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Does agenesis of Palmaris Longus tendon affect the hand grip strength?

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ABSTRACT

Background: The agenesis of Palmaris longus (PL) tendon varies with each Ethnic group of the population across the world. Literature review suggests Asians have the least prevalence of absence of Palmaris longus tendon whereas Turkish and Africans have the highest incidence. Lots of studies have been done to report the incidence of agenesis of the PL, and its association with hand-dominance, gender, laterality and hand grip strength with varying results. There has been no study conducted in the Mysorean population

Methods: 248 consecutive adults attending the outpatient department of orthopedics in JSS were included in this study. Patients were included based on selection criteria. Three tests were done to confirm the absence of PL by two independent observers including one senior author. The hand grip was recorded based on the mean value of three readings in each hand using a dynamometer. The results were statistically analyzed.

Results: Females had a higher incidence of agenesis of PL. Right-hand dominant individuals had a higher rate of agenesis of PL. Unilateral agenesis was more common than bilateral agenesis.

Conclusion: Absence of PL does not affect the hand grip strength of the patient. The PL tendon is an extremely useful donor tendon and may be sacrificed during reconstructive surgeries.

Key words: *Agenesis, Palmaris longus, hand grip strength, hand dominance, tendon donor*

Introduction

The prevalence of the Palmaris longus (PL) muscle has been studied abundantly in different ethnic populations [1–19]. The PL is weak accessory wrist flexor. However, it is more important role is to anchor the fascia as it contracts the sin and palmar fascia of the hand. It is also believed to play a role in abducting the thumb due to its course around the long abductor of the thumb. These functions of the PL are mainly accessory roles, and hence is usually sacrificed during surgery as a tendon donor.

The absence of the PL in humans is believed to be hereditary, but the genetic pattern of transmission is not well understood [20]. The absence of Palmaris longus

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can be easily determined by clinical examination. The traditional knowledge is that the PL muscle is absent in 15% of the global population [21]. Although there is a lot of literature available regarding the incidence of agenesis of the PL, very little has been published about the correlation between agenesis of PL and hand grip. Cetin et al. studied Turkish elementary school children and concluded that there the agenesis of PL did not affect the hand grip [22]. A similar study was conducted by Sebastin et al. in the Chinese population and concluded the same [23]. In this study we aim to support or refute the results published previously by studying the incidence of agenesis of PL in the Mysorean population and its effect on the mean hand grip strength. We also aim to study the variation of agenesis of PL with gender, age, hand dominance, and laterality.

Methods

We included 248 consecutive subjects who visited the Orthopedic outpatient department of our hospital. This study was conducted in patients from Mysore, India. The informed consent was taken for each patient before conducting the tests. Patients who did not give consent were withdrawn from the study. This study was approved by the institutional review board of our university.

Firstly, three independent tests were performed in each subject on each hand by two authors including the senior author to determine the presence of Palmaris longus tendon. The three tests were Thompson test (Test 1), Schaeffer's test(Test 2) and Mishra's (Test 3). In patients where Test 1, 2 and 3 were negative, Pushpakumar's test was performed to confirm the absence of Palmaris longus tendon. The mutually agreed presence or absence of the tendon was recorded for each subject in both the hands.

All adult subjects visiting the outpatient department of Orthopedics were included in this study. Subjects with previous history of trauma, neuromuscular conditions affecting upper limbs, congenital anomalies of the upper limbs, deformities of upper limb were excluded from the study.

In Thompson's test, the patient was asked to make a fist the thumb flexed over the fingers. The patient was then asked for palmar-flex the wrist joint against resistance. The prominence of the PL tendon was recorded to be present or absent [24] (Figure 1).

In Schaeffer's test, volunteers were asked to flex their elbow joint to 90°. The patient was then asked to oppose the thumb to meet the little finger with the wrist in slight palmar flexion [25] (Figure 2).

In Pushpakumar's "two-finger sign" method, the subjects were asked to extend their index and middle fingers, while the other fingers remained flexed. The thumb is opposed and flexed with the wrist joint in neutral [26]. The prominence of the PL is observed and recorded (Figure 3) Mishra's 1st test involved passive hyperextension of the metacarpophalangeal joints along with mild active flexion of the wrist [27].

A dynamometer was handed to each subject, and the grip strength was measured in both the hands. The average of three readings was recorded for each hand.

Statistical analysis was performed of the prevalence of agenesis of PL, and its correlation with gender, age, laterality, hand dominance and hand grip using SPSS software version 21. Continuous variables were reported as the mean ±standard deviation (SD), and categori-

Figure 1. Thompson test.

Figure 2. Schaeffers test.

Figure 3. Pushpakumara test.

cal variables were reported as number and percent. The unpaired t-test was used for comparison of continuous variables between the studied groups. Pearson chi-square test or Fisher's exact test was used for comparison of categorical variables between the studied groups. A value of $p<0.01$ was statistically significant.

Results

In this study, we included 248 participants. Out of the 248 participants, 168 were females, and 80 were males. (Table 1) The majority of the participants (151; 60.9%) were aged between 21 and 30 years. The mean age of the study population was 27.56 years. (Table 2) Majority of the participants (95.2%) were right hand dominant. The mean age of right-handed dominant subjects was 27.56+/- 8.385 years, and dominant left-handed subjects were 27.58 +/- 9.885 years (Tables 3, 4).

The strongest mean hand grip of the right hand (25.36+/-20.889) was recorded in patients aged 21 to 30 years. (Graph 1) The strongest mean hand grip of the left hand (29.67+/-12.111) was recorded in patients aged 51 to 60 years. The mean hand grip recorded in the left hand (24.83+/-20.653) was more than the mean hand grip of the right hand (23.67+/-19.948). (Table 2)

The rate of agenesis of PL was 15.322%. The prevalence of agenesis of PL in the left hand was 15.3% and in the right hand was 8.9%. (Table 5, 6) (Graph 2) Agenesis of PL was higher in females (12.1%) compared to males (3.2%). (Table 7) (Graph 3)

Bilateral absence of PL was recorded in 16 subjects (6.5%). Out of these 16 subjects, 15 were right-handed dominant, and one was left-handed dominant. (Table 8) Female subjects (n=12) had a higher rate of bilateral agenesis of PL compared to males (n=4). (Graph 4) Bilateral absence of PL was seen most often in the subjects aged between 21 to 30 years (n=10). (Graph 5) The mean grip strength in patients having a bilateral absence of PL was 23.06+/-14.920 in the left hand

Table 1. Distribution of study subjects based on their gender.

	Frequency	Percent
Male	80	32.3
Female	168	67.7
Total	248	100.0

Table 2. Distribution of study subjects based on their age category with correlation to the hand grip.

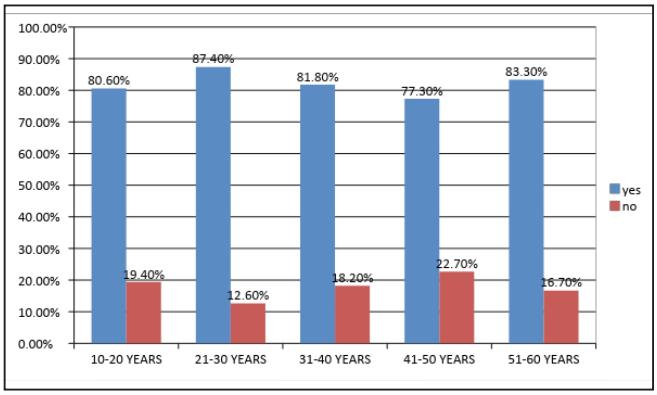
Age Category		N	Minimum	Maximum	Mean	Std. Deviation
10-20 Years	Grip Strength-Left	36	0	75	18.50	16.168
	Grip Strength-right	36	0	75	18.53	17.471
	Age	36	18	20	18.97	1.905
21-30 Years	Grip Strength-Left	151	0	92	25.81	21.498
	Grip Strength-right	151	0	90	25.36	20.899
	Age	151	21	30	24.50	2.419
31-40 Years	Grip Strength-Left	33	0	90	23.64	18.927
	Grip Strength-right	33	0	80	21.24	17.859
	Age	33	31	40	34.97	2.733
41-50 Years	Grip Strength-Left	22	0	84	28.91	24.444
	Grip Strength-right	22	0	75	24.32	20.785
	Age	22	41	50	44.59	2.576
51-60 Years	Grip Strength-Left	6	13	48	29.67	12.111
	Grip Strength-right	6	0	42	22.83	15.651
	Age	6	51	56	53.17	1.835

Table 3. Mean grip strength.

	N	Minimum	Maximum	Mean	Std. Deviation
Age	248	18	56	27.56	8.441
Grip Strength-Left	248	0	92	24.83	20.653
Grip Strength-right	248	0	90	23.67	19.948

Table 4. Distribution of study subjects based on their hand dominance.

	Frequency	Percent
Left	12	4.8
Right	236	95.2
Total	248	100.0



Graph 1. Grip strength versus age.

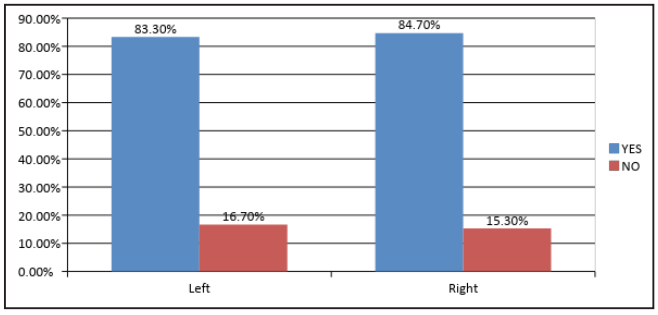
and 20.06 +/-20.250 in the right hand. (Graph 6) The mean grip strength of the left hand in patients having a bilateral absence of PL in dominant left-handed subjects was 32.42+/-28.978. The mean grip strength of the right hand in patients having a bilateral absence of PL in right-handed dominant subjects was 23.44+/-19.854. There was a statistically significant correlation between the handgrip strength and dominance of the hand (p=0.003 in the left hand, 0.0001 in the right hand) (Table 9). There was no statistically significant correlation between agenesis of PL and the mean hand grip strength. (p=0.55)

Table 5. Agenesis of PL in the left hand.

	Frequency	Percent
Yes	210	84.7
No	38	15.3
Total	248	100.0
Absence of palmaris in left side prevalence: 15.3%		

Table 6. Agenesis of PL in the right hand.

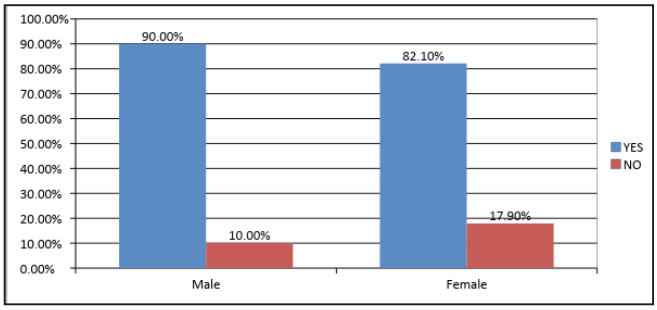
	Frequency	Percent
Yes	226	91.1
No	22	8.9
Total	248	100.0



Graph 2. Unilateral Agenesis of PL versus laterality.

Discussion

This study showed us that the rate of agenesis of PL in the Mysorean population was 15.322%. The agenesis of PL was more in the right hand compared to the left. Females had a higher incidence of agenesis of PL compared to males. Unilateral agenesis was more common than bilateral agenesis of PL.



Graph 3. Unilateral Agenesis of PL versus gender.

As many as 32 studies have been conducted to study the incidence of agenesis of the PL. Gangata et al. [28] reported the lowest incidence of 1.5% in the Zimbabwean population whereas Ceyhan et al. [13] reported the highest incidence of 63.9% in the Turkish population. Our review of the literature revealed that PL agenesis was low in the Black populations of Zimbabwe, Ghana, East Africa and Nigeria [3,4,28,29]. Low incidence of agenesis of PL was observed in China, South Korea, and Caucasians as well [5,10,15]. High incidences of agenesis of PL were reported in Bahrain, Egypt, and Turkey [13,19,30]. In our study, we report the incidence of agenesis of PL to be 15.322%.

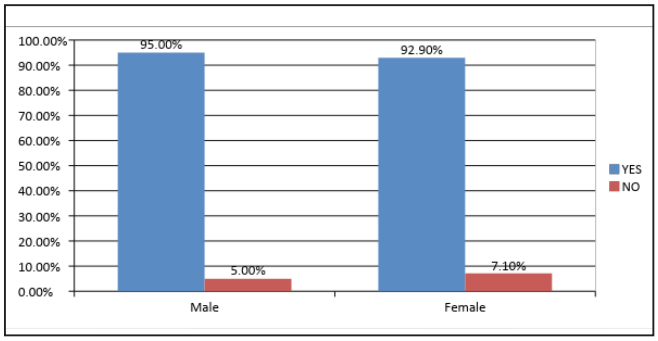
It is currently known that the agenesis of PL is more common in women compared to men. Ten studies have reported significant differences in the incidence of agenesis of PL in males versus females. Eight studies confirm that females have a higher preponderance of agenesis of PL [2,19,29–33]. In our study, we found that females (30; 17.9%) had a higher incidence

Table 7. Agenesis of PL versus gender.

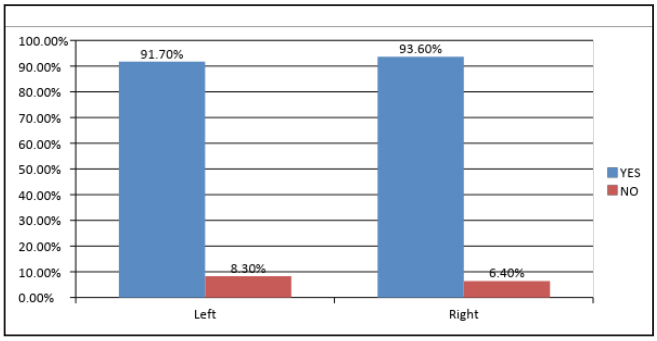
			Sex		Total
			Male	Female	
TEST (COMBINED)	YES	Frequency	76	156	232
		Percent	95.0%	92.9%	93.5%
	NO	Frequency	4	12	16
		Percent	5.0%	7.1%	6.5%
Total		Frequency	80	168	248
		Percent	100.0%	100.0%	100.0%

Table 8. Absence of PL versus hand dominance.

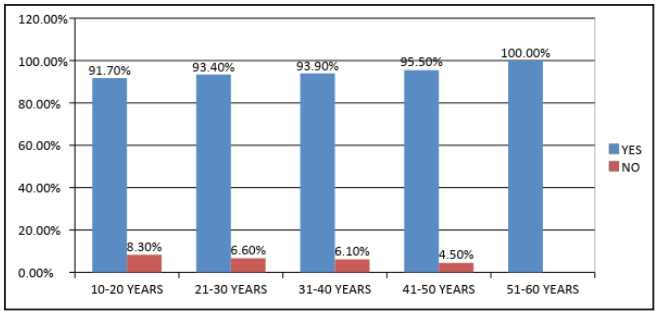
			Hand Dominance		Total
			Left	Right	
TEST (COMBINED)	YES	Frequency	11	221	232
		Percent	91.7%	93.6%	93.5%
	NO	Frequency	1	15	16
		Percent	8.3%	6.4%	6.5%
Total		Frequency	12	236	248
		Percent	100.0%	100.0%	100.0%



Graph 4. Bilateral agenesis of PL versus gender.



Graph 6. Bilateral Agenesis of PL verus laterality.



Graph 5. Bilateral agenesis of PL versus Age.

of absence of PL compared to males (8; 10%).

Laterality of agenesis of the PL has also been studied extensively. Nine studies have reported that the left hands have a higher preponderance for agenesis of PL muscle compared to the right hand [4,6,7,9,13,29,32–34]. Two studies have found the right hand had a higher incidence of agenesis of PL [2,35]. In our study we found that left hand (15.3%) has a higher incidence of agenesis of PL compared to the right hand (8.9%).

The PL muscle may be absent unilaterally or bilaterally. The incidence of agenesis of PL is believed to be higher bilaterally compared to unilateral agenesis. Bilateral agenesis was seen in nine studies [2,6,13,19,30,31,35,36]. However, four other studies reported unilateral agenesis to be significantly higher than bilateral agenesis [4,7,37,38]. In our study we found similar results with a higher rate of unilateral absence of PL compared to the bilateral absence of PL (16; 6.5%).

The absence of PL muscle is not related to hand dominance. However, results of five studies showed that the agenesis of PL is statistically significant in its relation to hand dominance [2,5,10,17,39]. Abdolahzadeh et al. studied the Iranian population and highlighted that there was a strong correlation between PL absence and left-handed dominance [9]. They reported that the people with agenesis of Pl were 3.7 times more likely to have left-handed dominance [9]. In our study, we observed right-handed dominant subjects had a higher rate of agenesis of PL. In our study, there was a significant correlation between the handgrip strength and

Table 9. Age versus Handgrip.

Hand Dominance		N	Mean	Std. Deviation	T-test	P value	95% Confidence Interval of the Difference	
							Lower	Upper
Left	Grip Strength-Left	12	32.42	28.978	3.875	0.003*	14.00	50.83
	Grip Strength-right	12	28.17	22.156	4.404	0.001*	14.09	42.24
	TEST LEFT	12	1.17	0.389	10.383	0.0001*	0.92	1.41
	TEST RIGHT	12	1.17	0.389	10.383	0.0001*	0.92	1.41
	TEST (COMBINED)	12	1.08	0.289	13.000	0.0001*	0.90	1.27
Right	Grip Strength-Left	236	24.44	20.148	18.635	0.0001*	21.86	27.02
	Grip Strength-right	236	23.44	19.854	18.134	0.0001*	20.89	25.98
	TEST LEFT	236	1.15	0.360	49.140	0.0001*	1.11	1.20
	TEST RIGHT	236	1.08	0.279	59.708	0.0001*	1.05	1.12
	TEST (COMBINED)	236	1.06	0.244	66.829	0.0001*	1.03	1.09

dominance of the hand. Dominant hands had a higher hand grip than the non-dominant hand in both left and right hands. (p=0.003 in the left hand, 0.0001 in the right hand)

The agenesis of PL has been reported to not have any effect on the hand grip strength or pinch strength. Sebastin et al. studied 418 Asian Subjects and found no correlation between the absence of PL and decrease in handgrip strength or pinch strength [40]. On the other hand, Cetin et al. reported there was no difference in the hand grip strength. However, there was a significant decrease in the pinch strength of the fourth and the fifth finger of the hands with absence of PL muscle [22]. However, the limitations of this study were that the study subjects were a heterogeneous combination of patients from different ethnic backgrounds. In our study, we included a homogenous set of patients from the same ethnic background of Mysore. Kose et al. studied 333 male subjects aged 18 to 25 years old to study the variation of handgrip strength and concluded that there was no significant variation in the hand grip strength in subjects with or without the PL [41]. We also did not find a statistically significant variation in the hand grip in subjects with agenesis of PL.

PL is vital to thumb abduction through its extension into the thenar eminence [42]. In the second study by Gangata et al., the strength of thumb abduction was recorded in patients with and without the PL tendon [14]. He reported that subjects with Palmaris longus tendon had a significantly stronger force of thumb abduction compared to subjects who did not have the PL. He concluded that the if the PL were harvested as a donor tendon, then the force of thumb abduction strength would be significantly decreased. He also reported that there are very few daily activities that require thumb abduction like opening scissors. Gagnata et al. [14] effectively concluded that although the thumb abduction strength was significantly reduced after harvesting PL as a donor tendon, the effective function of the hand was very unlikely to be affected

The limitations of this study are that we recruited a small population of 250 subjects for this study. The subjects of this population do not necessarily represent the anatomy of the entire Mysorean population. We did not perform pinch strength analysis in our subjects. This could provide more information about the correlation of absence of PL muscle with hand grip strength.

Our study concluded that there was no significant correlation between the hand grip and agenesis of PL tendon. Females had a higher incidence of PL com-

pared to males. Unilateral absence was more common than the bilateral absence of PL. Right-handed dominant individuals had a higher incidence of agenesis of PL compared to left-handed dominant individuals.

The Palmaris longus tendon is used as a donor for various reconstructive procedures like acromioclavicular joint reconstruction, lip augmentation, tendon transfer surgeries, ptosis correction, restoration of lip and chin defects, opponensplasty for severe carpal tunnel syndrome, and excisional arthroplasty of Kienbock's disease [1,12,21,37,39]. The results of this study might provide evidence to the surgeons that this tendon might be sacrificed without affecting the hand grip or the function of the wrist and hand.

Conclusion

There was no statistically significant correlation between agenesis of PL and the mean hand grip. Right-handed dominant individuals had a higher incidence of PL. Harvesting of the Palmaris longus tendon as an effective donor tendon during reconstruction surgery does not affect the function of the hand and is safe.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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