

Palmaris Longus Agenesis (PLA) among Dusun & Bajau ethnic groups of Northern Borneo

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Abstract

Background: The functional role of Palmaris longus muscle is little to human upper limb, but its long tendon is very useful as a donor tendon in hand reconstructive surgery. In the human body, Palmaris longus muscle is often described as one of the most variable muscles in both number and form. It is only to be consistently found in mammals especially in those using forelimbs for weight-bearing and ambulation. The absence of Palmaris longus in human appears to be hereditary but its possibility through genetic transmission has not been proven yet. The first report in 1559 estimated the Palmaris longus agenesis (PLA) was 17.2% among Indians and 12-24% in Caucasians. It was reported to be 4.6% among Singaporean-Chinese while 12.6% and 26.6% in Nigeria-black and Turkish people respectively. A 2007 UKM study shows prevalence of PLA in Malays was 11.3% followed by Indians (10.7%) and Chinese (6.0%). Studies had indicated that PLA would be associated with other anatomical variations of hand.

Borneo is the third largest island in the world and located in the centre of the Maritime Southeast Asia. Sabah, once known as north Borneo, is the second biggest states in Malaysia after Sarawak. The largest indigenous ethnic group in Sabah is Kadazan-Dusun residing mainly on the West Coast region of Sabah, making up about 30% of population. Bajau is the second largest indigenous ethnic group and can be found in east coast of Sabah.

Aim & Objectives: To determine the prevalence of PLA among the two major ethnic groups of Sabah namely Dusun (Kadazan-Dusun & Rungus) and Bajau and to compare the estimates between age and gender

Methods: The presence or absence of Palmaris longus tendon was clinically examined among the ethnic volunteers (18 years and above) by using standard tests namely Schaffer's test, Thompson's test, Mishra's test I and II, Pushpakumar's test.

Results/Findings: 22 villages from Sandakan, Kudat, Pitas, Kota Belud, Kota Kinabalu (Penanpang and Innanam) area were covered. 397 Dusun (129 males & 268 females) and 201 Bajau (85 males & 116 females) were examined. Only 64.7% of Dusun and 73.6% of Bajau

showed presence of Palmaris longus tendon in both hands. The bilateral absence of Palmaris longus tendon was 18.9% among Dusun and 11.4% among Bajau. PL tendon unilateral absence was 16.4% and 14.9% for Dusun and Bajau respectively. The PLA (both bilateral and unilateral) among Dusun 35.3% was significantly higher than the 26.4% of Bajau (χ^2 : 4.832 & $p < 0.03$). The females tend to have a significantly higher prevalence of PLA than males (i.e; 40.3% for Dusun and 31% for Bajau).

Conclusion: The Palmaris longus tendon agenesis (both bilateral and unilateral) among the studied ethnic groups of Sabah was much higher than the prevalence among Malays, Indians and Chinese of 2007 UKM study. Further research is needed to determine the anatomical variations associated with PLA among the ethnic groups of Sabah.

Key words: Palmaris longus agenesis, ethnic group, Borneo, Kadazan-Dusun, Bajau

Introduction

Palmaris longus muscle is one of the most superficial flexor muscles of the forearm. It is a slender, fusiform shaped muscle, located between flexor carpi radialis and flexor carpi ulnaris muscles. It has a short muscle belly with a long tendon. It arises from common flexor origin of the medial epicondyle of the humerus. The Palmaris longus muscle has two actions: well-known action is the weak flexor of the wrist and anchors the skin and fascia of the hand. So it stabilizes the superficial structures in the palm, in preparation of the thumb abduction. The Palmaris longus tendon has been suggested that it is phylogenetically degenerated in flexion of the metacarpo-phalangeal joint. So its main function seems to be as an anchor of the skin and fascia of the hand.

At the wrist, median nerve lies partly under the cover of the Palmaris longus tendon and partly between the flexor carpi radialis and the Palmaris longus tendon.¹ So the tendon protects the median nerve which passes deep to it. In the absence of the Palmaris longus tendon, the median nerve becomes the most superficial structure in the wrist. The nerve will be at risk of injury during trauma and surgical incision.² Thompson et al., 2001 stated that the Palmaris longus muscle is often used in reconstructive surgery because it is considered an accessory muscle and has little functional use to human upper limb. But its long tendon is the first choice as a donor tendon in hand and reconstructive surgery because the long tendon fulfils the necessary requirements of diameter, length and availability and can be used without producing any functional deformity. The presence of Palmaris longus tendon can be easily tested by preoperative examination.³

The Palmaris longus muscle is completely developed at birth while fascia lata, also used in reconstructive surgery, is not so well developed at that age⁴. Due to all these factors, it becomes commonly used donor tendon by hand surgeons, second stage tendon reconstruction as well as tendon grafting. Plastic surgeons also utilize the Palmaris longus muscle in restoration of chin and lip defects,⁵ correction of ptosis^{6, 7} and in the treatment of facial paralysis.⁸

In the human body, Palmaris longus muscle is often described as one of the most variable muscles in both number and form. Reimann et al; studied the anatomical variations of the Palmaris longus muscle in 1600 extremities. It is said that 12.8% agenesis and other

variations of the Palmaris longus muscle constitute 9% in total.⁹ It is only found in mammals and well developed in those where forelimb is used for weight-bearing and ambulation. Example, Palmaris longus is always present in the orangutan but it is absent variably in higher apes such as gorillas and chimpanzees.^{9,11} It has been noted that the Palmaris longus tendon is rapidly degenerating in humans. The absence of Palmaris longus in human appears to be hereditary but it is not clear in genetic transmission.^{10, 11, 12}

The prevalence of agenesis of the Palmaris longus has been well studied following the first report in 1559 by Colombos in *De Re anatomica* Librib^{12, 13}. It is well known that there is a wide variation in the reported prevalence of Palmaris longus absence in different ethnic groups.^{15, 16} The Palmaris longus agenesis (PLA) varied with gender, laterality and ethnicity in previous studies. In 2010, Eric et al reported that comparison of Palmaris longus agenesis to hand dominance. They stated that Palmaris longus agenesis was more common on non-dominant hands.¹⁸ Different authors mentioned their results according to their findings. In Indian, the Palmaris longus agenesis is 17.2%¹⁰, 12-24% of absence in Caucasians.^{9,11} Machando described 3.6% absence in a study of 379 Amazon Indians¹⁵. But according to Sebastin et al (2006), PLA was 4.6% among Singaporean Chinese¹⁷, 12.6% in Nigeria blacks^{18,19} and 26.6% in the Turkish population.²⁰ The Malays had a prevalence of PLA at 11.3% followed by Indians at 10.7% and the Chinese at 6.0%.²¹ The reason for this strong racial variation is not very clear. It may be due to a higher prevalence of manual workers in Asia and African population.²² Some authors suggested that apart from ethnic variations, its absence is more common in female subjects, more frequently on the left side.²³ But Thompson et al., 2001 gave a different study result from others. On 300 Caucasian¹³ subjects, PLA was unilaterally found in 16% and bilaterally in 9%. The absence (unilateral & bilateral) was said to be more common in males but this was not statistically significant ($p < 0.25$ and $p < 0.56$ respectively).

Objectives

To determine the prevalence of PLA among the two major ethnic groups of Sabah namely Dusun (*Kadazan-Dusun & Rungus*) and Bajau and to compare the estimates between age and gender

Materials and Methods

The study included 598 subjects residing in 22 villages from various regions of Sabah, i.e.; Sandakan, Kudat, Pitas, Kota Belud and Kota Kinabalu (Penanpang and Innanam) areas. It involved 214 males & 384 females with an age range between **18 to 82** years. The subjects who have physical abnormalities of upper extremities (injuries, diseases) or any previous surgery of the upper limb and those who would not give consent to follow the clinical tests for the Palmaris longus were excluded. General identification questionnaires including age, sex, race and ethnicity was followed by examination of PLA. The presence or absence of the Palmaris longus (PL) tendon was examined by the researcher using the standard Schaffer's test¹⁴ (thumb is opposed to the little finger while the wrist is flexed). If the Palmaris longus tendon is present, it will form the protuberance under the skin at wrist. It can be palpable and seen on inspection. If the presence or absence of the tendon is not sure, then an extending

force will apply to the hand. If the tendon is still not visible as any protuberance or cannot palpate on the anterior aspect of the wrist, other four additional tests namely Thompson's test¹⁶, Mishra's test I and II²³, Pushpakumar's test²⁴ had been done to confirm the absence. A single examiner checked all the subjects to reduce inter-observer variation.

The Schaffer's test: It involves opposing the thumb to the little finger and then followed by the flexion of the wrist. (Fig. 2)

Thompson's test: The test involves the flexion of the fingers to form a fist followed by the flexion of the wrist and finally the thumb is opposed and flexed over the fingers (Fig.3).

Mishra's test I: The metacarpo-phalangeal joints of all fingers are passively hyperextended by the examiner and then subject is asked to actively flex the wrist.

Mishra's test II: The test involves the abduction of the thumb against the resistance with the wrist in slightly palmar flexion (Fig.4).

Pushpakumar's test (two fingers sign method): It involves the fully extension of the index and middle finger then with flexion of the other fingers and the wrist followed by opposition and flexion of the thumb (Fig.5).

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Results

Overall prevalence of PLA

In this study 598 subjects (214 males and 384 females) were examined of which 397 were of Dusun (*Kadazan-Dusun & Rungus*) ethnic group (129 males & 268 females) and 201 were Bajau (85 males & 116 females). In general, the overall absence (bilateral and unilateral) of Palmaris longus is 193 (32.3%).

PLA and ethnicity

It was significantly higher among the Kadazan-Dusun & Rungus group (Rungus are of the same ethnic origin as *Kadazan-Dusun* of Sabah) than the ethnic Bajau people of Sabah. (Table 2)

The bilateral absence was recorded in 98 (16.4%) and unilateral absence was in 95 subjects (15.9%). In Kadazan-Dusun & Rungus ethnic group, bilateral absence was 18.9% and unilateral absence was 16.4%. In Bajau, bilateral absence was 11.4% and unilateral absence was 14.9%. It was noted that the Bajau ethnic group showed lower prevalence of PLA either bilateral or unilateral absence. (Table 3)

When the right and left sides were compared, the right-sided unilateral absence was seen in 32 and left-sided unilateral absence in 63 subjects. Comparison among ethnic groups also showed that the left-sided unilateral absence was more common in both ethnic groups. The left sided preponderance was seen regardless of the ethnicity (Table 4).

This left sided preponderance of Palmaris longus agenesis should be notified to the reconstructive surgeons as they naturally would attempt to spare the Palmaris longus tendon of the right side since 95.15% of the population are right handed.

PLA and gender

Among the ethnic groups, significant female preponderance was seen only in Kadazan-Dusun & Rungus ethnic group (Table 5). No significant gender differential was observed in Bajau ethnic group. (Table 6)

According to ethnic group, the PLA (both bilateral and unilateral) among Kadazan-Dusun & Rungus 35.3% was significantly higher than the 26.4% of Bajau (χ^2 : 4.832 & p :<0.03). The females tend to have a significantly higher prevalence of PL agenesis than males (i.e; 40.3% for Dusun and 31% for Bajau). (Table 5 and 6)

Discussion

In forearm, the Palmaris longus muscle is one of the superficial slender muscles. It is a phylogenetically degenerated muscle and acts as flexor of the metacarpo-phalangeal joint.¹⁹ During degeneration, the function of the muscle becomes less important to human hand. Even without the muscle, the human hand can perform normal functions. It is believed that the functionality of the muscle will ultimately decline as PLA occurrence among human beings gradually increases, and later its function will be totally lost²⁵. PLA is considered as the most frequent anatomical variation because it is often described as one of the most variable muscles in both number and form.¹

Due to its length, superficial in position and minor function to the human upper limb, the Palmaris longus tendon is the first choice as a donor tendon of repair and reconstructive surgery especially in orthopaedic, reconstructive and hand surgical procedures. It is commonly used for tendon transfer, tendon grafting and restoration of chin and lip defects⁵, correction of ptosis^{6,7} and in the treatment of facial paralysis.⁸ Due to its potential usefulness, the presence or absence of Palmaris longus tendon should be sought for before these surgical procedures.

The prior knowledge of its potential absence (prevalence of PLA) among specific population would assist the surgeons in their choice of donor tendon for reconstructive and aesthetic surgical procedures. This study is the first of its kind among the ethnic groups of Sabah residing in the Northern part of Borneo Island. Due to the fact that the majority of ethnic people are living a simple non-sedentary life, earning their livelihood through agriculture, aquaculture or forest related jobs, it was expected that the PLA prevalence would not be much high among them.

However, this study revealed that the overall absence (bilateral and unilateral) of Palmaris longus is 193 (32.3%). The unilateral absence was more common on left side (10.5% vs. 5.4%). Bilateral absence was more common in female than male (20.1% vs. 9.8%). Right-sided absence was slightly higher in female (5.7% vs. 4.7%). Left-sided absence was more common in female (11.7% vs. 8.4%). Results of this study showed that bilateral and unilateral absence of Palmaris longus was not too much different (16.4% vs. 15.9%). This was different from the findings of other studies which stated that bilateral absence is more common than unilateral absence.^{9,14,19,25} Several studies reported that the incidence of **PLA** is more common in female subjects and on the left side.^{9,10,14} Our study results are consistent with those findings.

Table 7 showed the comparison of our study results with other ethnic group studies conducted in Caucasian population of North Ireland¹³, Chinese population¹⁷, Nigerian population¹⁹, Indian population¹⁰ and Turkish population.²⁰ The results of this study revealed that PLA was more common in Sabah ethnic groups of Malaysia than others.

The present study revealed that Palmaris longus tendon agenesis was more common on left side. The prevalence of **PLA** was more pronounced in female population. The limitation of this study is the absence of Palmaris longus tendon by clinical examinations would not confirm the total agenesis of the muscle as in some studies conducted on human cadavers. The clinical tests used in this study could not describe the variety of muscular or tendon anomalies related to PLA. Even with those limitations, the study highlighted that the PLA prevalence was much higher than those of Malays from Peninsular Malaysia.

Conclusion

The study findings supported that the Palmaris longus agenesis is more common in female and on the left side. Among the studied ethnic groups of Sabah, the Palmaris longus tendon agenesis (both bilateral and unilateral) was much higher than the prevalence among Malays, Indians and Chinese of 2007 UKM study. Of the two ethnic groups under study, Kadazan-Dusun & Rungus people (Dusun ethnic group) showed higher prevalence of PLA than the Bajau ethnic group. Since PLA is said to be associated with anomalies of vascular formations in the hand, further research is needed to determine the anatomical variations associated with PL agenesis among the ethnic groups of Sabah.

Conflict of Interest: None declared.

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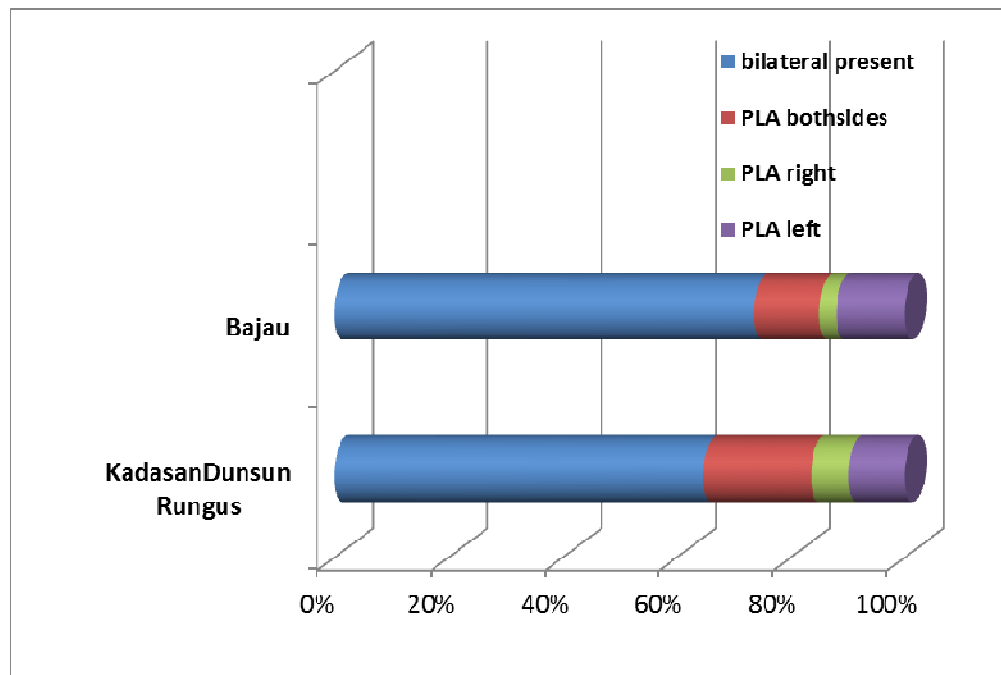


Fig 1: PLA among two ethnic groups



Fig 2.Schaffer's test, 1909

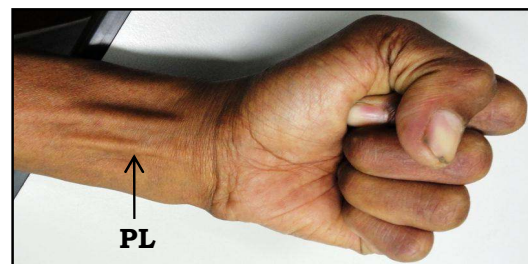


Fig 3.Thompson's test

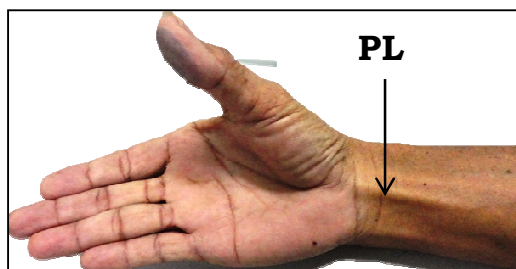


Fig 4.Mishra's test II



Fig 5.Pushpakumar's test

Table 1: Demographic characteristics of various ethnic groups

	age group	Dunsun	Bajau	Total
male	18-30	27	25	52
		20.9%	29.4%	24.3%
	31-40	13	16	29
		10.1%	18.8%	13.6%
	41-50	26	17	43
		20.2%	20.0%	20.1%
	51-60	25	12	37
		19.4%	14.1%	17.3%
61-70	24	7	31	
	18.6%	8.2%	14.5%	
71 & above	14	8	22	
	10.9%	9.4%	10.3%	
Total		129	85	214
		100.0%	100.0%	100.0%
Pearson Chi-Square 9.137 p < 0.104				
	age group	Dunsun	Bajau	Total
female	18-30	39	36	75
		14.6%	31.0%	19.5%
	31-40	52	24	76
		19.4%	20.7%	19.8%
	41-50	56	22	78
		20.9%	19.0%	20.3%
	51-60	59	13	72
		22.0%	11.2%	18.8%
61-70	36	16	52	
	13.4%	13.8%	13.5%	
71 & above	26	5	31	
	9.7%	4.3%	8.1%	
Total		268	116	384
		100.0%	100.0%	100.0%
Pearson Chi-Square 20.413 p < 0.001				

Table 2: Prevalence of PLA in two major ethnic groups of Sabah, Malaysia

Ethnic Group	PLA + PL tendon absent	PLA - PL tendon present	Total
Kadazan-Dusun & Rungus	140 35.3%	257 64.7%	397
Bajau	53 26.4%	148 73.6%	201
Total	193 32.3%	405 67.7%	598

Pearson Chi-Square = 4.832, $p < 0.028$

Table 3: Bilateral & Unilateral PLA among the two ethnic groups

Ethnic Group	PL tendon Bilateral absent	PL tendon Unilateral absent	PLA - PL tendon present	Total
Kadazan-Dusun & Rungus	75 18.9%	65 16.4%	257 64.7%	397
Bajau	23 11.4%	30 14.9%	148 73.6%	201
Total	98 16.4%	95 15.9%	405 67.7%	598

Pearson Chi-Square = 6.253, $p < 0.044$

Table 4: Unilateral PLA among the two ethnic groups

Ethnic Group	PL tendon absent only on Right side	PL tendon absent only on Left side	Total
Kadazan-Dusun & Rungus	26 40.0%	39 60.0%	65
Bajau	6 20.0%	24 80.0%	30
Total	32 33.7%	63 66.3%	95

Pearson Chi-Square = 3.676, $p < 0.055$

Table 5: PLA and gender

(among Kadazan-Dusun & Rungus ethnic groups of Sabah, Malaysia)

Gender	PLA + PL tendon absent	PLA - PL tendon present	Total
Male	32 24.8%	97 75.2%	129
Female	108 40.3%	160 59.7%	268
Total	140 35.3%	257 64.7%	397

Pearson Chi-Square = 9.156, $p < 0.002$ **Table 6: PLA and gender**

(among Bajau ethnic groups of Sabah, Malaysia)

Gender	PLA + PL tendon absent	PLA - PL tendon present	Total
Male	17 20.0%	68 80.0%	85
Female	36 31.0%	80 69.0%	116
Total	53 26.4%	148 73.6%	201

Pearson Chi-Square = 3.076, $p < 0.079$

Table 7: Prevalence of PLA among various ethnic groups

Ethnic Group	PL tendon Bilateral absent%	PL tendon Unilateral absent %	Overall PLA %
Turkish ²⁰	15.04	11.56	26.6
Caucasian ¹³	9.0	6.0	25.0
Nigerian ¹⁹	18.75	12.5	31.25
Chinese ¹⁷	1.2	3.4	4.6
Indian ¹⁰	8.0	9.2	17.2
Malay ²¹ (UKM)	3.3	8.0	11.3
Kadazan-Dusun & Rungus	18.9	16.4	35.3
Bajau	11.4	14.9	26.4