

Original research article

Morphometric Study and Anatomical Variations of Palmaris Longus and Plantaris Tendons

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Abstract

Background and objectives: Tendons are frequently used for reconstructive surgery. This includes tendons of palmaris longus, plantaris, the long extensors of the toes and fingers as well as the flexors of the fingers. The surgeon must base his or her selection of the donor tendon for grafting on what is needed, for example tendon size, length, and width. The most desirable tendons in reconstructive surgery are the palmaris longus and plantaris tendons. To study the presence, variations and relationship between palmaris longus and plantaris tendons. To compare the prevalence of absence in right and left sides.

Method: The study was done on 30 cadavers. The palmaris longus and plantaris muscles are indeed subject to variation, whether in the general anatomy, form, attachment, actions and/or prevalence. Parameters like muscle length, tendon length, total length, of both the muscle were measured using measuring tape and the muscle width and tendon width were measured using digital vernier caliper and recorded bilaterally and statistically analysed.

Conclusion: based on the morphology and prevalence of the palmaris longus and plantaris muscles in a North Bihar region, they are ideal for the use of flaps and/or tendon graft in reconstructive surgery.

Keywords: palmaris longus, plantaris, prevalence, variation, reconstructive surgery.

Introduction

The desire to replace missing tissue in the human body had existed since the beginning of medicine¹. The first efficient procedure of replacing a mutilated nose with a tissue flap was accredited to susruta who lived in the 6th or 7th century². In the 16th century, the term flap originated from the dutch word flappe which means something that is loose and only attached by one side³. About 4 centuries ago, an Italian surgeon called Gaspere Tagliacozzi took a delayed flap from an arm and used it for reconstruction of the nose². In 1863, the first true axial pattern cutaneous flap was done by John wood in London, whose main interest was in reconstructive surgery. He reported a case of an 8 year old girl with severe burns to her hand. He attempted an operation to transplant a flap what he called a “groin flap”². At the end of the 19th century physicians realized that by transferring tendons, function of an extremity could be restored. The polio epidemic in Europe, in the 20th century, helped with the advancement of tendon transfers. Later tendon transfer surgery expanded not just to the patients with polio and cerebral palsy, but also to those who required reconstructive surgery for injuries during the first world war⁴. Thus all the concepts, technical abilities and the anatomical knowledge were adequately established in the 1920s to make reconstructive surgery using flaps or tendon possible^{2,4}. Five principles of the flap surgery are described in the literature to consider before performing surgery. The fourth principle stands out clearly above the rest and states that one should “steal from peter to pay paul”. But this is only true

if “peter” can afford it³. That is why a donor flap is selected for transfer because it is thought to be nonessential in its original location^{6,4}, meaning that the donor site can survive without the presence of this structure and functionally is not compromised. This is the case with the plantaris and Palmaris longus muscles, which are found to be frequently absent without any adverse effects. The most desirable tendons in reconstructive surgery are the Palmaris longus and plantaris tendons, while the long extensors of the toes and hands as well as the flexor digitorum superficialis are regarded as suitable⁷. These two muscles are also considered to be the easiest tendons to harvest, and therefore they remain the ideal choices for tendon graft⁶. When one take a closer look at the Palmaris longus tendon its superficial location makes the process of harvesting easier and these makes the procedure less complicated and safer⁸. It is also said to be a dispensable tendon, which will not affect the function of the wrist significantly⁸. Kapoor and co-workers (2008) is of the opinion that the Palmaris longus tendon has little functional use to the upper limb in humans, but has great significance when used as a donor tendon in reconstructive surgery⁹. It is said that the existence and importance of the plantaris muscle cannot be under estimated.

Objectives

1. To study the presence, variations and relationship between palmaris longus and plantaris tendons.
2. To obtain data of dimensions of these tendons to evaluate the adequacy for grafting which will be helpful for surgeons.
3. To determine and compare whether there is any significant difference in the prevalence of absence of these tendons among different ethnic groups .
4. To compare the prevalence of absence in right and left sides.

Material and Method

The study was done on 30 cadavers. The palmaris longus and plantaris muscles are indeed subject to variation, whether in the general anatomy, form, attachment, actions and/or prevalence. Parameters like muscle length, tendon length, total length, of both the muscle were measured using measuring tape and the muscle width and tendon width were measured using digital vernier caliper and recorded bilaterally and statistically analysed. Dissection set, digital vernier calliper and measuring tape .

Inclusion criteria

Adult cadavers of both sexes without any limb deformity was studied.

The sample consisted of 30 cadavers from the department of anatomy at Government Medical College and Hospital Purnea, and help of other medical college Bihar. region as mentioned above. Cadavers were dissected by routine dissection method. The sample included 25 male and 5 female cadavers. The origin of palmaris longus is defined as the medial epicondyle of the humerus, most commonly known as the common flexor origin. The insertion is the distal half of the flexor retinaculum, at the apex of the palmar aponeurosis. The origin of the plantaris muscle is defined as the inferior end of the lateral supracondylar line on the femur. The insertion is on the calcaneus, via the calcaneal tendon. Measurements included the length and width of both the fleshy belly and tendon of Palmaris longus & plantaris. The origin, insertion and possible variations were observed and documented. Total length of the both the muscle from its origin to insertion was measured using measuring tape. Then the tendon length of palmaris longus was defined by measuring the length between the distal wrist crease to the musculotendinous junction to the muscle origin. Plantaris tendon length was defined by measuring length between its insertion to musculotendinous junction

and the muscle length from musculotendinous junction to muscle origin. The width of both the belly and tendon was taken at their widest parts.

Table 1: Comparison of Tendon length of Palmaris longus of both sides

	No. of specimens	Mean (cms)	Std. Deviation	Minimum (cms)	Maximum (cms)
rt_tendon_length	28	13.0143	2.06393	9.00	18.00
lt_tendon_length	29	12.9207	1.85460	9.00	16.00

Table 2: Comparison of Total length of Palmaris longus of both sides

	No. of specimens	Mean (cms)	Std. Deviation	Minimum (cms)	Maximum (cms)
rt total length	28	23.2224	5.13086	.53	29.00
lt total length	29	24.0517	2.30862	19.00	29.00

Table 3: Comparison of Tendon width of Palmaris longus of both sides

	No. of specimens	Mean (cms)	Std. Deviation	Minimum (cms)	Maximum (cms)
rt tendon width	28	.5722	.21967	.20	1.28
lt tendon width	29	.6177	.18295	.38	1.31

Table 4: Absence of the palmaris longus muscle.

Specimen no.	Male/Female	Right/Left Side/ B/l	% absence
12	Male	Right Side	1.6
26	Female	B/l	3.3
Total	-	-	5

By dissection method it is observed that there's bilateral absence seen in one male cadaver specimen no. 26 and unilateral (right sided) absence in one female cadaver. Percentage of bilateral absence of palmaris longus is 3.3%. Total absence of palmaris longus is 5%.

Table 5: Unilateral absence of the Plantaris muscle = 01

Specimen no.	Male/Female	Right/Left Side	% of absence
6	Male	Right Side	1.3

By dissection method it is observed that there's unilateral (right sided) absence in one male cadaver.

Results

illustrates that the right palmaris longus tendon was present in 28 specimens, absent in 2 specimens. Mean is 13.0143 cm and S.D is 2.06393, interquartile range is 12 to 14 (Interquartile range is 25% to 75% percentile). The left palmaris longus tendon was present in 29 specimens, absent in specimen. Mean is 12.9207 cm and S.D is 1.85460, interquartile range is 9 to 16. illustrates that the the right palmaris longus tendon was present in 28 specimens, absent in 2 specimens. Belly length mean is 11.4036 cm and S.D is 2.75647, interquartile range is 9-21.50. The left palmaris longus tendon was present in 29 specimen, absent in 1 specimen. Belly length Mean is 11.1828 cm and S.D is 2.26969, interquartile range is 8 to 18.40. illustrates that the the right palmaris longus was present in 28 specimens,

absent in 2 specimens. Mean of right side total length is 23.2224 cm and S.D is 5.13086, interquartile range is 0.53-29 . The left palmaris longus was present in 29 specimens, absent in 1 specimen . Mean of left tendon 0.6177 is cm and S.D is 0.18295, interquartile range is 1.28-1.31. illustrates that the the right palmaris longus was present in 28 specimens, absent in 2 specimens. Mean of right belly width is 1.3984 cm and S.D is, 0.35026 ,interquartile range is 1.00-2.52. The left palmaris longus tendon was present in 29 specimens, absent in 1 specimen . Mean of left belly width is 1.3677 cm and S.D is, 0.36614,interquartile range is 0.49-1.89. illustrates that the right plantaris was present in 29 specimens, absent in 1 specimen. Mean of right belly width is 1.7014 cm and S.D is, 0.57534 interquartile range is 0.52-2.51. The left plantaris was present in 30 specimens . Mean of left belly width is 1.7303 cm and S.D is 0.58901, interquartile range is 0.52-2.80. illustrates that the right plantaris was present in 29 specimens, absent in 1 specimen. Mean of right tendon width is 0.5297 cm and S.D is 0.11747 interquartile range is 0.3-0.82. The left plantaris was present in 30 specimens . Mean of left muscle width is 0.5009 cm and S.D is 0.13151, interquartile range is 0.30-0.79. There is a statistically significant difference in the mean value of the total length of the right and left length of plantaris muscle and the P value is 0.058. By comparing the mean of all the parameters of both the palmaris longus, the tendon length , belly length, and belly width is greater on the right side when compared with left side. The total length and tendon width is greater in left side when compared with right side. The mean and the range of measurements from minimum to maximum in centimeters for total palmaris longus muscle i.e n = 57 specimens (1 unilateral absence, 2 bilateral absence of palmaris longus muscle) are . Mean Tendon length is 13.0143 cm (9 -18 cm)

1. Mean Tendon width is 0.5949 cm (0.38-1.31 cm)
2. Mean belly length is 11.2932 cm (8-21.50 cm)
3. Mean belly width is 1.383 cm (0.49-2.52 cm)
4. Mean Total length is 23.637 cm (19-29 cm)

In plantaris when mean of all the parameters of both side were compared the tendon length, total length, and tendon width of right side was greater than left side. The muscle length and muscle width were greater on left side. There was presence plantaris in 98.7% cadavers and an unilateral absence of plantaris muscle on right side in a male cadaver. Percentage of unilateral absence is 1.3%. Variations in insertion of plantaris were present, like Small muscle belly, with thick short tendon. Distal part of the tendon is fused with medial margin of soleus in a female cadaver on left side. B/L multiple slips form the tendon , few slips inserted to deep fascia, few slips to medial margin of soleus muscle & a long slip to calcaneum in a male cadaver.

Discussion

The morphology of the palmaris longus and plantaris muscles were described and slight differences were found between the current study and that reported in the literature. The prevalence of these muscles yielded the same results when compared to past studies conducted on samples/populations other than North Bihar. The palmaris longus is a slender, fusiform muscle with a long tendon¹⁰ and is likely to show variations in its structure, origin and insertion¹¹. Therefore one should expect some form of dissimilarity when investigating this particular muscle. It is also said that the tendon of the palmaris longus develops in proportion to the length of the forearm and this is determined genetically before birth¹². The morphology of the palmaris longus and plantaris muscles, examined on the cadaver specimens, correlated to that stated in the literature. White (1960) reported the length of the palmaris longus tendon to be between 100 mm and 150 mm long, compared to the study conducted by Carlson and co-workers (1993) which had a slightly longer tendon, approximately 160 mm. The length and width of the palmaris longus tendon was also

measured in paediatric patients undergoing ptosis correction⁸. The tendon lengths ranged from 90- 120 mm and the width ranged from 2-3 mm, depending on the age of the patient. Masaaki and co-workers (2001) reported that the average tendon length for adult Japanese males is 124.6 mm, 108.3 mm in females and 116.6 mm in the total sample. They further stated that the average tendon width is 4.5 mm in males, 4mm in females and 4.2 mm for the study¹². Mobarakeh (2008) measured the tendon length and width in an Iranian population. The length of the tendon in this study was 136.2 mm and the width was 4 mm¹³. Stecco *et al.* (2009) measured the palmaris longus muscle and found that the muscle in total was 225-315 mm long. The muscular belly measured 95-230 mm long and the tendon between 80-155 mm. It was further stated that the length of the tendon represents about half of the total length of the palmaris longus muscle¹⁴. The plantaris muscle is vestigial and may show variation in its structure, as well as in its points of origin and insertion¹¹. This is important to realize when it is planned to use the plantaris tendon in reconstructive surgery. The length of the plantaris tendon measured in a North Bihar cadaver population is longer than described in the literature (349.8 mm). The average width of the plantaris muscle tendon was found to be 5.53 mm, and based on a search of similar studies conducted in the past, to the author's knowledge this is the first study to measure the width of the plantaris tendon on a cadaver sample. The length of the belly is within the range described in the literature. The total length of the plantaris muscle was, on average, 420.3mm. The length of the plantaris tendon, in the current study, meets the requirements necessary to be used as a graft in reconstructive surgery. White (1960) reported the length of the muscular belly of the plantaris muscle does seldom exceed 100mm and that the length of the tendon is about three to four times longer, meaning 300-400 mm. Daseler and Anson (1943) and Williams (1995) and reported a belly length of between 70 mm and 100 mm. It is said that the palmaris longus and plantaris muscles have a lot in common^{7,10}, while Vanderhooft (1996) maintained that there is no correlation between these muscles¹⁵. There are several similarities between the palmaris longus and plantaris muscles. Daseler and Anson (1943) found them to be genetically similar, while White (1960) contends that they are similar in structure and relationship and also equally suited as tendon grafts. The position of the insertion of the palmaris longus muscle might have changed, the tendon might have become longer, or the difference in the frequency of the absence of this muscle between different races are all indications that the palmaris longus muscle is phylogenetic degenerative.

Conclusion

It has been the subject of several cadaveric as well as in vivo studies because of its clinical importance as a donor tendon. Although it is well known that there is a wide variation in the reported prevalence of palmaris longus absence in different ethnic groups, it is clear that a standard prevalence of absence of palmaris longus cannot be applied to all population.

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