

## ORIGINAL ARTICLE

## CLINICAL ASSESSMENT OF ABSENCE OF THE PALMARIS LONGUS MUSCLE IN AFRICAN ANTIGUAN POPULATION.

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## ABSTRACT

**Background:** The knowledge of the prevalence of the palmaris longus (PL) tendon according to gender and ethnicity is important for surgeons planning to use its tendon for transfer and transplant. Unfortunately, there is no information related to the prevalence of PL agenesis in the African Antiguan population. This study aimed to determine the prevalence of PL agenesis and its association with gender, body side and hand dominance in the African Antiguan population by using the Chi-square test.

**Methods:** In this random cross-sectional study, six hundred African Antiguan subjects (300- males and 300- females; age range 18-62 years) were tested for the absence of PL tendon, using Schaffer's test. In subjects with negative Schaffer's test, Thompson's test, Mishra's test I, Mishra's test II, and Pushpakumar's "two-finger sign" method were used to confirm its absence.

**Results:** Overall agenesis of PL in the present study reached 12.8%, unilateral agenesis (7%) was more common than bilateral absence (5.8%). The PL agenesis was found significantly greater ( $p=0.037$ ) in females (15.6%) than the males (10%). The muscle agenesis was significantly more often on the left side than the right ( $p=0.02$ ). In both right-hand ( $p>0.05$ ) and left-hand ( $p<0.05$ ) dominant subjects, the left-sided agenesis was greater.

**Conclusions:** This study reaffirms the existence of ethnic differences in the prevalence of PL agenesis. The prevalence of PL agenesis in the African Antiguan population is lesser than the reported incidence of 15% in standard textbooks, and much higher than the black and Asian population. The PM tendon is prevalent in vast majority (87.2%) of African Antiguan, and it is not diminishing rapidly like in middle eastern populations. Hence the surgeons can still harvest the tendon for various reconstructive and tendon graft surgery in African Antiguan.

**Key words:** Palmaris longus; Agensis; Hand dominance; Variation.

## INTRODUCTION

Palmaris longus (PL) is a phylogenetically retrogressive muscle having a short fusiform belly and a long slender tendon. It arises from the medial epicondyle of the humerus, with additional origin from intermuscular septa and the antebrachial fascia this myotendinous flexor continues distally with palmar aponeurosis [1]. The PL muscle exhibits numerous variations due to functional evolutionary influence; it may be agenesis, either unilaterally or bilaterally, split, incomplete, double, digastric, or anomalous insertion [2]. In addition, it has been noted that some of the PL anomalies lead to various clinical conditions, for instance, entrapment of the ulnar nerve and artery in the tunnel of Guyon, and compression of the median nerve in the carpal tunnel [3]. Palmaris longus contributes to the strength of thumb abduction and it anchors the skin and fascia of the hand to resist the horizontal shear force in the distal direction, as in holding a cricket bat [1,4]. The cognizant of the prevalence of PL in association with ethnicity, sex, and limb side is important for surgeons for its use as a tendon graft in various cosmetic and reconstructive hand surgeries.

Most surgeons consider the PL as an ideal choice

of tendon grafts for secondary tendon reconstruction, tendon transfers, and other reconstructive efforts because it accomplishes the necessary criteria of length, thickness, and availability. Since it is superficial in the position it can be harvested without resulting in any maneuvering disability [5]. For several decades, anatomists and clinicians have documented variations in the rate of absence of PL across races, ranging from 0.6% in the Korean population to 63.9% in the Turkish population [6,7]. Studies have been done on agenesis of PL in various ethnic groups of African [8-15]. However, there are no reports available on the prevalence of PL in African Antiguan populations. Therefore, this study was undertaken to determine the prevalence of unilateral/bilateral PL absences and its association with body side, sex, and hand dominance in African Antiguan populations.

## MATERIALS AND METHODS

## Study design

This analytical cross-sectional study was conducted to determine the prevalence of PL agenesis in the African Antiguan community and,

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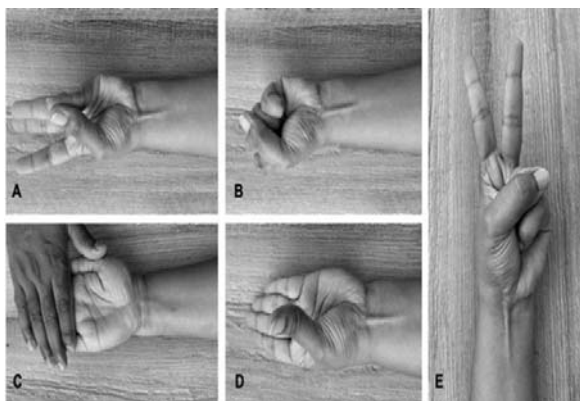
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secondly, to evaluate its association with gender, side of the limb, and hand dominance using a battery of clinical tests.

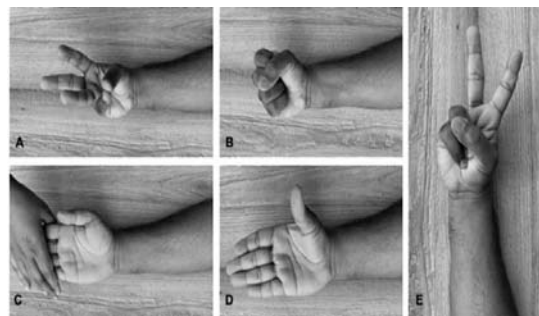
**Subjects:** Six hundred African Antiguan subjects (300- males and 300- females; age range 18-62 years) were examined for the presence or absence of PL tendon, using the clinical tests. The study was approved by Institutional Review Board of American University of Antigua (AUA IRB). The procedure was explained, and informed consent was obtained from the subjects. The subjects filled the questionnaire format that included age, gender, hand dominance, and ethnicity. The study excluded the people with a history of injury, surgery, scars on the wrist area, or any physical disabilities of their upper limbs. The sample size was determined using the approximate population size of 64,000 Antiguan age group between 18-62 years (Male-30000, Female-34000) using a confidence interval of 95% and a margin of error of 5% and the sample size was calculated as 600 (Male -300, Female-300). The normal male and female subjects were recruited randomly from the hospital, university sector and those who attended the community health fairs (year 2015-2017) organized by the American University of Antigua, Antigua.

**Clinical tests and data collection:** The presence of the PL tendon was assessed on both sides of the wrist using five clinical tests. We primarily asked the subjects to perform a standard test (Schaeffer's test): opposition of the thumb to the little finger and then flex the wrist (Fig. 1A).



**Figure 1.** Presence of the Palmaris longus tendon. A. Standard test (Schaeffer's test); B. Thompson's test; C. Mishra's test I; D. Mishra's test II; E. Pushpakumar's "two-finger sign" test

If the tendon was visible as a raised ridge on both sides of the wrist, then the PL tendon was declared as bilaterally present. If the tendon is not visible and palpable, then the subjects performed four additional tests to confirm its absence (Fig. 2).



**Figure 2.** Absence of the Palmaris longus tendon. A. Standard test (Schaeffer's test); B. Thompson's test; C. Mishra's test I; D. Mishra's test II; E. Pushpakumar's "two-finger sign" test

The four tests were Thompson's test: The subject was asked to make a fist, then flex the wrist, and finally, the thumb was opposed and flexed over the fingers (Fig. 1B). Mishra's test I: The metacarpophalangeal joints of all fingers were passively hyperextended by the examiner and the subject was asked to actively flex the wrist (Fig. 1C). Mishra's test II: The subject was asked to abduct the thumb against resistance with the wrist in slight palmar flexion (Fig. 1D). Pushpakumar's "two-finger sign" test: The subject was asked to fully extend the index and middle finger; the wrist and other fingers were flexed and finally the thumb was fully opposed and flexed (Fig. 1E). The data was entered in the following parameter. Bilateral absence: Absence of the PL tendon on both sides. Symmetry of palmaris longus in relation to body side: If the absence was only on one side, either in right or left hand, then it was recorded as unilateral absence on the corresponding side and the dominant hand of the subjects was also noted. For accuracy, all the tests were performed thrice and the principal investigator who investigated the agenesis of PL tendon is a clinician as well as the subject expert.

**Data analysis:** The data were presented in percentage values and the palmaris longus absence was analyzed statistically using SPSS software (version 11.5). The prevalence of PL tendon agenesis and its association with gender, limb laterality, and hand dominance were analyzed statistically by the Chi-square test. Statistical significance was set at  $P < 0.05$ .

## RESULTS

The overall PL absence was found in 77 (12.8%) subjects, the absence was significantly ( $P=0.037$ ) greater in females (15.6%) than in the males (10%). The palmaris longus muscle was absent bilaterally in 35 (5.8%) subjects and

unilateral absence was found in 42 (7%) subjects with no statistically significant sex difference. The bilateral (female-7%, male-4.6%) and unilateral (female-8.6%,male-5.3%) absence of PL were greater in females than the male, with no significant difference. Unilateral absence of the PL was significantly higher (P = 0.01) in the left hand [23 (10.8%)] than in the right hand [9 (7.0%)]. The PL absence in the left hand was significantly (P=0.02) greater in females [23 (7.6%)] than the male subjects [10 (3.3%)], while in the right hand the PL absence was greater in males [6 (2%)] than the female subjects [3 (1%)] with no significant sex differences (Table.1).

We noted that 554 (92.33%) subjects had right-hand dominance and 46 (7.66%) subjects had left-hand dominance. The left-hand dominant had a significantly higher (P=0.02) absence of Palmaris Longus (23.9%) when compared with right-hand dominant (11.94%) (Table.2).

In right-hand dominant subjects, PL was absent on the left side in 23 (4.15%) and on the right side in eight (1.4%) subjects with significant difference (P=0.006). In left-handed dominant subjects, it was absent on the right side in one (2.17%) and on the left side in 10 (21.73%) subjects with significant difference (P=0.003). Therefore, the left-sided absence was greater in both left-hand and right-hand dominant subjects, but a significant difference was found only in the left-hand dominant subjects (P<0.001) (Table.3).

**Table 1. Gender wise distribution of Palmaris longus agenesis and its lateralization**

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Gender	PLP n(%)	PLA n(%)	ULA n(%)	BLA n(%)	PLP n(%)	ULA n(%)	PLP n(%)	BLA n(%)	Right Hand n(%)		Left Hand n(%)	
									Present	Absent	Present	Absent
Male (n=300)	270 90%	30 10%	16 5.3%	14 4.6%	270 90%	16 5.3%	270 90%	14 4.6%	294 98%	6 2%	290 90%	10 3.3%
Female (n=300)	253 84.3%	47 15.6%	26 8.6%	21 7%	253 84.3%	26 8.6%	253 84.3%	21 7%	297 99%	3 1%	277 92.4%	23 7.6%
overall (n=600)	523 87.2%	77 12.8%	42 7%	35 5.8%	523 87.2%	42 7%	523 87.2%	35 5.8%	591 98.5%	9 1.5%	567 94.5%	33 5.5%
Chi-square	4.305		0.0291		2.847		1.773		1.015		5.419	
p-value	0.037*		0.864		0.091		0.183		0.314		0.02*	

PLP- Palmaris longus present; PLA- Palmaris longus Agenesis; ULA-Unilateral Agenesis; BLA-Bilateral Agenesis  
\*Significantly different.

**Table 2. Association between palmaris longus agenesis and hand dominance**

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PL	Hand dominance		Chi - square	p-value
	Right n(%)	Left n(%)		
Present	488 (88.06%)	35 (76.08%)	5.467	0.02*
Absent	66 (11.94%)	11 (23.9%)		
Overall	554 (92.33%)	46 (7.66%)		

PL- Palmaris longus; \* Significantly different

**Table 3. Association between laterality of palmaris longus agenesis and hand dominance**

Palmaris longus	Hand dominance		Chi -square	p-value
	Right n(%)	Left n(%)		
Right absent	8 (1.4)	1 (2.17)	0.153	0.695
Left absent	23 (4.15)	10 (21.73)	25.27	0.001*
Chi -square	7.46	8.36		
p-Value	0.006*	0.003*		

\* Significantly different

## DISCUSSION

Palmaris longus muscle is well developed in arboreal mammals like orangutans. Other primates like humans, chimpanzees, and gorillas are less arboreal; hence PL gradually undergoes degeneration due to non-adaptive evolution in the Homininae [16]. Standard textbooks of hand surgery state that the rate of absence of PL is 15% in the global population [17]; this statement differs markedly when the present study data were compared with the results of other ethnic groups (Table.4). Overall agenesis of PL in the African Antigua population was 12.8%. This value is comparable to the very low prevalence of PL agenesis in the black populations, Ghana [8,9], East Africa [10], Nigerian population [11] and the lowest was recorded in Zimbabwe (1.5%) [12]. However, South African [13] and Ethiopian populations [15] exhibited a slightly greater prevalence of PL agenesis. The reason for less degeneration of PL in the African population could be explained by the high pervasiveness of manual labor which requires a tensed palmar fascia for a strong grip [10]. In the South and Southeast Asian population, the agenesis of PL was very low in Koreans and Chinese, but in Indians, Malays, Nepalese, and Filipinos the rate of absence was moderate [18-23]. In the two multiethnic studies done on the Malaysian and Indonesian population, the overall absence of PL was 9.3% and 10.4% respectively [24,25]. Among the Middle Eastern population, very high percentages of PL agenesis were observed in Bahrain; Iran, and Egypt populations [26-28]. The highest prevalence of PL agenesis was recorded by Ceyhan and Mavt in Turkey (63.9%) [7]. Solanti et al. in a multiethnic study on the USA population reported that the prevalence of PL tendon agenesis is greater in whites (14.9%) than the African Americans (4.5%) and Asians (2.9%) [29]. Eric et al. in Serbian [30] and Thompson et al. in the Caucasian population [16] reported the greater absence rate of PL. In the South American population, also the agenesis of PL was slightly higher in the Chilean and Brazilian populations [31,32].

Apart from ethnic variations in the PL agenesis, various studies proposed that its absence is more common

in women, bilateral absence is more common than unilateral, and unilateral absence occurs more frequently on the left side. This type of distribution in the prevalence pattern doesn't fit completely with the results of our study. In agreement, the overall prevalence of PL agenesis in the African Antigua population was significantly greater in females than the males. Numerous studies have indicated that the agenesis of PL is more common in females than males [8,9,12,14,15,21-24,26-29,31-33]. In accordance, with our study, significant sex difference was observed in Malay [21], Iran [27], Egyptian [28], Brazilian [32], and Turkey populations [33]. This could be explained by that female has low expressivity of the gene of the presence of PL compared to males [34]. In contrast, few studies reported that PL absence is more common in males [10,11,13,16,18,19,20,30].

In our study unilateral absence was greater than the bilateral absence with no significant difference. In concurrence with our study, other African populations also reported unilateral agenesis was more common [8,10-13,14,15]. Furthermore, other studies done on Caucasians [16], Chinese [19], Indian [20], Malays [21], Nepalese [22], Filipino [23] Serbian [30] and Chilean [31] also reported in favorable to our study. Mbaka et al. [11] in Nigerian, Yong et al. [21] in Malays and Eric et al. [30] in the Serbian population found unilateral absence is significantly more common than the bilateral absence. The bilateral absence was greater than the unilateral absence among most of the Middle Eastern population [7, 26-28,33], but the significant difference was reported by Ceyhan et al., Kose et al. and Hiz et al. [7,33,35] in Turkey and Rouf et al in Egyptian population [28]. In the present study, both unilateral and bilateral absence of PL was greater in females than the males. However, no significant sex difference was found. In contrast, Mkaba et al. [11] in the Yoruba Nigerian population reported a significantly higher bilateral agenesis rate in

**Table 4. Compilation of palmaris longus agenesis prevalence reported in various population**

Authors	Population	PL absence						Total (%)
		Unilateral		Bilateral		Overall		
		M (%)	F (%)	M (%)	F (%)	M (%)	F (%)	
Gangata et al., 2009	Zimbabwe	0.33	0.56	0.22	0.33	0.56	0.9	1.46
Offei et al., 2014	Ghana	2.1	4.7	0.7	1.6	2.7	6.3	3.8
Kigera et al., 2011	An East African Study	3.6	3	1.3	1	4.9	3.9	4.4
Mbaka et al., 2009	Nigerian	5.4	6	1.5	0.4	6.9	6.4	6.7
Berhe et al., 2014	Ethiopian	6.9	7.7	7.4	10.1	14.3	17.8	15.3
Ndou et al., 2010	Mixed South African	1.5	4.5	1.5	4	3	8.5	11.5
Osonuga et al., 2012	Ghanaian	1.3	1.36	0	0.44	1.3	1.8	3.1
Venter et al., 2014	South African	7.7	6.8	6.5	5.4	14.2	12.2	24.4
Sater et al., 2010	Bahrain	17.8	17.9	16.2	21.3	34	39.2	36.8
Raouf et al., 2013	Egypt	21.9	19.7	26.8	32.8	41	54.7 4	50.8
Kose et al., 2009	Turkey	9.03	13.62	11.7	18.3 7	20.74	32.4 4	26.59
Karimi-Jashni et al., 2014	Iran	9.1	13.2	13.5	25.4	22.7	38.6	30.7
Ceyhan and Mavt., 1997	Turkey	19.5	22.9	42.1	45.3	61.6	68.3	63.91
Kyung et al., 2012	South Korea	1.3	2.5	3.3	0.8	4.7	3.3	4.1
Sebastin et al., 2006	Singaporean China	3.8	2.5	1	1.7	8.3	2.4	4.6
Roohi et al., 2007	Malaysia	5.8	7.1	1.3	4.4	7.1	11.5	9.3
Yong et al., 2017	Malay	6.08	9.77	3.04	4.4	9.1	14.2	11.7
Lamichhane et al., 2017	Filipino	12.94	15.3	0.4	2.58	4.77	12.7 2	17.5
Sharma et al., 2019	Nepalese	11.2	11	3.2	4.1	14.4	15.2	14.8
Kapoor et al., 2008	Indian	12.71	6.06	5.08	10.0 6	17.8	16.6 7	17.2
Hadi & Masri., 2015	Indonesian	6.43	6.51	3.71	4.14	10.2	10.7	10.4
Thompson et al., 2001	Caucasian	19.3	13.3	10	7.3	29.3	20.6	25
Alves et al., 2011	Chilean	10.46	11.4	6.97	10.5 2	17.44	21.9 3	20
Morais et al., 2012	Brazilian	10.3	16.7	13.1	10.7	21.1	29.7	26.5
Eric et al., 2010	Serbia	18.5	22.25	18.5	13.3	39.5	35.5	37.5
Solanti et al., 2012	Multiethnic USA	7.6	10.1	6.6	8.8	14.2	18.9	16.3
Present study	African Antiguan	5.3	8.6	4.6	7	10	15.6	12.58

PL- Palmaris Longus Muscle; M- Male, F-Female

males. Kapoor et al. [20] in Indian, Sater et al. [26] in Bahrain, and Karimi et al. [27] in the Iranian population found significantly greater bilateral absence in females.

Our study in the African Antiguan population confirmed that the overall prevalence of unilateral agenesis on the left side is significantly more common in women. This is consistent with studies done on Indians, Bahrain, Iranian, Serbian, and Turkish populations [20,26,27,30,33], but no significant sex difference was observed in the Nigerian and Chinese populations [11,19]. Alternatively, Abledu et al. in the Ghana population observed that unilateral right-side agenesis was significantly more common in females [8]. While in Malays, the left-side agenesis was significantly higher in males [21], no significant sex difference was observed in studies done on East African [10] and Nepalese populations [22].

In both right and left-hand dominant subjects, the PL genesis was significantly more common on the left side. This result is consistent with Morais et al study on the Brazilian population [34]. In Caucasian [36], Ghana [8], East Africans [10], Zimbabwe [12], Ethiopian [15], and Malay [21] populations the absence was more common on the non-dominant. In another study on the Brazilian population, the left-handed subjects showed higher PL agenesis on the left side, and in right-handed subjects, the agenesis was similar on both sides [32]. The limitation of this study is that the clinical test may rarely lead to the fallacy of a normal muscle as a pathological finding or agenesis. Ultrasonography or MRI would confirm the variations of PL, but like the clinical test, they cannot be applied for documenting the prevalence of PL tendon in large-scale population studies because it is neither cost-effective nor time-saving [33].

Among the clinical test, the Schaeffer test was not always reliable because it showed negative results in subjects with feebly developed PL. In such cases, Mishra's second test which involves resisted abduction of the thumb demonstrated the PL tendon more prominently.

From an embryological point of view, the PL develops as a skeletal muscle from the somatic mesoderm of the myotomes. The premyogenic cells migrate, proliferate, and differentiate into muscle tissue, this process is regulated by the intrinsic factor and environmental signals. The absence of these signals and muscle regulatory factors during embryogenesis causes premature differentiation of myogenic cells, resulting in the agenesis or incomplete genesis of the corresponding muscles [37,38].

## CONCLUSION

Our study concludes the existence of ethnic differences in the prevalence of PL agenesis. The prevalence

of PL agenesis in the African Antiguan population is lesser than the reported incidence of 15% in standard textbooks and much higher than the black and Asian populations. The PL agenesis was more common in females and on the left side. In both dominant hands, the left-sided agenesis was more common. The PL tendon is prevalent in the vast majority (87.2%) of African Antiguan, and it is not diminishing rapidly like in the middle eastern population. Hence the surgeons can still harvest the tendon for various reconstructive and tendon graft surgery in African Antiguan.

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