Novel Method to Estimate the Length of the Palmaris Longus Tendon

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ABSTRACT

Palmaris longus is tendon of choice in reconstructive, plastic and cosmetic surgeries. Thus, a suitable length is required and it would be more convenient if the length of the tendon of the palmaris longus could be estimated before harvesting. This study was carried out to determine the relationship between the length and width of the palmaris longus tendon and the length of forearm and hand, the relationship between the length and the width of the palmaris longus tendon and wrist width and wrist circumference, as well as to identify a technique to estimate the length of the tendinous part of palmaris longus before harvesting it. A standardized proforma was used to collect the data of each of the 31 cadavers upper limbs. These data were analysed using SPSS software version 17. It is important to note that p value less than 0.05 is considered as statistically significant in this study. Out of the 31 upper limbs, palmaris longus tendon was absent in 3 (9.68%). Meanwhile, the mean length and width of the palmaris longus tendon was found to be 16.20 cm and 0.48 cm, respectively. The mean length of the forearm and hand was 26.6 cm and 21.2 cm, respectively. The mean width of the wrist and wrist circumference was 8.2 cm and 14.82 cm, respectively. These indicate a significant and moderate relationship between the length of palmaris longus tendon and the length of forearm (r = 0.49, r^2 = 0.24, p < 0.01). In addition, there was also a significant relationship between the length of palmaris longus tendon and the length of hand (r = 0.56, p < 0.01). This paper presents the technique used to estimate the length and width of the tendinous part of palmaris longus before harvesting. The length of palmaris longus can be estimated pre-operatively by measuring the length of the hand by using the technique explained in this paper.

Keywords: Estimation, relationship, palmaris longus tendon, length of hand

INTRODUCTION

The palmaris longus is the most readily available source for tendon grafting and it is also the most common donor material for tendon and joint reconstructive surgeries. It is used for lip augmentation[1], ptosis correction[2-4], facial paralysis[5], Kienbock disease[6], and reconstruction of collateral ligaments of fingers, thumb and elbow[7]. Palmaris longus tendon of suitable length is required for tendon grafting. It would be very convenient if the length of the tendon of the palmaris longus could be estimated before harvesting it. Ito *et al*. reported that there was a strong relationship between lengths of the palmaris longaus tendon and length of forearm[8]. The objectives of the study were to determine the relationship between the length and width of the palmaris longus tendon and the length of forearm and hand; to determine the relationship between the length and width of the palmaris longus tendon and wrist width and wrist circumference; and to estimate the length and width of the tendinous part of palmaris longus before harvesting it.

METHODS

A cross sectional study design was used in this study. All the 31 cadavers upper limbs available in Universiti Putra Malaysia anatomy dissecting hall and Hospital Serdang mortuary were included in the study. Meanwhile, a standardized proforma was used to collect the data. The presence or absence of palmaris longus was noted. The length and width of palmaris longus tendons were measured in the upper limbs where palmaris longus was

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present. The length of the palmaris longus was measured from the most distal part of muscle-tendon border, which is defined as the point where a line connecting the pisiform and tubercle of the scaphoid bone crosses the palmaris longus tendon to its proximal end which is defined as the most distal point of the muscle-tendon border[8]. The width of the palmaris longus tendon was measured at its proximal end. The length and width of each tendon were measured to the closest 0.1 mm by using a slide calliper. The length of forearm was measured in centimetre using a measure tape from the styloid process of the ulna to the tip of the olecranon with the forearm in neutral rotation. The length of the hand was measured as the straight distance from the bistyloid line to the most distal point of the middle finger. The width of wrist is the distance between the radial styloid process and the ulnar styloid process. To measure the wrist circumference, firstly, the styloid process of the radius and ulna bone was located. Then, a string was wrapped around it. The length of the string was then measured using a metal ruler. Data were analyzed using SPSS software version 18. The relationship between the length and/or width of the palmaris longus tendon and length of forearm, length of hand, width of wrist and wrist circumference was expressed by regression analysis. Multiple Linear Regression was used to estimate the length of the palmaris longus. A *p*-value of < 0.05 was considered as statistically significant.

RESULTS

Mean Length and Width of the Palmaris Longus Tendon

The palmaris longus tendon was absent in 3 (9.68%) out of the 31 upper limbs. Table 1 shows that the mean length and width of the palmaris longus tendon was 162.0 mm and 4.7 mm, respectively. Meanwhile, the mean length of forearm and hand was 26.7 cm and 21.3 cm, respectively. The mean width of the wrist and wrist circumference was 8.2 cm and 14.9 cm.

Table 1.   Length and width of palmaris longus tendon, lengths of forearm and hand, width of wrist and wrist circumference (N = 28)

Variables	Mean (SD)	95% CI	Minimum	Maximum
Length of palmaris longus tendon	162.0 (19.5) mm	154.4 – 169.5 mm	111.0 mm	193.0 mm
Width of palmaris longus tendon	4.7 (1.2) mm	4.3 – 5.2 mm	2.0 mm	6.7 mm
Length of forearm	26.7 (2.7) cm	25.6 – 27.7 cm	23.9cm	36.8 cm
Length of hand	21.3 (1.5) cm	20.7 – 21.9 cm	18.4 cm	24.8 cm
Width of wrist	8.3 (0.9) cm	8.0 – 8.6 cm	7.0 cm	10.0 cm
Wrist circumference	14.9 (1.0) cm	14.6 – 15.3 cm	13.1 cm	17.3 cm

SD: standard deviation
95% CI: 95% Confidence interval

Relationship between the Length of Palmaris Longus Tendon and the Length of Forearm, Length of Hand, Width of Wrist and Wrist Circumference

Table 2 shows that there is a direct significant moderate relationship between the length of palmaris longus and the length of hand (r = 0.56, r^2 = 0.33, p = 0.001). There is also a direct significant moderate relationship between the length of palmaris and the length of forearm (r = 0.43, r^2 = 0.19, p < 0.02). The results indicate that 33% of the variations in the increase of the length of palmaris longus are explained by the length of hand and 19% by the length of forearm. However, there is no significant relationship between the length of palmaris and the width of wrist and wrist circumference (p>0.05).

Table 2. The relationship between the length of palmaris longus tendon and length of forearm, length of hand, width of wrist and wrist circumference (dependent variable: length of palmaris longus tendon)

Length of palmaris longus tendon	r	r²	p
Length of hand	0.57	0.33	0.001*
Length of forearm	0.43	0.19	0.02*
Width of wrist	0.00	0.00	0.99
Wrist circumference	0.00	0.00	0.99

* Significant at $p < 0.05$.

Relationship between the Width of Palmaris Longus Tendon and the Length of Forearm, Length of Hand, Width of Wrist and Wrist Circumference

Table 3 shows that there is no significant relationship between width of palmaris longus tendon and length of hand, length of forearm, width of wrist and wrist circumference ($p > 0.05$). Table 4 shows the multiple regression analysis results which show that there was a direct significant relationship between length of palmaris longus and

Table 3. The relationship between the width of palmaris longus tendon and length of forearm, length of hand, width of wrist and wrist circumference (dependent variable: width of palmaris longus tendon)

Width of palmaris longus tendon	r	r²	p
Length of hand	0.16	0.03	0.42
Length of forearm	0.02	00.0	0.94
Width of wrist	0.05	0.00	0.80
Wrist circumference	0.18	0.03	0.35

* Significant at $p < 0.05$

Table 4. Results of the multiple linear regression

Model		Unstandardized Coefficients		Standardized Coefficients		
		Beta	Std. Error	Beta	t	Sig.
1	(Constant)	0.554	4.417		0.125	0.901
	Length of Hand	0.734	0.207	0.571	3.550	0.001
2	(Constant)	0.090	4.504		0.020	0.984
	Length of Hand	0.624	0.258	0.486	2.416	0.023
	Length of Forearm	0.105	0.145	0.146	0.724	0.476
3	(Constant)	0.604	5.390		0.112	0.912
	Length of Hand	0.627	0.264	0.487	2.375	0.026
	Length of Forearm	0.105	0.148	0.145	0.709	0.485
	Width of Wrist	-0.068	0.370	-0.030	-0.182	0.857
4	(Constant)	4.025	6.212		.648	.523
	Length of Hand	0.637	0.263	0.496	2.424	0.024
	Length of Forearm	0.152	0.154	0.210	0.987	0.334
	Width of Wrist	0.113	0.404	0.050	0.279	0.783
	Wrist Circumference	-0.428	0.391	-0.211	-1.094	0.285
5	(Constant)	4.025	6.352		0.634	0.533
	Length of Hand	0.637	.273	0.495	2.331	0.029
	Length of Forearm	0.152	.159	0.210	0.957	0.349
	Width of Wrist	0.113	0.413	0.050	0.273	0.788
	Wrist Circumference	-0.429	0.407	-0.211	-1.054	0.303
	Width of Palmaris Longus	.030	2.923	.002	0.010	0.992

* Significant at $p < 0.05$

length of hand (p < 0.05) only. Table 5 shows the correlation coefficient (r), and the strength of both relationships is moderate. However, it clearly shows that the strength of the relationship between the length of hand with the length of palmaris longus tendon is stronger compared to the relationship using the length of forearm.

Table 5.   Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
a	0.57a	0.33	0.30	1.63
b	0.58b	0.34	0.29	1.64
c	0.58c	0.34	0.26	1.67
d	0.61d	0.37	0.27	1.67
e	0.61e	0.37	0.23	1.71

a. Predictor: (Constant), Length of Hand
b. Predictors: (Constant), Length of Hand, Length of Forearm
c. Predictors: (Constant), Length of Hand, Length of Forearm, Width of Wrist
d. Predictors: (Constant), Length of Hand, Length of Forearm, Width of Wrist, Wrist Circumference
e. Predictors: (Constant), Length of Hand, Length of Forearm, Width of Wrist, Wrist Circumference, Width of Palmaris Longus

Estimation of the Length of Palmaris Longus

Table 6 shows that with every increase of one millimetre in the length of hand, the length of palmaris longus (on the average) increases by 0.734 mm, p < 0.001. We can thus estimate the length of the palmaris longus based on the length of hand, as follows: 'y' = 0.55 + 0.73 'x' whereby 'y' is the length of the palmaris longus and 'x' is the length of the hand. For example, if length of hand is 21.3 cm, then the length of palmaris longus tendon = 0.554 + (21.3 × 0.734) = 0.554 + 15.6 cm = 16.19 cm. Thus, if we measure the length of hand and it is 21.3 cm, the approximate length of palmaris longus tendon is 16.2 cm.

Table 6.   Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	p
	Beta	Std. Error	Beta		
(Constant)	0.554	4.41		0.125	0.901
Length of Hand	0.734	0.21	0.571	3.550	0.001

Dependent Variable: Length of Palmaris Longus
* Significant at p < 0.05

Predicting the Length of Palmaris Longus Tendon Based on the Length of Hand

Table 7 shows the approximate length of the tendinous part of palmaris longus tendon based on a novel technique for different lengths of hand. It shows that if the length of hand is 20 cm, the length of the tendinous part of palmaris longus tendon will be approximately 15.2 cm.

DISCUSSION

Variations of the palmaris longus tendon, both in the forms of size and its presence are frequently the most common variation of this muscle, i.e. its absence either unilaterally or bilaterally. The presence of palmaris longus tendon can be easily appreciated because of the prominence of this tendon at the wrist. The prevalence of the absence of palmaris longus tendon in our study was 9.67%. This value is comparably higher than the low prevalence (4.60%) of the absence of palmaris longus tendon reported by Sebastian *et al*. in the Chinese population in Singapore[9]. Meanwhile, Ito reported that the palmaris longus tendon was absent in 4.1 % in the Japanese population[8]. Hentz and Chase in their standard textbook of hand of surgery quoted a prevalence of the absence of palmaris longus tendon of around 15%[10]. In our study, the mean length and width of the palmaris longus was 162 mm and 4.7 mm,

Table 7. Predicted Length of Palmaris Longus Tendon Based on the Length of Hand

Length of Hand (cm)	Length of Palmaris longus (cm)
10	7.9
12	9.4
14	10.8
16	12.3
18	13.8
20	15.2
22	16.7
24	18.2
26	19.6
28	21.1
30	22.6

respectively. In the Japanese study, the value was 124.6 mm and 4.5 mm, respectively[8]. The differences could be attributable to the techniques used to measure and due to the different ethnicity.

In Japan, Ito found a significant relationship between the length of forearm and the length of palmaris longus tendon[8]. We also studied the relationship between the length of palmaris longus and the length of forearm and found a direct significant relationship between the length of the palmaris longus and the length of the forearm. This finding is comparable to the studies by Ito[8] and Alagoz[11]. Ito was able to estimate the length of palmaris longus tendon using the length of forearm. However, the use of the length of hand to estimate the length of palmaris longus tendon was not mentioned. The strength of the relationship between the length of hand and the length of palmaris longus tendon in comparison to the relationship using the length of forearm was not studied. From our study, it was found that the length of the palmaris longus could be better estimated from the length of hand because the strength of the relationship between the length of hand and the length of palmaris longus tendon is stronger compared to the relationship using the length of forearm. Hence, the length of hand is a better measurement for estimating the length of palmaris longus tendon as compared to using the length of forearm. Moreover, as the hand is more distal and readily assessable, it is easier to measure the length of hand than the length of forearm. An estimate of the length of palmaris longus is useful in preoperative planning for procedures involving tendon grafting and ligament reconstructions such as the Brian Adams procedure for distal radio ulnar joint instability. Additional length can be obtained by doing the extended palmaris longus tendon graft by including the palmar aponeurosis[12]. It was earlier thought that the palmaris longus develops in proportion to the length of the forearm[13]. Based on the findings of our study, the length of hand also has a significant relationship with the length of palmaris longus tendon.

CONCLUSIONS

These results of our study indicate that we can preoperatively estimate the length of palmaris longus tendon based on the lengths of hand and forearm.

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