength in the fourth and fifth fingers of the hands (especially in the right hand). Based on these findings, it can be concluded that the pal-
maris longus muscle may impact the opposition movement of the fingers [11].

Some authors consider what functionally, though the muscle is primarily a wrist flexor, acting as an adjunct to digital flexion at the metacarpophalangeal joint, observation lend credence to the observation that the distal tendinous segments of the muscle aid in fixing the open-ended mobile end of the long axis around which supination of forearm is executed. Shifting of the distal terminus of the axis in the complex articulations of the supination - pronation kinetics, is facilitated by the proximal, middle and distal radio-ulnar joints through the divergent fibrous extensions of the aponeurosis, by the tendinous insertion of the palmaris longus muscle [12]. Several authors have described the PL muscle as a mere phylogenetically degenerate metacarpophalangeal flexor because of its clinical insignificance and its numerous anatomical variations. However, the less common variants can lead to pathological conditions due to the narrow topographical relationship between the PL and the median nerve, causing median nerve compression. Understanding the anatomical variations of the PL is important because it often plays a crucial role during reconstructive surgeries due to its suitable length and diameter, ease of harvest and lack of donor site morbidity. It is essential to clinically examine reconstructive patients for potential PL anatomical variations to avoid inappropriate surgical procedures and prevent disappointing surgical results [1].

The vascularity of the palmaris longus is most commonly supplied by branches of the ulnar artery, followed by branches of the brachial artery. Branches of the median nerve supply innervation [1]. In the present study the PL was innervated by branches of the median nerve in the proximal third of the forearm. The Acc PL muscle passed superficial to the ulnar artery and ulnar nerve, and was supplied by the deep branch of the ulnar nerve.

Conclusion

The knowledge of these variations is significant for radiologist, orthopaedic, plastic surgeons, clinicians, therapists is important in clinical diagnosis and surgical practice, since these muscles have potential use in orthopaedic and reconstructive surgery and their variations may be implicated in the etiopathology of neuromuscular symptoms and morphological alterations in the forearm.

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Competing interests

None.

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University of Pamplona is the responsible institution

References


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