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Anatomy and variations of palmaris longus in fetuses

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Abstract

The aim of this study was to assess the absence of the palmaris longus, the proportion of the lengths of tendon and muscle belly, the development of the tendon and the belly during the fetal period, look for any difference between sides and gender. Fifty-eight spontaneously aborted human fetuses (26 female, 32 male, 116 upper extremities) were studied. The presence or absence of the palmaris longus was determined. The lengths of the belly and tendon were measured, and belly/tendon length ratio was calculated. Correlation with gestational age, body side and gender were studied. The muscle was absent in 44 forearms (37.93%; 20 right side, 34.48%; 24 left side, 41.38%); being bilateral in 19 of 58 fetuses (32.76%) and unilateral in six (10.34%). The unilateral absence rate was higher on the left side with a statistically significant difference. The absence of palmaris longus was more common in females, and the difference was statistically significant. The belly/tendon length ratio was 1.04±0.35 on the right side and 1.09±0.3 on the left. It did not show any difference according the fetal age. A sound knowledge on the anatomy and variations of palmaris longus is of great importance during surgical interventions; because it is the first choice for tendon grafts, by the virtue of its structure and function. Thus, this study is of academic interest for anatomists and hand surgeons alike.

Keywords: palmaris longus, absence, variations, belly/tendon length ratio.

Introduction

Palmaris longus is a slender and fusiform muscle, which lies medial to flexor carpi radialis. It originates from the medial epicondyle by the common tendon and from adjacent intermuscular septa and deep fascia and converges on a long tendon, which passes superficial to the flexor retinaculum. A few fibers leave the tendon and interweave with the transverse fibers of the retinaculum, but most of the tendon passes distally. As the tendon crosses the retinaculum it broadens out to become a flat sheet that becomes incorporated into the palmar aponeurosis. The muscle belly of palmaris longus is supplied by a small branch from the anterior ulnar recurrent artery and innervated by the median nerve [1].

Palmaris longus is often described as one of the most variable muscles in the human body and is phylogenetically classified as a retrogressive muscle; *i.e.*, a muscle with a short belly and a long tendon [2–4]. The palmaris longus muscle is extremely variable in both number and form [2, 5]. It may be in the classically described form or may show variation in location and form of its fleshy part as double, reversed, central, bifid, two or three-headed [5–11]. Its tendon may be divided into two or three; it may show aberrancy of attachment at its origin or insertion, or the muscle may be completely absent [6, 11]. However, the rate of its absence varies across different populations around the world, from 0.6% in the Korean population [12] through 63.9% in the Turkish population [13].

Palmaris longus is often used in surgery because it is considered as an accessory muscle and not essential for normal function of the hand [14, 15]. Many surgeons agree that the palmaris longus tendon is the first choice as a donor tendon because it meets the necessary requirements of length, diameter and availability, and can be used without causing any functional deformity [2–4]. Palmaris longus tendon has been used in the reconstruction of other tendons like extensor pollicis longus, flexor pollicis longus, etc. [16, 17]. It has been also used for correction of ptosis, as a substitute for ligaments in the stabilization of joints, in the repair of the moderate-sized post-oncologic soft palate defects, in the reconstruction of lips and eyelids, in the reconstruction of total maxillectomy and surgery for facial paralysis [18–28].

The aim of this study was to assess the absence of the palmaris longus, the proportion of the lengths of tendon and muscle belly, the development of the tendon and the belly during the fetal period, look for any difference between sides and gender. Another hypothesis to prove was examining the absence of palmaris longus,

whether it is more frequent on the left side and in women, as it is in the previous studies conducted on adults.

Materials and Methods

We studied 58 spontaneously aborted human fetuses (26 female, 32 male, 116 upper extremities) in Department of Anatomy in the Faculty of Medicine at Süleyman Demirel University. Gestational age range was 12 to 40 weeks. Ages of fetuses were determined using bi-parietal diameter, head circumference, femur length and foot length. Fetuses with no external pathology or anomaly were obtained from Isparta Maternity and Children's Hospital. Written consent obtained from the families, and the Ethics Board of the Faculty of Medicine at Süleyman Demirel University approved the study.

An incision was made on each forearm in accordance with flexor carpi ulnaris muscle trace under the dissecting microscope (Olympus SZ-STU1 Stereo Microscope, 10× and 15×). Skin and superficial fascia were removed and muscles of the forearm were exposed. At first, the presence or absence of the palmaris longus was determined. In the presence of the palmaris longus muscle, its belly and tendon were measured and belly/tendon length rate was calculated. Any type of anatomical variations of the muscle was noted. The relationships between findings and gestational ages, as well as the difference between body side and gender were studied.

The means of parameters were computed with respect to groups using an SPSS 15.0 statistical package (SPSS Inc, Chicago, IL). A level of significance (*p*-value) was set at 0.001; *chi*-square test was used to compare genders and sides. The correlations between the parametric values and the gestational age (weeks) have been evaluated by the Pearson's correlation coefficient. Data were expressed as mean ± standard deviation. With respect to nonparametric data, a chi-square test was used to compare percent distributions among groups.

Results

The palmaris longus was absent in 44 forearms in total of 116 (37.93%). The absence was bilateral in 19 of 58 fetuses (32.76%) and unilateral in six (10.34%). Bilateral absence was more common than unilateral absence in all cases ($p<0.001$, Tables 1 and 2).

Table 1 – ***Prevalence of the absence of palmaris longus in different studies***

Study	Bilateral agenesis [%]	Unilateral agenesis [%]
Current study	32.8	10.3
Erić M *et al.* (2011) [14]	25.1	17.3
Erić M *et al.* (2010) [2]	15.9	21.6
Doğramaci Y *et al.* (2010) [29]	14.2	7.7
Sater MS *et al.* (2010) [30]	19	17.9
Kose O *et al.* (2009) [31]	15	11.5
Gangata H (2009) [32]	0.6	0.9
Kapoor SK *et al.* (2008) [33]	8	9.2
Sebastin SJ *et al.* (2005) [34]	1.2	3.3
Thompson NW *et al.* (2001) [4]	9	16
Ceyhan O and Mavt A (1997) [13]	43.2	20.6

Table 2 – ***Frequency of absence of palmaris longus with respect to sides and genders, n (%)***

	Bilateral agenesis	Unilateral agenesis
Male	9 (28.13)	4 (12.50)***
Female	10 (38.46)	2 (7.69)***
Total	19 (32.76)*	6 (10.34)* [right: 1 (1.72)**; left: 5 (8.62)**]

*Bilateral absence was more common than unilateral absence in all cases ($p<0.001$). **The unilateral absence rate was higher on the left side with a statistically significant difference ($p<0.001$). ***The unilateral absence rate was higher in males with a statistically significant difference ($p<0.001$).

Unilateral absence was on the left side in five forearms (8.62% and on the right in one (1.72%). Regarding the laterality, the palmaris longus was absent in 20 right forearms (34.48%) and in 24 left forearms (41.38%) in total of 58. The unilateral absence rate was higher on the left side with a statistically significant difference ($p<0.001$, Table 2).

In total of 26 female fetuses, the palmaris longus was absent in 22 of 52 forearms (42.31%); in 10 (38.46%) fetuses the absence was bilateral and in two (7.69%) fetuses unilateral. In total of 32 male fetuses, the palmaris longus was absent in 22 of 64 (34.38%) forearms; in nine (28.13%) fetuses the absence was bilateral and in four (12.50%) fetuses unilateral (Figure 1). The absence of palmaris longus was more common in females, but the difference was not statistically significant ($p=0.257$). Furthermore the unilateral absence rate was higher in males with a statistically significant difference ($p<0.001$, Table 2).

In the study, the lengths of the muscle belly and tendon of the palmaris longus have also been measured and length of the muscle belly/length of the tendon ratio has been calculated. This ratio was 1.04±0.35 on the right side and 1.09±0.3 on the left. The correlation between the ratios and fetal age was not significant ($p>0.05$). Thus, during the muscle belly and tendon development the length of the muscle belly/length of the tendon ratio was maintained.

During the dissections, some palmaris longus variations were also encountered. In five forearms in total of 116 (4.31%), the tendon of palmaris longus was emerging from the muscle belly as a single band, and then divided into two unilaterally in three fetuses and bilaterally in one fetus. In one case, one of these tendons was passing deep to the flexor retinaculum, the other superficial to it (Figure 2). In two (1.72%) forearms, the palmaris longus muscles were inverted (Figure 3). The inverted palmaris longus cases were unilateral; in one case, the opposite forearm was lack of palmaris longus. Bifid palmaris longus tendon was encountered in only one (0.86%) case; one of these tendons was passing deep to the flexor retinaculum, the other superficial to it (Figure 4).

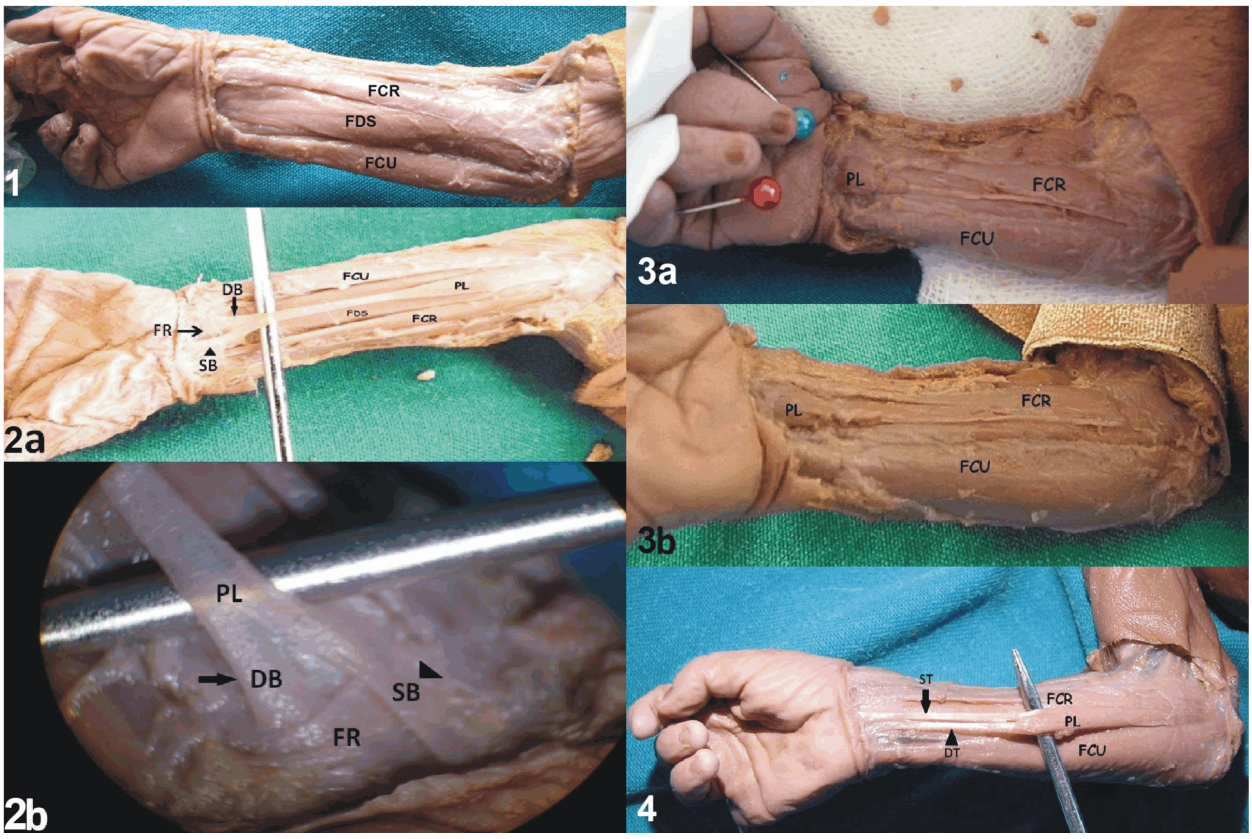

Figure 1 – ***Absence of palmaris longus on the right side. FCR: Flexor carpi radialis; FDS: Flexor digitorum superficialis; FCU: Flexor carpi ulnaris.*** **Figure 2** – ***The palmaris longus tendon emerging as a single band, then dividing into two; one band passing deep to the flexor retinaculum, the other superficial to it. (a) Macroscopic view. (b) Dissecting microscopic view (magnification 15×). PL: Palmaris longus; FCR: Flexor carpi radialis; FCU: Flexor carpi ulnaris; FDS: Flexor digitorum superficialis; FR: Flexor retinaculum; SB: The tendon band passing superficial to the flexor retinaculum; DB: The tendon band passing deep to the flexor retinaculum.*** **Figure 3** – ***Inverted palmaris longus cases with a distal muscle belly and proximal tendon. (a) Case No. 1. (b) Case No. 2. PL: Palmaris longus; FCU: Flexor carpi ulnaris; FCR: Flexor carpi radialis.*** **Figure 4** – ***Bifid palmaris longus tendon. PL: Palmaris longus; FCU: Flexor carpi ulnaris; FCR: Flexor carpi radialis; ST: The tendon passing superficial to the flexor retinaculum; DT: The tendon passing deep to the flexor retinaculum.***

Discussion

Palmaris longus is a muscle of forearm. It is slender, fusiform and lies medial to flexor carpi radialis. It takes origin from the medial epicondyle of humerus by the common flexor tendon, and from adjacent intermuscular septa and deep fascia. It converges on a long tendon, which passes superficial to the flexor retinaculum [1].

Baral P *et al.* reported a case in which the muscle had the same origin and course in the forearm as the palmaris longus, without any attachment to the flexor retinaculum and seeming as a distinct part of flexor digitorum superficialis. They described this muscle as a variant palmaris longus [35]. However, this case might also be described as flexor digiti minimi longus.

The absence rate of palmaris longus is highly variable in different populations in literature. We compared our study with the previous studies available in literature (Table 1). In our study, bilateral absence was more common than unilateral absence; this is comparable to the results of earlier studies, which were performed on Turkish, Afghan and Bahraini populations [12, 29–31]. On the other hand, unilateral absence was more common than bilateral absence in most of the other populations [4, 32, 34].

There is conflict in the literature regarding the symmetry of absence of palmaris longus and the gender in which absence is more common. Most studies indicate that absence of palmaris longus is more common on the left side and in women [6, 33]. In our study, we also found that absence of palmaris longus is more common on the left side (statistically significant) and women (statistically not significant). Others argue that there is no statistically significant correlation between the absence of palmaris longus with gender or body side [4, 34].

In literature, we came across only one palmaris longus study on fetuses. In this study, only the lengths of muscle belly and tendon have been measured [36]. In the studies covering adults, the lengths of muscle belly and tendon have been measured and the mean values have been calculated [14, 37]. In our study, we also measured the lengths of muscle belly and tendon, and calculated the belly/tendon ratio.

Clinical methods are used in most of the palmaris longus studies on adults [2, 4, 14, 29, 31, 34]. There is limited number of studies based on dissections [3, 15]. We opine that dissection method is more accurate; because in the absence of palmaris longus, the tendon of flexor carpi radialis may be mistakenly identified as palmaris longus in clinical methods. On the contrary,

a person having palmaris longus may not accurately perform the clinical method or may not apply desired muscle power; in this case, the palmaris tendon may not be recognized and this may lead to wrong diagnosis of absent palmaris longus. To our opinion, dissection method is the best way for an accurate diagnosis of the absence/presence of the muscle. Moreover, possible variations are better specified in dissection. By this way, more precise information is collected for a better knowledge of the anatomy of this region.

In our study, we also described the variations of palmaris longus. In 4.31% of the cases, a single tendon emerged from the muscle; it then divided into two: one tendon passing superficial to the flexor retinaculum and the other passing deep to it (Figure 2). In 1.72% of the cases, we encountered inverted palmaris longus, with a distal belly and proximal tendon (Figure 3). Bifid palmaris longus tendon was present in only one forearm (0.86%); one tendon was passing superficial to the flexor retinaculum and the other deep to it (Figure 4). The anatomical variations of palmaris longus are clinically important. Particularly, inverted palmaris longus may compress the median nerve, leading to carpal tunnel syndrome [5, 38].

Conclusions

A sound knowledge on the anatomy and variations of palmaris longus is of great importance during surgical interventions; because it is the first choice for tendon grafts, by the virtue of its structure and function. This study is one of the pioneers as being focused on the anatomy of fetal palmaris longus. Our results are of academic interest for anatomists and hand surgeons alike.

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