Original Article :

Anatomical Variations of the Palmaris Longus Muscle

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Abstract

Background and Aims:
The palmaris longus muscle (PLM) attaches to the common flexor tendon and inserts distally into the palmar aponeurosis. This study was performed to identify surface anatomical variations in the palmaris longus muscle among Omdurman Islamic University students.

Methods:
A cross-sectional study was conducted on Omdurman Islamic University students (Medical and Health Services Administration, Prof. Abd Ala al Aledressi Health Center). The sample size was determined by using 12,000 first-year university students in 2020/2021 with a confidence interval of 95% and a margin of error of 3.5%, and it was calculated to be 737 subjects (520 males and 217 females).

Result:
The overall frequency of palmaris longus muscle absence in both males and females, either unilaterally or bilaterally, was 12.6%. Of the overall study subjects (N = 737), palmaris longus muscle was detected in 644 (87.4%) bilateral cases, 24 (3.3%) agenesis in the right case, 32 (4.3%) agenesis in the left case, and 37 (5%) bilateral absent cases. Females are more likely than males to exhibit bilateral palmaris longus muscle agenesis, especially on the left side ($p<.05$). The relationship between handedness and the prevalence of missing palmaris longus is statistically insignificant ($p > 0.05$).

Conclusion:
It was concluded that 12.6% of Omdurman Islamic University students missing the palmaris longus muscle. Females exhibit a higher frequency of absence.

Keywords:
Palmaris Longus, Variation, Anatomy, Sudanese

Introduction:

The palmaris longus muscle (PLM) is a flexor muscle that originates from the common flexor tendon and inserts further distally into the palmar aponeurosis. The PL is exceedingly varied and can include agenesis, duplication, split tendon, reversed PL, hypertrophy, additional PL, and many heads[1].

The slim architecture of the PL with a tiny belly and a prolonged tendon has been considered a phylogenetically degenerative characteristic, as has the distal tendon gained through the palmar aponeurosis[2]. The PL produces limited flexion in the metacarpophalangeal joints of the fingers[3]. Despite its minimal biomechanical role, the PL has a wide anatomic range that can induce forearm and wrist conditions such as median nerve compression[4].

The median nerve normally supplies the PL (C7-8). It gets blood from the minor branches of the anterior ulnar recurrent artery and the median artery[2].

The activation of a group of mesenchymal cells in the lateral plate mesoderm initiates the development of PL alongside limb development. Towards the end of the fourth week of growth, the ventrolateral body wall elevates to form the limb buds. Each limb bud consists of a mass of mesenchyme surrounded by ectoderm[5].

The PL is thought to be active with greater functionality in mammals that use their upper extremities for mobility. And it is absent in 13% of arms[3,6]. The worldwide incidence of absence of PL is around 10-15%[6,7]. A study of Yoruba, Nigerian, and East African peoples found that the lack of the PL muscle was substantially lower, at 6.7% and 4.4%, respectively. Also showed a reduced prevalence of lack of PL (or 2.9%) as compared to Caucasian and Hispanic reference groups[8,9].

A couple of studies on black African populations have been conducted: in the Republic of Congo and Uganda, with rates of absence ranging from 3.0% to 14.6%[10]. An examination of an adult male India cadaver revealed an unexpected variation in the insertion of the PL tendon in both upper limbs[11]. There was no association identified between the absence of PL and other surrounding anomalies, such as the absence of FDS on the little finger and incomplete SPA[12].

Objectives:

To determine the anatomical variations of the palmaris longus muscle, including its presence and absence, tendon variations include duplication and absence of the palmaris longus muscle, the relationship be-

tween genders, and handedness with variations in the palmaris longus muscle.

Methods and materials:

Research Design:

Cross-sectional descriptive research. The sampling was carried out successively until the desired sample was reached.

Study Area:

The study focused on Omdurman Islamic University students pursuing Medical and Health Services Administration at Prof. Abd Alaal Aledressi Health Center.

Study duration:

The trial ran from March to August 2021.

Sample Size and Sampling Technique:

737 subjects (520 males and 217 females) were selected from 12.000 first-year university students (2020/2021) using the formula $n^{!} = \frac{n}{1+\frac{z^{2} \times \hat{p}(1-\hat{p})}{\varepsilon^{2} n}}$

The population proportion was estimated at 50%, with a 95% confidence level and a 3.5% margin of error.

Ethical Considerations:

The Omdurman Islamic University ethical committee accepted the study and was given authorization to proceed without numbering.

Selection criteria:

The investigation was conducted on both male and female participants. Before starting the study, the subjects were asked for verbal agreement.

Inclusion criteria:

The study comprised male and female university students who provided consent and were in good health.

Exclusion criteria:

The study excluded subjects with hand and wrist malformations and those who had previously injured or undergone forearm and wrist surgery.

Data Collection Tools and Methods:

Data collection tools:

The data was collected using a specially designed data-collecting table, and the researcher inputted the information. The table includes socio-demographic variables such as age and gender, as well as the subject's handedness. The remaining columns contain information about whether the PL was present or absent. If present, the type of tendon is described in the following column. The last columns show ways to determine the existence or absence of PL.

Data collection technique:

The palmaris longus muscle and its variants were assessed on the anterior portion

of the distal forearm. The Shaeffer's test was performed to detect the presence of the PL tendon. If the tendon could not be visualized, three more tests were used: Thompson's, Pushpakumar's, and Bhattacharya's. When the tendon remained absent after these four procedures, palpation was utilized to establish the absence of the PL.

Shaeffer's Traditional Test:

Standard test (Schaeffer's test): the subject is requested to resist the thumb and little finger before extending the wrist[13].

Thompson's Test:

Involves creating a fist, flexing the wrist against resistance, and placing the thumb over the fingers[13].

Pushpakumar's two-finger Test:

This requires fully extending the index and middle fingers while fully flexing the wrist and other fingers, with the thumb opposed and flexed[14].

Bhattacharya's Test:

The wrist is flexed against resistance[14].

Statistical analysis:

The data was evaluated using the Statistical Package for Social Sciences (SPSS) 25.0 software and a Chi-square test, where needed. A p-value of < 0.05 was considered statistically significant.

Result:

Socio-demographic features:

A total of 737 subjects were examined by Omdurman Islamic University students (Medical & Health Services Administration Prof. Abd Alaal Aledressi Health Center); of these subjects, 217 were females and 520 were males Table 1.

Table 1: Sex distribution of palmaris longus absence (N=93) and Socio-demographic characteristics of participants (n=737):

	Female (%) n	Male (%) n	Total (%) n
	217 (29.4%)	520 (70.6%)	737 (100%)
Frequency of PL Absence			
Unilateral absence (Right)	(0.9%) 2	(4.2%) 22	(3.3%) 24
Unilateral absence (Left)	(4.1%) 9	(4.4%) 23	(4.3%) 32
Bilateral absence	(6.9%) 15	(4.2%) 22	(5%) 37
Total absence PL	**26 (11.9%)**	**67 (12.8%)**	**93 (12.6%)**

Variations of the palmaris longus:

Out of the total study subjects (N= 737), palmaris longus muscle was found in 64 subjects (87.4%) in bilateral cases, 24 subjects (3.3%) in the right case, 32 subjects (4.3%) in the left case, and 37 subjects (5%) in bilateral absent cases.

Palmaris longus agenesis:

The overall frequency of absence of palmaris longus muscle in both males and females, either unilaterally or bilaterally, was found to be 12.6% (N = 93) (Table 1).

Out of the total, unilateral absence was observed to be (56), of which right unilateral absence was (24) and left unilateral

absence was (32). The frequency of bilateral absence of palmaris longus was observed to be (37). The distribution of absence is based on gender given in Table 1 is shown in pictures 1 to 3 of the cases of bilateral absence in both males.

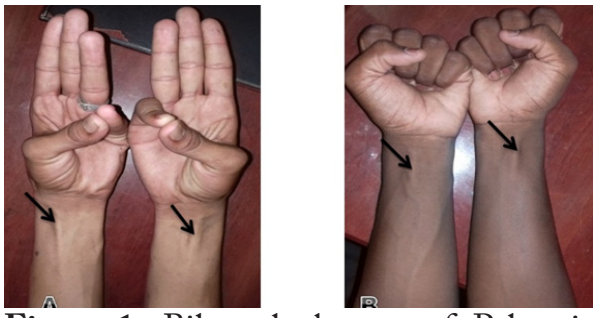


Figure 1: Bilateral absence of Palmaris longus in two Sudanese male students demonstrated by (A) Shaeffer's test for which the tendon could not be visualized (B) Thompson's test clearly shows the bilateral absence of the palmaris longus tendon. Only the tendons of the flexor carpi radialis (arrowheads) were present in the distal forearms of both the right and left sides.

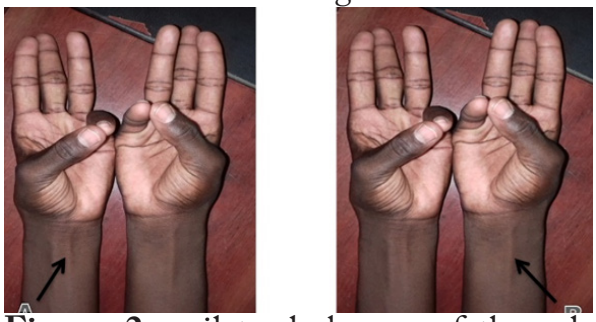


Figure 2: unilateral absence of the palmaris longus tendon on the right forearm of a Sudanese student. The arrow (A) is pointing towards the tendon of the palmaris longus on the left; (B) is pointing towards the flexor carpi radialis, which has become more prominent due to the absence of palmaris longus.

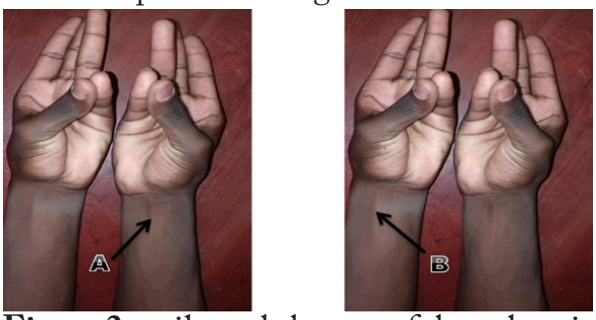


Figure 3: unilateral absence of the palmaris longus tendon on the left forearm of a Sudanese student. The arrow (A) is pointing towards the tendon of the palmaris longus on the right; (B) is pointing towards the flexor carpi radialis, which has become more prominent due to the absence of palmaris longus.

Tendon of palmaris longus:

Out of the total study subjects (N = 737), the palmaris longus tendon was found normal in 657 cases (89.1%). (39) Cases (5.3%) showed a split (bifid) tendon, (2) cases (0.3%) presented with a double tendon, and (2) cases (0.3%) presented with another tendon as shown in Table 2.

Table 2: variations of palmaris longus muscle based on tendon:

Tendon	Frequency	%Percent
Normal	657	89.1
Split	39	5.3
Double	2	0.3
Other	2	0.3
Absent	37	5
Total	**737**	**100**

The left and bilateral split PL tendon is depicted in Pictures 4 & 5.

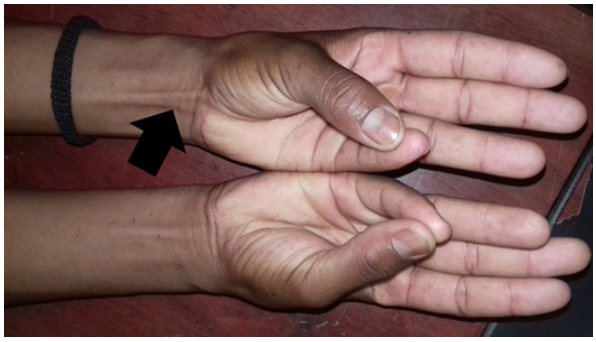


Figure 4: Left split tendon of palmaris longus in a male Sudanese student (shown by the arrowhead) into a V shape visualized by Shaeffer's test.

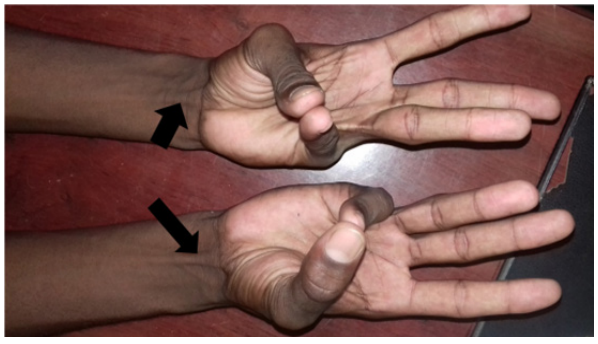


Figure 5: Bilateral split tendon of palmaris longus in a male Sudanese student, in both forearms, the tendon split into a Y or V shape, as shown by the arrowheads visualized by Shaeffer's test.

Relationship between PL variations and gender and handedness:

PL variations and gender:

The difference in palmaris longus agenesis between males and females is statistically significant ($p<.05$), implying that females have a higher frequency of bilateral palmaris longus muscle agenesis, particularly on the left side as shown in Table 3.

Table 3: Relationship between absence of palmaris longus and gender:

	Status of Palmaris longus muscle					
	Present		Absent			
	n	%	n	%	Total	p-value
Gender						
Female	191	88	15	6.9	206	0.012
Male	453	87.1	22	4.2	475	
Total	**644**		**37**		**681**	

PL variations and hand dominance:

Out of the 737 subjects, 707 were right-handed and 30 were left-handed. 24 cases showed the absence of PL on the right and 32 cases on the left. Out of the total (93) cases of absence, bilateral absence occurred in 36 right-hand dominant subjects and 1 left-hand dominant subject.

Left-sided unilateral absence occurs in 31 right-handed subjects and 1 left-handed subject, while right-sided unilateral absence occurs in 23 right-handed subjects and 1 left-handed subject. The association between handedness and the incidence of palmaris longus absence is statistically not significant ($p > 0.05$) as shown in Table

Table 4: Relationship between handedness and frequency of absence palmaris longus:

Right		PLM				Total
		Left	Both	Absent		
Handedness	Right	23	31	617	36	707
	Left	1	1	27	1	30
Total		24	32	644	37	737
Chi-Square Tests						
			Value	Df	Asymp. Sig. (2-sided)	
Pearson Chi-Square			.276a	3	.965	
Likelihood Ratio			.305	3		
Linear-by-Linear Association			.010	1		
N of Valid Cases			737			
			.959			
			.921			

Discussion:

The PLM is an anterior forearm flexor muscle found at the wrist between the FCU and FCD tendons. Various investigations have found numerous variants on the PL tendon, including its absence. More research is being conducted to see whether there is a link between the lack of PLM and gender or hand dominance.

This study found that the total prevalence of PL absence amongst OIU students appeared 12.6% (Table 1). This result is equivalent to a study that discovered a unilateral or bilateral absence rate of 11.5%[15]. The study comprised 201 consenting volunteers who considered mixed-race South Africans and studied the Universities of Cape Town and Western Cape. The study likewise seems in agreement with the global rate of absence being 15%[16]. Furthermore, the number corresponds to the worldwide incidence of absence in an ethnically diverse US population, which had been identified in Korean as 4.6%[17], in Chinese around 5.6%[18], and Japanese it was 4.1%[19]. Similarly in Ghana, the incidence of PL absence was found to be 3.8%[20] while in Zimbabwe study found it 1.6%[10]. Many research investigations have identified an elevated rate of absence, most notably in the Gaziantep community of Turkey, which had the greatest incidence of 63.9%[21], followed by 40.5% in Saudi Arabia[22], India (28%) in the study by Sankar et.al[23], Nigeria (26.7%) by Adejuwon, S.A., et al[24], Turkey (26.6%) in a study by Kose, O et.al.[25], Caucasians (25%) in the study by Thompson, N. et.al.[26], and

Iran 22.8% by Lahiji, F.A. et.al.[27]. Additionally, a study carried out in Van, Turkey, revealed an overall incidence of 15.1% by Hiz, Ö., et al.[28]. A further study of an Indian group reported a frequency of 17.2% by Kapoor, S.K., et al.[29]. Based on a study by Lamichhane, P.S. et.al.[30], the absence rate among first-year Filipino medical students was 17.09%, in contrast to 17.2% of 500 Indian subjects who were absent[31]. In our study, the overall PL absence prevalence was 12.6%, comprising 56 (7.6%) cases of unilateral absence and 37 (5%) cases of bilateral absence (Picture 1). In the unilateral cases, 24 participants (3.3%) displayed unilateral absence on the right side while 32 (4.3%) showed unilateral absence on the left (Table 1).

The study discovered unilateral absence of the PL tendon is more common. Alves et al.[32] reported that among the 21% prevalence of PL absence, approximately 11% was unilateral and 9% was bilateral. Additionally, out of an 8.3% total absenteeism rate, 33 employees experienced 6.4% unilateral and 2.9% bilateral absence. Furthermore, the East African study[14] showed that 3.3% of the total 4.4% of absences were unilateral, with 1.1% constituting bilateral.

In contrast, the previous study by Lahiji, F.A., et.al. in Iran[27] indicated a greater percentage of bilateral absence (6.7% of the total 10.2%). Additional studies encountered no significant difference involving unilateral and bilateral cases; for example, Adejuwon, S.A., et. al.[24] concluded that 13% of the 26.7% of absences were unilateral, however, 13.7% constituted bilateral. The current study demonstrated that unilateral cases were observed on both the left (4.3%) and the right (3.3%) (Picture 2). This is in accordance with a study conducted by Aliyu, M.[1], which observed a higher distribution on the left (9.3%) than on the right (3.1%). This is contrary to the findings of the participants in the study by Lahiji, F.A., et.al.[27], who found a higher distribution on the right side (10.2%) in comparison to the left (5.9%). In comparison, Adejuwon, S.A., et. al.[24] documented a distribution that was equal on both the right and left sides (5.6%), whereas Abledu, J. & Offei, E. in their study reported a 1.4% absence rate on both sides[20].

Research has been conducted to explore the association between PL absence frequency and gender. In keeping with a study by Alves, N. et.al.[32], female participants had PL absence at a higher percentage (15.1%) over males (11.2%), having 9.0% of those incidents occurring on the left. Women missed more days (10.6%) than men (6.8%). There was a significant relationship ($p<0.05$) between gender and

the lack of PL. The incidence rate of absence on the right side was 3.3% (n=24) of individuals, whereas it was 4.3% (n=32) of subjects on the left; around 0.9% (n=2) of female participants had unilateral absence on the right, and 4.1% (n=9) subjects had unilateral[34]. However, Kyung, D.-S. et.al.[17] identified that males exhibited a greater likelihood of absenteeism (4.7%) than females (3.3%), with no statistically significant difference in laterality. According to Alves, N. et.al.[32], the PL usually doesn't exist on the left side in women, but the statistical test was not significant.

PLM was discovered to be absent bilaterally in 36 right-hand dominant patients and one left-hand dominant person in the current study. Unilateral absence on the left side was demonstrated in 31 cases, whereas unilateral absence on the right side was revealed in 23 cases. In contrast, one of the left-handed dominant individuals had bilateral absence of PLM, alongside one subject possessing unilateral absence on the right and unilateral absence on the left. (Table 4) demonstrates no significant difference between right- and left-hand dominance or frequency of PL absence (p-value =0.965, p <.05). The non-dominant hand was more likely to be left-handed.

Conclusion:

In sum, the study looked at 737 people, 217 of whom were female and 520 of whom were male. According to this study, the overall frequency of PL absence among Omdurman Islamic University students was 12.6%. Females have a higher frequency of absence, and the statistical analysis was significant at $p<0.05$ on the left side. The association between handedness and the incidence of palmaris longus absence is statistically insignificant ($p > 0.05$). Other PL variations included 39 cases (5.3%) of split (bifid) tendon and 2 cases (0.3%) of PL double tendon.

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Conflict of interest:

The authors declare no conflict of interest.

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