

# The palmaris longus muscle: A surface study of the population of North Cyprus

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## ABSTRACT

**Objective:** The aim of this research is to determine the frequency of surface anatomical variations of palmaris longus (PL) muscle in the population of North Cyprus and their association with gender, body side, and hand dominance.

**Materials and Methods:** The presence of PL was determined in 1280 subjects (660 females and 620 males) using four testing methods; Schaeffer's test, the Thompson's test, Pushpakumar's test and the Bhattacharya's test. Where the presence of the PL could not be determined by any of these tests, palpation was performed as the final confirmatory test.

**Results:** The overall frequency of absence was 17.4%. Female subjects showed a higher frequency of absence of 10.6% compared to males (6.8%). The absence was more likely to occur in the non-dominant hand. In those that had the PL, there were 28 (2.6%) cases of a split tendon and 3 cases (0.2%) of a laterally displaced tendon of the PL.

**Conclusion:** The overall frequency of absence of PL in North Cyprus was 17.4% and absence is more likely to occur in females, on the left side and in the non-dominant hand. Other variations recorded are the split tendons and laterally displaced tendons.

**Keywords:** Palmaris longus, Anatomical variation, Agenesis, Forearm, North Cyprus

## 1. INTRODUCTION

The palmaris longus (PL) muscle is one of the four superficial muscles on the flexor aspect of the forearm. It originates from the common flexor tendon at the medial epicondyle of humerus and converges into a long and slender tendon that passes anterior to the flexor retinaculum before it becomes flattened to blend with the palmar aponeurosis. It flexes the wrist joint and tenses the palmar aponeurosis [1-3].

The PL has received worldwide attention from researchers, despite the fact that functionally, it is a negligible muscle. It is believed to be functionally more active in mammals that use their upper limbs for mobilization [4, 5]. It has lost its function in the course of human evolution and is gradually becoming extinct [6-8]. This evolution-induced morphometric change has made the PL one of the most variable muscles in the body [4, 5, 9]. It may be absent on one or both sides [3, 10] or may be reversed, duplicated or digastric [3].

Surgeons consider the tendon of PL as the tendon of choice in reconstructive surgeries, because it is of the right length and

diameter, it is easily accessible and its absence does not produce any functional deformity [4, 11]. It is used by plastic surgeons in treatment of facial paralysis, repairing ptosis, lip augmentation, and in the restoration of lip and chin defects [12-14]. The tendon of PL is also harvested to repair oncologic defects of head and neck and arthritis of the thumb [15].

The variations of PL can cause many clinical syndromes as reported by various researchers. A study reported a clinical case of a bitendinous PL causing median nerve compression during a standard carpal tunnel release [16].

Many textbooks of anatomy show a worldwide prevalence of absence of PL as 10-15% [3, 17] although, prevalence as low as 0.6% has been recorded in the Korean population [18] and as high as 63.9% in the Turkish population [19].

However, despite the several studies to determine the prevalence of absence of the PL in various ethnic groups worldwide, there is a dearth of information on the North Cyprus population. To the best of the authors' knowledge, the prevalence of absence of

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the PL in the North Cyprus population is unknown. Therefore, the aim of this research is to determine the frequency of surface anatomical variations of PL muscle in North Cyprus and their association with gender, body side and hand dominance. The findings will be useful to surgeons working in North Cyprus, especially in the fields of plastic surgery and orthopedics. It will also increase the available data on the PL, thus contributing to the research community.

**2. MATERIALS and METHODS**

The study was done in the Faculty of Medicine, Department of Anatomy, Near East University after approval of the Ethical Board of the Institute of Health Sciences, Near East University (Project Number: 807, Meeting Number: 2019/68, Date of the Ethical Board Meeting: 02/05/2019) and the Ministry of Education, North Cyprus. A written informed consent was sought from each participant before the study was carried out.

The study was conducted in 3 schools within the Nicosia district of North Cyprus; the Turkish High School of Nicosia, the Turkish Education College, and the Near East University. The study was planned as a cross sectional study and the sampling was done sequentially until the target population is reached. The sample size was determined using the population of 300,000 North Cypriots using a confidence interval of 95% and a margin of error of 3% and was calculated to be 1,064.

A total of 1280 participants were assessed for surface variations of the PL. Four testing methods were used, which included the Schaeffer’s test, the Thompson’s test, Pushpakumar’s test and the Bhattacharya’s test [20]. Where the PL was not visualized by the 4 methods, palpation was done as the final confirmatory for absence. Presence of other variations of the PL tendon was also assessed. Subjects with hand and wrist deformities, previous injuries or surgeries in the forearm and wrist, less than 10 years age or above 60 years, were excluded from the study.

**Statistical Analysis**

The data collected was entered into a Microsoft Excel spreadsheet then exported to SPSS version 20. All statistical analyses were carried out using SPSS. These include frequencies, percentages and chi-square tests. A value of  $p < 0.05$  was considered to indicate a statistical significance between variables and the degree of freedom was taken as 1. The Yates correction was applied in 2 data sets.

**3. RESULTS**

A total of 1,280 subjects were examined out of which 660 were females and 620 were males. PL agenesis was found in 223 cases (17.4%). 28 cases (2.6%) showed a split (bifid) tendon and 3 cases (0.2%) presented with a laterally shifted tendon (Figure 1).

Out of the total, unilateral absence was observed to be 158 (12.3%), of which right unilateral absence was 40 (3.1%), and left unilateral absence was 118 (9.3%). The frequency of bilateral

absence of PL was observed to be 65 (5.1%). The distribution of absence based on gender is shown in Figure 2.

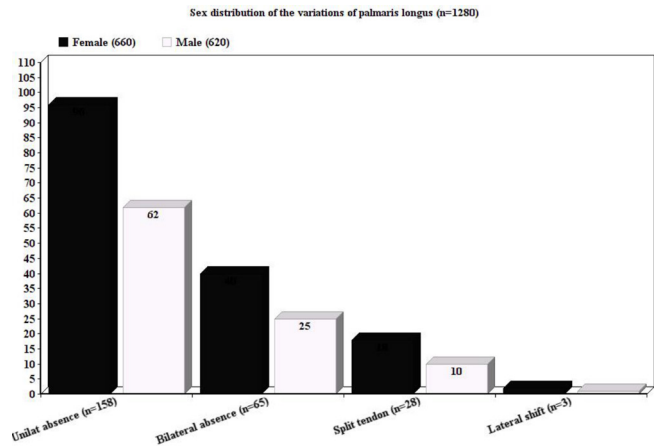


Figure 1. Distribution of variations based on sex

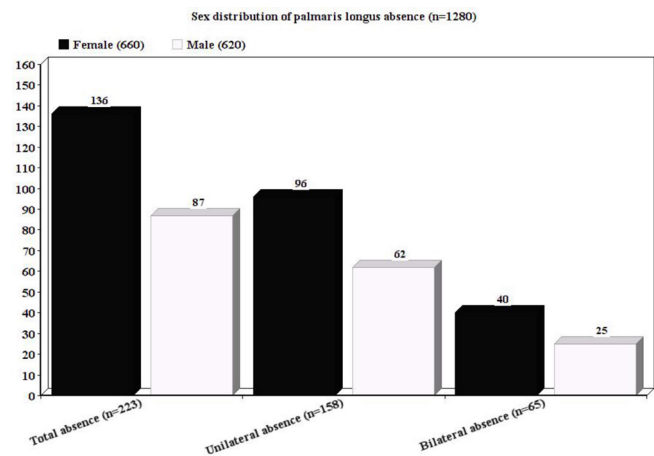


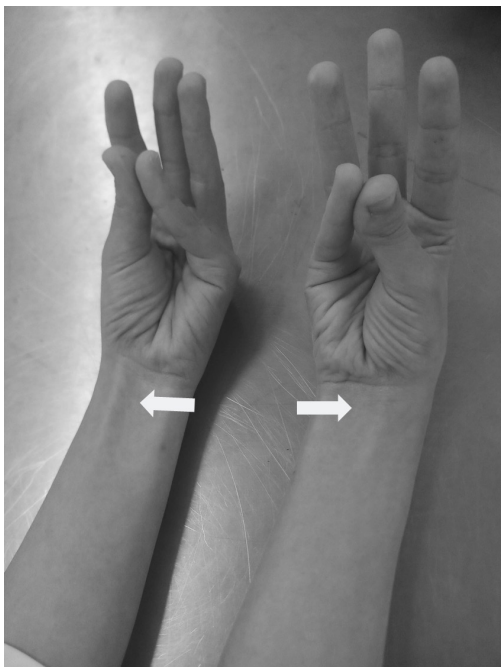
Figure 2. Distribution of PL absence based on sex

The distribution of PL agenesis among the different nationalities and/or regions was found to be 96 (7.5%) for Cypriots, 86 (6.7%) for Turks, 30 (2.3%) for Arabs, 4 (0.3%) for Africans and 7 (0.5%) for others (Table I).

Table I. Distribution of palmaris longus absence based on nationalities and/or regions (North Cyprus, Nicosia, 2019) (N=1280)

	Right		Left		Bilateral		Total	
	Absence		Absence		Absence		n	%
	n	%	n	%	n	%	n	%
Cypriots (n=633)	20	20.8	43	44.8	26	27.1	96	100
Turks (n=518)	16	18.6	45	52.3	32	33.3	86	100
Arabs (n=66)	2	6.7	25	83.3	3	10	30	100
Africans (n=45)	1	25.0	1	25.0	2	50	4	100
Others (n=18)	1	14.2	4	57.1	2	28.6	7	100
<b>Total</b>	<b>40</b>		<b>118</b>		<b>65</b>		<b>223</b>	

Unilateral and bilateral absence of PL is shown by Figures 3A-B. The presence of a split tendon was observed in 28 subjects (2.6%); 24 cases occurred on the right, 2 on the left, and 2 bilaterally (Figures 4 A-B).



**Figure 3A.** Bilateral absence of palmaris longus tendon in a 22y old Persian female demonstrated by the Shaeffer's test

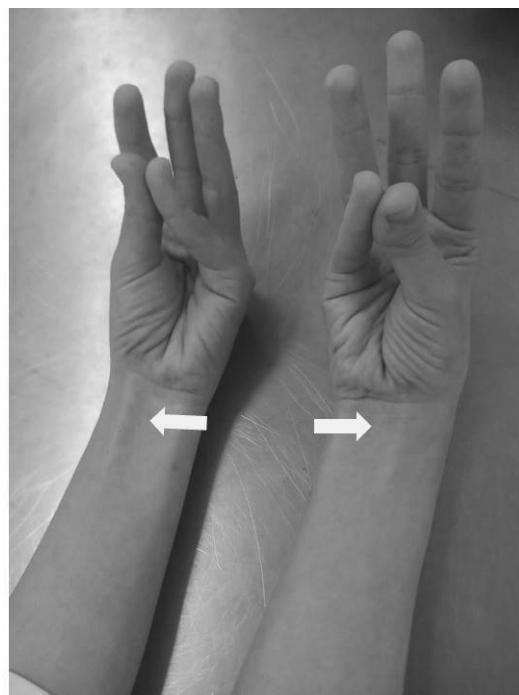
Out of the total number of cases that presented with PL tendon (n=1057), 3 cases (0.2%) were observed to have a laterally displaced tendon; 2 cases were females (an African and a Turk) and the other was a Turkish male (Figures 5A-B).



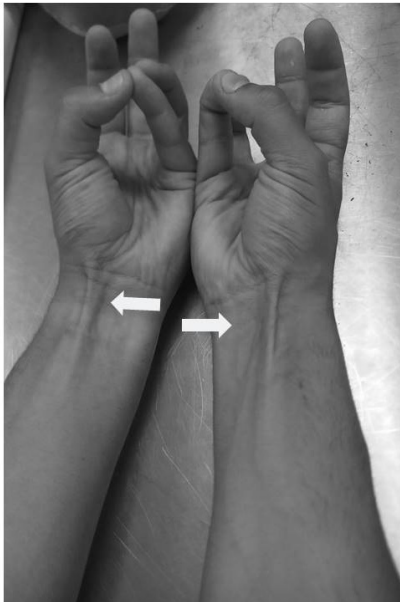
**Figure 4A.** Left split tendon (shown by arrow head) in a 22y old Russian female visualized by Shaeffer's test



**Figure 3B.** Unilateral left absence of palmaris longus in a 19y old Cypriot female. The arrow heads point to the tendon of flexor carpi ulnaris which has become more prominent



**Figure 4B.** Right split tendon in a 16y old African female



**Figure 5A.** Laterally displaced tendon of palmaris longus in the right distal forearm of a 24y old Turkish male and split tendon of palmaris longus on the right



**Figure 5B.** Laterally displaced left palmaris longus and right split tendon in an African female

The overall difference in PL agenesis between males and females was statistically significant ( $p < .05$ ), which implies that females have a higher frequency of absence of PL muscle (Table II).

**Table II.** Relationship between absence of palmaris longus and gender (North Cyprus, Nicosia, 2019) (N=1280)

Gender	Present		Absent		Total	$\chi^2$	p-value
	n	%	n	%			
Female	524	79.4	136	20.6	660	9.61	0.002
Male	533	86.0	87	14.0	620		
Total	1057		223		1280		

While trying to find a correlation between the occurrence of the split tendon and gender, the result was not statistically significant ( $p > .05$ ). Although, the frequency of a split tendon was higher in females, the chi-square test was not statistically significant (Table III).

**Table III.** Correlation between split tendon and gender (North Cyprus, Nicosia, 2019) (N=1280)

Tendon	Normal		Split		$\chi^2$	p-value
	n	%	n	%		
Male	533	98.2	10	1.8	1.39	0.238
Female	524	96.7	18	3.3		
Total	1057		28			

\*Yates correction

Concerning laterality or body side, there was also a significant statistical difference ( $p < .05$  for left side) between the right and left sides, which shows that PL agenesis occurs more frequently on the left side (Table IV).

**Table IV.** Laterality in palmaris longus muscle absence (North Cyprus, Nicosia, 2019) (N=1280)

Laterality	Present		Absent		Total	$\chi^2$	p-value
	n	%	n	%			
Left	1162	90.8	118	9.2	1280	41.04	$P < 0.001$
Right	1280	96.9	40	3.1	1280		

The result of the correlation between body side and occurrence of a split tendon was statistically significant at  $p < .05$ , and shows that the split tendon is more likely to occur on the right side as shown in Table V.

**Table V.** Relationship between body side and split tendon of palmaris longus (North Cyprus, Nicosia, 2019) (N=1280)

	Normal		Split tendon		Total	$\chi^2$	p-value
	n	%	n	%			
Right	1240	98.1	24	1.9	1264	13.40	$p < 0.001$
Left	1162	99.7	4	0.3	1166		

\*Yates correction

Out of the 1280 subjects, 1214 were right handed and 66 were left handed. 40 cases showed absence of PL on the right and 118 on the left. Out of the total 223 cases of absence, bilateral absence occurred in 57 right hand dominant subjects and 8 left hand dominant subjects. This is shown in Table VI.

**Table VI.** Relationship between handedness and frequency of absence of palmaris longus (North Cyprus, Nicosia, 1280) (N=1280)

	Handedness		Absence of PL		$\chi^2$	p-value
	n	%	n	%		
Right	1214	96.8	40	3.2	609.27	$P < 0.001$
Left	66	35.9	118	64.1		
Total	1280		158			

Left sided unilateral absence occurred in 109 right handed subjects and 9 left handed subjects while right sided unilateral absence occurred in 37 right handed subjects and 3 left handed subjects. The relationship between handedness and frequency of absence of PL was statistically significant ( $p < .05$ ) in that the absence was more likely to occur in the non-dominant hand. The p-value for the left hand was  $< .001$  which meant PL agenesis was more likely to occur on the left side in a right-handed individuals.

All the cases of the split tendon occurred in right handed subjects, so a comparison could not be made. There were only 3 cases of a laterally displaced tendon, so no statistical analysis could be made.

#### 4. DISCUSSION

The tendon of PL muscle, an anterior forearm flexor muscle, is found at the level of the wrist lying between the tendons of the flexor carpi ulnaris and flexor carpi radialis. Various studies have reported many different variations of the tendon of PL, especially its absence [3-5, 20-28]. More studies have been conducted to establish a correlation of the absence of PL to body side, gender and hand dominance [6, 29, 30-32].

In this study, the overall frequency of absence of PL among the North Cyprus population was found to be 17.4% ( $n=223$ ) (Figure 1). This value is comparable to the study recorded with a 17.09% frequency of absence among first year Filipino medical students [15]. A similar study conducted on 500 Indian subjects recorded a similar prevalence of absence of 17.2% [33]. Another study on an Indian population also reported a similar prevalence of 17.2% [27]. The value is also similar to the worldwide prevalence of absence of 15% [17]. A study in Van, Turkey recorded a total prevalence of 15.1% [7]. Higher prevalence of PL agenesis have been given in Chilean subjects as 21% [6] while it was 22.8% in Iran [4], 26.6% in Turkey [8], 26.7% in Nigeria [29], 28% in India [13], and 40.5% in Saudi Arabia [12]. A study conducted in the Gaziantep population of Turkey reported the highest prevalence as 63.9% [19]. Many studies have recorded lower prevalence of absence especially in studies conducted in Africa and Asia. In South Africa it was reported as 11.5% [34]; In Iranian subjects it was reported as 10.2% prevalence of absence [4], while it was 9.3% in Malaysia [14]; Yoruba population of Nigeria showed 6.7% [15]; East Africa as 4.4% [9]; Korea as 4.1% [18]; Ghana as 3.8% [35]; and Zimbabwe as 1.6% [30].

Out of the total prevalence of absence in this study (17.4%), a total of 158 (12.3%) cases exhibited unilateral absence while 65 (5.1%) cases showed bilateral absence. In the unilateral cases, 40 subjects (3.1%) exhibited unilaterality on the right, and 118 (9.3%) showed left unilateral absence (Figure 2). From this study, it was inferred that there is a higher frequency of unilateral absence of the PL tendon. This was supported by a report with the total prevalence of absence of 21%, 11% were unilateral and 9% bilateral [6]. In another study, it is also recorded with a 6.4% unilateral absence and 2.9% bilateral absence, out of the total 8.3% [14]. The study by Yong et al., also reported that left sided absence was more common [32]. Also, the East African study

reported that out of the total 4.4% cases of absence, 3.3% were unilateral and 1.1% was bilateral [9]. The results of the current study were in contrast to the results of a study that reported a higher incidence of bilateral absence (6.7% out of the total 10.2%) [4]. Some other studies showed no significant difference between unilateral and bilateral cases; one study reported that of the 26.7% cases of absence, 13% were unilateral and 13.7% were bilateral [29] while another one reported no statistically significant difference in terms of sidedness [15]. Similarly, one of the studies reported that the development and the prevalence of agenesis of the PL in the fetal period had no significant differences based on sidedness, although, bilateral absence was significantly higher (62.2%) when compared to unilateral prevalence (15%) [36]. In the current study, the unilateral cases were 3.1% on the right and 9.3% on the left (Table IV). This contrasted with the study that showed a higher distribution on the right side (10.2%) compared to the 5.9% on the left [4]. In comparison, a study showed equal distribution on both right and left sides (5.6%) [29], same as another study which showed 1.4% prevalence of absence on both sides [35]. One study showed a slightly higher prevalence on the left (6%) compared to the 5% on the right side [6].

Studies have tried to correlate the frequency of absence of the PL with gender. The report of a study showed a higher frequency of absence in females (15.1%) compared to males (11.2); of these cases, 9.0% cases were on the left side [6]. The current study also showed a higher frequency of absence in females (10.6%) compared to the males (6.8%). The relationship between gender and absence of the PL was statistically significant ( $p < .05$ ) (Table II). The total frequency of absence on the right side was 3.1% while on the left, it was 9.2%; 19 of the female subjects (1.9%) had unilateral absence on the right and 77 (6.0%) had unilateral absence on the left; while the male frequency of absence was 1.6% on the right and 3.2% on the left. In this study, the p-value for the left was statistically significant ( $p < .05$ ) (Table IV). This finding was also supported by the study which reported 37.5% absence in females and 27.9% in males, with a p-value for left hand being 0.017 [37]. While, one study also reported a higher frequency of absence in females and on the left [29], another study reported males to have 16% unilateral agenesis and 4% bilateral agenesis while females had 29% unilateral agenesis and 14% bilateral agenesis [18]. In contrast, another study reported a higher frequency of absence in males (4.7%) compared to 3.3% in females, with no statistically significant difference as to laterality. A study conducted in Malaysia reported a higher frequency in females (11.5% compared to 7.1% in males) but there was no statistically significant difference in laterality as the p-value for the left was 0.105 [14]. This finding was in contrast to the findings of studies that showed no statistically significant difference in genders [4, 34]. The study of frequency in Chilean subjects showed that the PL was most frequently absent on the left side and in women, but the statistical test was not significant [6].

The current study recorded a bilateral absence of PL in 57 (4.5%) right hand dominant subjects and 8 (0.6%) in left hand dominant subjects. 109 cases (8.5%) had unilateral absence on the left side

while 9 cases (0.7%) had unilateral absence on the left side. On the other hand, 37 right-handed subjects (2.9%) had unilateral absence on the right; while 3 (0.2%) left-handed subjects had absence on the right. The difference between right and left hand dominance and frequency of absence of PL was statistically significant ( $p$ -value is  $< .001$  at  $p < .05$ ) for the non-dominant hand, which showed that absence of PL was more likely to occur in the non-dominant hand (Table VI). This finding was supported by a study concluded that right-sided absence was more common in left-handed persons while left-sided absence was more common in the right-handed persons [38]. Kigera and Mukwaya reported similar findings that PL agenesis was more likely to occur in a non-dominant hand [9]. Another study reported no significant difference in terms of gender, body side and handedness, but concluded that the absence of PL tendon was more likely to occur in the non-dominant hand [35]. Another study however, reported a contradicting result that there was a significant relationship between PL agenesis and left hand dominance, that those with PL agenesis were 3.7 times more likely to be left-hand dominant and left handed people were 3.7 times more likely to have PL agenesis [4]. No other study has reported similar findings. Kyung et al., concluded that there was no relationship between hand dominance and PL absence [18].

This study also documented 28 cases (2.5%) of the total number of those that were positive for the PL tendon of a split (bifid) tendon of PL, of which 10 (0.9%) cases occurred in males and 17 (1.6%) in females. Although, the frequency of a split tendon was higher in females, the chi-square test was 1.43 and  $p$ -value was .23 which was  $p > .05$  (Table III); this implied that the difference in gender was not statistically significant. In the cases with split tendon, 24 cases occurred on the right, 1 bilaterally and 2 on the left side. The chi-square test was 14.86 and  $p$  - value was  $< 0.001$ , which was statistically significant at  $p < .05$ , which means that the split tendon is more likely to occur on the right side (Table V). However, no similar studies were found to compare and contrast this result. In the literature, there is a case report of 2 cases of an anomalous V-shaped bifid tendon of PL [39].

There were 3 cases (0.2%) of a laterally displaced tendon of PL on the right forearms of a Turkish male (Figure 3A), Turkish female, and the left forearm of an African female (Picture 3b). Another study reported a lateral shift in the tendon of PL in 1.1% of subjects [30].

The frequency of absence in the ethnic groups of North Cyprus could not be compared as there were no similar studies in the region to compare. No other abnormalities have been observed in this study.

In summary, the goals of this research were to establish the frequency of surface anatomical variations in the different races in North Cyprus and to correlate these variations with gender, body side and hand dominance. All these have been established in this research. The frequency of absence was 17.4%, frequency of split tendon was 2.5% and lateral tendon was 0.2%. There was a significant statistical correlation between these variations, gender, body side and hand dominance. From this study, it can

be concluded that PL agenesis is more likely to occur in females and on the left side, and in the non-dominant hand.

### Compliance with Ethical Standards

**Ethical Approval:** This study was approved by the Ethics Committee of the Institute of Health Sciences, Near East University (Project Number: 807, Meeting Number: 2019/68, Date of the Ethical Board Meeting: 02/05/2019) and the Ministry of Education, North Cyprus. A written informed consent was sought from each participant before the study was carried out.

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