

## Morphometric Analysis of the Palmaris Longus Muscle: A Cadaveric Study

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### Abstract

**Background:** One of the most variable muscles in the human body is palmaris longus. The donor tendon is selected for grafting is dependent on the size, length, and width of the tendon. In view of the above significance, this study is taken up with the purpose to determine the morphological variations of palmaris longus muscle. **Aim:** The palmaris longus muscle was studied pertaining to its: width & length of the fleshy belly, width & length of the tendon. **Materials & methods:** This study was conducted in Anatomy Department of following colleges: Dr B.R. Ambedkar Medical college, Bangalore, Hassan Institute of Medical Science, Hassan and Sri Devaraj Urs Academy of Higher Education and Research, Tamaka, Kolar. A total of 60 upper limbs out of which, 25 were from males cadavers & 5 were female cadavers were dissected and study was conducted from 2011 to 2014. All the measurements of palmaris longus were taken using digital vernier calipers. **Results:** The length of Palmaris longus tendon 238.4 mm and width of palmaris longus tendon is 5.94 mm. The results of this study confirms that in a South Karnataka region suggest the palmaris longus tendons would be of ideal width and strength for use as grafts in reconstructive surgery. **Conclusion:** In our study, the width of palmaris longus tendon is 5.94 mm. Hence, tendons from upper limb should be considered when strength of width is important. The palmaris longus and plantaris tendons are the most suitable tendons in reconstructive surgeries. The other tendons which are suitable are extensors of the digits and tendons of flexor digitorum superficialis.

**Keywords:** Palmaris Longus; Morphometric; Tendon Graft; Reconstructive Surgery; Plastic Surgery.

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### Introduction

The palmaris longus is one of the most variable muscles in the human body. The selection of the donor tendon for grafting is dependent tendon size, length, and width. In view of the above significance,

this study is taken up with the purpose to determine the morphological variations of palmaris longus muscle. One of the superficial flexor muscles of the forearm is palmaris longus. It has got a thin & fusiform belly and a long tendon. It takes origin from the anterior surface of medial epicondyle in common with the other superficial flexor muscles of forearm: common flexor origin, just medial to flexor carpi radialis muscle. The tendon of palmaris longus runs superficial to flexor retinaculum finally gets attached to apex of palmar aponeurosis. It is supplied by median nerve, flexor of wrist and it is a degenerate metacarpophalangeal joint flexor on evolution [1]. It is often absent on one or both sides. The literature reports that the Palmaris longus muscle is a sex-linked dominant trait [2,3].

Palmaris longus muscle has a relatively short muscular belly in comparison to the length of the tendon. The Palmaris longus possesses a long

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tendon that has a uniform oval cross-sectional shape with an even taper along its longitudinal axis and flattens and broadens as it passes anterior to the flexor retinaculum [4].

Very few fibers of palmaris longus tendon interweave with the retinaculum. The palmaris longus tendon of the splits in the palm to form fibers that are longitudinally directed and it forms a part of the palmar aponeurosis [1,5].

This study was undertaken to throw more light for surgeons performing tendon grafting, plastic and reconstructive surgeries, maxillofacial surgeons, oncosurgeons, ophthalmologists, orthopedic surgeons and anatomists. The variations of this muscle, many a times could pose problems in differential diagnosis.

Hypothetically, if the length of tendons is longer, it could indicate that the muscle is going to degenerate, hence, study of morphometry was given due importance.

### Materials and Methods

This study was conducted in Anatomy Department of following colleges: Dr B.R. Ambedkar Medical college, Bangalore, Hassan Institute of Medical Science, Hassan and Sri Devaraj Urs Academy of Higher Education and Research, Tamaka, Kolar. A total of 60 upper limbs out of which, 25 were from males cadavers & 5 were female cadavers were dissected and study was conducted from 2011 to 2014. If there were visible trauma, pathology or prior surgeries in the forearm, they were excluded from the study. Dissection of the upper limb were carried out following the Cunningham's Manual of Practical Anatomy. During forearm dissection, the Palmaris longus muscle was identified & carefully dissected. Origin was confirmed and then, it was traced towards its insertion. Morphometry analysis was done and photographed. Total length of the muscle from its origin to insertion was measured using measuring tape. Then the tendon length was obtained, from musculotendinous junction to the distal wrist crease. The width of both the belly and tendon was taken at their widest parts. Measuring tape was used to measure the length and digital vernier calliper was used to measure the width of muscle belly and its tendon. The measurements were noted down and results were statistically interpreted and then compared with previous studies.

### Statistical software

The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables.



Fig. 1: Materials used for the present study

### Results

In our study, Dissection of 30 cadavers (25 male, 5 female cadavers) revealed the following details:

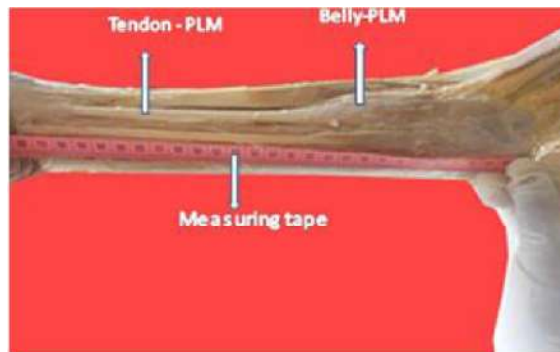


Fig. 2: Measurement of total length of palmaris longus muscle



Fig. 3: Measurement of tendon width of palmaris longus by digital Vernier caliper

Two-tailed test was used to compare the difference in the mean values of Palmaris longus Right and left muscle length  $p=0.821$ , right and left total length  $p=0.278$ , right and left belly width  $p=0.839$ , right and left tendon width  $p=0.074$ .

Paired sample T test was used to compare the difference in the mean values of Rt and Lt tendon lengths and  $p=0.915$ .

**Table 1:** Comparison of Tendon length of Palmaris longus of both sides

Tendon length	No. of specimens	Mean (cms)	Std. Deviation	Minimum (cms)	Maximum (cms)
Right side	28	13.1	2.06	9	18
Left side	29	12.9	1.85	9	16

**Table 2:** Comparison of Belly length of Palmaris longus of both sides

Belly length	No. of specimens	Mean (cms)	Std. Deviation	Minimum (cms)	Maximum (cms)
Right side	28	11.4	2.75	9	21.5
Left side	29	11.1	2.26	8	18.4

**Table 3:** Comparison of Total length of Palmaris longus of both sides

Total length	No. of specimens	Mean (cms)	Std. Deviation	Minimum (cms)	Maximum (cms)
Right side	28	23.2	5.31	0.53	29
Left side	29	24.0	2.30	19	29

**Table 4:** Comparison of Tendon width of Palmaris longus of both sides

Tendon width	No. of specimens	Mean (cms)	Std. Deviation	Minimum (cms)	Maximum (cms)
Right side	28	0.57	0.21	0.20	1.28
Left side	29	0.61	0.18	0.38	1.31

**Table 5:** Comparison of belly width of Palmaris longus of both sides

Belly width	No. of specimens	Mean (cms)	Std. Deviation	Minimum (cms)	Maximum (cms)
Right side	28	1.39	0.35	1.00	2.52
Left side	29	0.61	0.18	0.38	1.31

**Table 6:** Test statistics: Test used for palmaris longus

Palmaris longus	Side	Belly length	Total length	Belly width	Tendon width
Z	Left	-0.22	-1.08	-0.20c	-1.788
Asymp. Sig. (2 tailed)	Right	0.82	0.27	0.83	0.074

## Discussion

The present study was to determine the morphology of the palmaris longus muscle of in Karnataka. The results of present work were then compared with that already available in the literature, done in different population groups. Present study throws light on morphometry and may aid surgeons in reconstructive surgery, using these muscles as grafts or flaps. Also, helps radiologists in analysis of the presence and/or absence of these muscles in a Karnataka.

The morphometry of palmaris longus muscle was described and slight differences were found between the current study and that reported in the literature. The prevalence of these muscles yielded the same results when compared to past studies conducted on samples/populations other than Karnataka.

The highly variable structure in the human body is muscles. Variations in the muscles can be of 3 types: it may be retrogressive, progressive and atavistic. Some muscles tends to undergo degeneration & they represent retrogressive type,

eg: palmaris longus and plantaris muscles. Some muscles become more complex & they represent progressive type, eg: deep flexor muscles of forearm. Some muscles which have been lost completely during the course of evolution and they make an abrupt reappearance again is called atavistic muscles, eg: axillary arch muscle, a remnant of panniculus carnosus [6].

Variations in palmaris longus can be a) complete agenesis; b) variation in location of muscle belly; c) aberrancy of attachment at its origin or its insertion; d) accessory slips [7] e) duplication or triplication [8].

In 11.2% of forearms, palmaris longus is absent [7]. Though it is a negligible muscle functionally but bears a morphological interest & it is absent in 13% of arms [9].

Palmaris longus muscle attached distal to the apex of palmar aponeurosis. However, other points of insertion have been described in the literature. One of interest is an insertion on to the antebrachial fascia [10].

Functionally, it is a weak flexor of wrist, so it is an expendable muscle, function of the wrist will not be affected significantly by its absence [11].

Reconstructive surgeries, their tendon is frequently used. Other tendons used are plantaris, the long extensors of the fingers and toes [12,13].

The surgeons makes the choice of donor tendon for grafting on what is needed, for example tendon length, size and width. A tendon of more than 190 mm cannot be harvested from the upper limb, while the lower limb can yield lengths up to 400 mm while the upper extremity can provide tendons as wide as 6 mm compared to lower limb that provides a maximum of width of 4 mm. An important factor to consider is that a difference in strength between a 2 mm and a 3 mm tendon width could be significant. Thus, according to Wehbe & Mawr (1992), tendons from upper limb should be considered when strength of width is important and the lower limb tendons when length is a factor [12].

The most desirable tendons in reconstructive surgery are the palmaris longus and plantaris tendons, while the long extensors of the toes and hands as well as the flexor digitorum superficialis are regarded as suitable [14].

One of the easiest tendons to harvest is the palmaris longus and plantaris tendons and therefore they remain the number one choice for tendon graft. The superficial location of palmaris makes the process of harvesting easier and these makes the procedure less complicated and safer. It is also said to be a dispensable tendon and function of the wrist is not affected significantly by its absence [15].

Kapoor and co-workers (2008) is of the opinion that there is a little functional use to the upper limb by palmaris longus in humans, but has great significance when used in reconstructive surgery as a donor tendon [16].

Upon investigation of the prevalence of palmaris longus, it was found that the percentage values, obtained in this study, correlated well with what has been reported in the literature (Table 7).

The measurements given for the tendon length of the palmaris longus muscle, in the literature, were slightly shorter than what is obtained in the current study, with the exception of Carlson and co-workers (1993) [4]. The width of the tendons measured, were wider than those described in the literature. Wehbé (1992) suggested that one should consider that an increase of 1 mm in the width of a tendon could have a significant influence in its strength [12].

The average width (0.594 cm) of the palmaris longus tendon in a Indian population met the requirements necessary for a graft to be viable in reconstructive surgery.

The belly length fell within the range given in the literature. Lastly the total length of the palmaris longus was located within the range seen in the literature. Thus, the overall measurements obtained from a Indian population in the present study coincide well with similar measurements obtained in previous studies.

**Table 7:** Comparison of the measurements of the palmaris longus muscle with the different studies found in the literature. The measurements are in millimetres

Authors(year)	Tendon length (mm)	Tendon width (mm)	Belly length (mm)	Belly width (mm)	Total length (mm)
White (1960) [14]	100-150	-	-	-	-
Carlson & co-workers (1993) [13]	160	-	-	-	-
Lam (1998) [15]	90-120	2-3	-	-	-
Masaaki & co-workers (2001) [17]	116.6	4.2	-	-	-
Mobarakeh (2008) [18]	136.2	4	-	-	-
Stecco(2009) [10]	80-155	-	95-230	-	225-315
Present study	90-180	3.8-13.1	80-21.5	49-25.2	190-290

When comparing the total length of the palmaris longus muscle. Masaaki and co-workers (2001) reported a statistical significant difference between males and females, in a Japanese population, but only for the length of the palmaris longus tendon, and not the muscle as a whole. Therefore only the length of the tendon could be compared to the literature. They reported an average of 12.46 cm for males and 10.83 cm for females while the current study found the average length to be 23.63 cm which correlates with study done by Stecco *et al.* This can possibly be explained by the fact that the Japanese population on average is smaller in stature compared to other population groups, and thus the length of their palmaris longus muscles will be shorter [10,17].

Mobarakeh and co-workers (2008) reported a difference between males and females, in an Iranian population. This was found to be not statistically significant: the tendon length of the palmaris longus muscle measured 14.2 cm for males and 12.8 cm for females. This shows a difference in measurements between Japanese, Iranian and a Indian population [18].

Variations in the morphology of the palmaris longus muscle were found only in a few cadavers in the present study. One case of 'reversed' palmaris longus was noted. Similar variations have been described in previous studies on the palmaris longus muscle conducted by Reimann and co-workers (1955) [19], Carlson and co-workers (1993) [4], Depuydt and co-workers (1998) [20], Ommen (2002) [21], Tiengo and co-workers (2006) [22], Natsis and co-workers (2007) [23] and Mobarakeh and co-workers (2008) [18].

Georgiev *et al.*, (2009) reported a case of a male with Palmaris longus with a muscular belly, proximal and two tendons, distally on his left arm. The medial tendon inserted on the proximal aspect of the flexor retinaculum, while the lateral tendon passed superficial to the flexor retinaculum and inserted on the Palmaris aponeurosis [24].

Although palmaris longus is completely present on both or at least one arm in 95% of the Karnataka population, the presence of the palmaris longus muscle does not guarantee its usefulness in reconstructive surgery [25]; instead its usefulness is determined by the morphology of this specific muscle. Thus the palmaris longus muscle needs to be present in the patient, in order for it to be used in a reconstructive procedure. However, even if present it might still not be viable for use in reconstructive surgery, as variation in the morphology of the

palmaris longus muscle was found during this study and described in the literature.

*Morphological importance:* With the development of forelimb as a prehensile organ, the long flexor muscles of the forearm, Palmaris longus muscle started degenerating in a caudo-cranial direction. Degeneration of functionless muscle occurred much earlier in phylogenetic forebearers likes Gibbon and Orangutan. Chimpanzees and apes shows maximum degeneration, only 25% of Gorillas have got Palmaris longus muscle. Palmaris longus is more degenerate in apes and monkeys than in man [26].

*Embryological importance:* The flexor muscles of the forearm develop from the flexor mass, which subsequently divides into 2 layers, superficial and deep. The deep layer gives rise to the flexor digitorum superficialis, flexor digitorum profundus and flexor pollicis longus. The superficial layer of flexor mass gives rise to the pronator teres, flexor carpi radialis, flexor carpi ulnaris and palmaris longus [27].

## Conclusion

Palmaris longus muscle is one of the common flexor muscles of the forearm. Phylogenetically classified as retrogressive muscle as the muscle has a short belly and long tendon. The palmaris longus muscle is one of the most variable muscles in the human body, not only in terms of absence but also in terms of its muscle variation and anomalies. The surgeons make their selection of the donor tendon for grafting based on tendon size, length, and width. An important factor to consider is that a difference in strength of muscle between a 2 mm and a 3 mm tendon width could be significant. In our study, the width of palmaris longus tendon is 5.94 mm. Hence, tendons from upper limb should be considered when strength of width is important. The most desirable tendons in reconstructive surgery are the palmaris longus and plantaris tendons, while the long extensors of the toes and hands as well as the flexor digitorum superficialis are regarded as suitable. The palmaris longus tendon is preferred tendon in case of tendon graft procedure because it has a wider tendon. The palmaris longus is subjected to variations, like reversal of palmaris longus inversus and duplication of palmaris longus can compress the median nerve mimicking carpal tunnel syndrome, Guyon canal entrapment syndrome, ganglion swellings. Knowledge of these variations is important for surgeons before harvesting the tendons for graft.

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