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MORPHOLOGICAL VARIATIONS AND CLINICAL APPLICATIONS OF PALMARIS LONGUS MUSCLE: A CADAVERIC STUDY

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ABSTRACT

The Palmaris longus muscle is the most suitable autograft material for various reconstructive surgeries. Keeping this in view the present cadaveric study was undertaken. The study was carried out in the Department of Anatomy, JSS Medical College, Mysore, Karnataka State, India. The Palmaris longus muscle was dissected in 30 adult embalmed cadavers (60 limbs), 10 females and 20 males, the average age of the cadavers was between 40-60 years. Variations pertaining to agnesis, aberrancy of its attachment in its origin and insertion, duplication and triplication, accessory slips were observed and noted. The length, breadth and thickness of each muscle belly and tendon was carefully measured and noted. It was observed that in each specimen there were variations in the thickness and length of Palmaris longus muscle and tendon. The Palmaris longus muscle, which was once thought to be a vestigial and degenerating structure, can be of maximum use as a graft material in various plastic & reconstructive surgeries which will be discussed in detail, without producing any residual defects in the donor. The various clinical applications of Palmaris longus will be discussed in detail.

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INTRODUCTION

The Palmaris longus is a slender, fusiform muscle present in the superficial compartment of the forearm. It originates with a small belly from the medial epicondyle of the humerus and its long tendon gets inserted into the apex of the palmar aponeurosis. It is innervated by the median nerve. Palmaris longus is a phylogenetically degenerated metacarpophalangeal joint flexor its main function is to anchor the skin and fascia of the hand, in resisting horizontal shearing forces in a distal direction, which would tend to deglove the skin of the palm. (William, 2005). The Palmaris longus has a highly variable prevalence in different ethnic populations. It was studied that the African American population had a statistically significantly lower rate of absent Palmaris longus (4.5%) and Asians (2.9%) compared to the Caucasians having unilateral absence of 16% and bilateral absence of 9%, with males being more affected. (Ali, 2012). Palmaris longus muscle is the most variable muscle in the body; its absence was reported as early as 1559, in 800 cases, it was absent in 7.7% of cases, absent on right side in 4.5% and absent on left side in 5.2%, it was absent more often in the females and on the left side in both sexes. (Bergmann, 1988)

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MATERIALS AND METHODS

The present study was carried out in the Department of Anatomy, JSS Medical College, Mysore, Karnataka State, India. The Palmaris longus muscle was dissected in 30 adult embalmed cadavers (60 limbs), 10 females and 20 males, the average age of the cadavers was between 40-60 years. The duration of the study was one year. The materials used were as follows: Dissection instruments like Scalpel; Toothed forceps; Blunt forceps; Pointed forceps; Small pointed scissors; Large blunt Scissors; Divider and Scale; Vernier's Caliper; Measuring tape; Hand gloves and Cotton thread. These embalmed cadavers were given for dissection to undergraduate medical students in the department of Anatomy, J.S.S. Medical College, Mysore, Karnataka state, India. Each muscle was identified and meticulously traced taking care not to disturb its surrounding structures like blood vessels and nerves, first blunt dissection was done later followed by fine dissection. The origin, insertion and its nerve supply was noted and documented with utmost care. The length, breadth and the thickness of the muscle and tendon were measured using Vernier's caliper, Divider, Measuring scale and Cotton thread. Each muscle belly was measured from its point of origin to the myotendinous junction and for the tendon from the myotendinous junction to its point of insertion.

The presence and absence of the Palmaris longus muscle was noted. The length, breadth and thickness of each muscle belly and tendon was carefully noted. The variations in the origin, insertion, duplication of the muscle was also noted and documented.

(See Tables – 1, 2, 3)

Table 1. Character of the Palmaris longus muscle and its tendon

Specimen number	Sex - female (F) or male (M)	Side- right (a) and left (b)	Development and character of muscle belly.	Character of the tendon.
1	F	a	+	Thick, long
		b	+	Thick, long
2	F	a	+	Thin, long
		b	+	Thin, long
3	M	a	+	Thin, long
		b	+	Thin, long
4	M	a	+	Thin, long
		b	+	Thin, long
5	M	a	+	Thin, long
		b	+	Thin, long
6	F	a	-	100% thick and long
		b	+	90% thin and long
7	M	a	+	Thick, long
		b	+	Thick, long
8	M	a		Totally absent on the right side
		b		Totally absent on the left side
9	F	a	+++	Thick and long
		b	+++	Thick and long
10	M	a	+++	Thick and long
		b	+++	Thick and long
11	M	a	+++	Thick and long
		b	++	Thin and long
12	M	a	++	Thin and long
		b	++	Thick and short
13	F	a	++	Thick and long
		b	+	Thin and long
14	M	a	+++	Thick, long
		b	+++	Thick, long
15	M	a	+	Thin, short
		b	+	Thin, short
16	F	a	+++	Thin, long
		b	+++	Thin, Long
17	F	a	+++	Thick, long
		b	+++	Thick, long
18	M	a	+++	Thick, short
		b	+++	Thick, short
19	M	a	+++	Very thick and short
		b	+++	Thin, long
20	M	a	++	Very thin and long
		b	++	Thick, long
21	M	a	++	Thick, very short
		b	++	Thick, very long
22	M	a	++	Thick, very long
		b	+	Thick, long
23	M	a	+	Thin, long
		b	+	Thin, long
24	M	a	++	Thin, long
		b	++	Thin, long
25	M	a	++	Thin, long
		b	++	Thin, long
26	F	a		Totally absent on the right side
		b	++	Thick, very short, distal part is fused with Flexor Carpi Ulnaris tendon on the left side.
27	M	a	++	Thick, long
		b	++	Thick, long
28	F	a	+	Thin, long
		b	+	Thick, long
29	F	a	+	Thin, short
		b	+	Thin, short
30	M	a	++	Thick, long
		b	++	Thick, long

Well developed muscle belly: +++

Moderately developed muscle belly: ++

Slightly developed muscle belly: +

No fleshy muscle bell: --

RESULTS

In the present study, it was noted that the specimen no:6, in a female cadaver, the Palmaris longus muscle was 100%

Table 2. Frequency of agenesis of Palmaris longus muscle in the present study: (Unilateral – UL, Bilateral (BL))

Right side				Left side			
Methods	Agenesis	Presence	%	Methods	Agenesis	Presence	%
Clinical (140 limbs)	UL=00 BL=04	136	2.85	Clinical (140 limbs)	UL=02 BL=04	134	UL=1.43 BL=2.86 Total=4.29
Dissection (60 limbs)	UL=01 BL=01	58	3.33	Dissection (60 limbs)	UL=01 BL=01	59	1.66
Ultrasound scanning (20 limbs)	UL=00 BL=00	10	00	Ultrasound scanning (20 limbs)	UL=01 BL=00	09	UL=5.0 BL=00 Total=5
TOTAL (220 limbs)	UL=01 BL=05	204	3.0	TOTAL (220 limbs)	UL=04 BL=05	202	UL=6.036 BL=2.59 Total=10.95

Table 3. Frequency of agenesis of Palmaris longus muscle in different studies

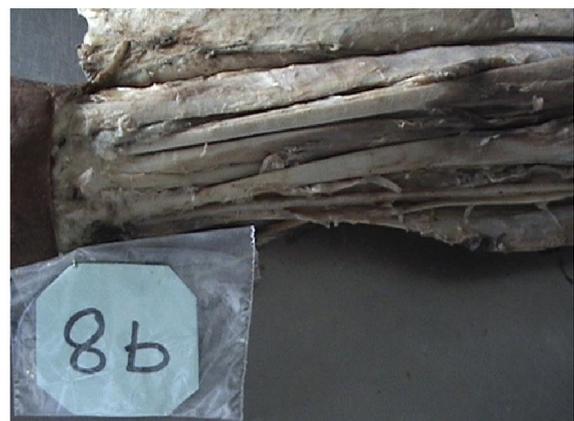
Author & Year	Method of examination	Frequency of absence (%)			Sex Male/ Female
		Unilateral		Both sides Or bilateral	
		Right side	Left side		
Colombos; 1559	Clinical method	4.5 %	5.2 %	7.7 %	Female
Reimann et al; 1944	Surgical method	-	12.9% (out of 1600 cases)	-	Female
Parsons Schaeffer; 1953	Clinical method	4.5 %	5.2 %	7.7 %	female
John Basmajian; 1983	Dissection method	7.0 %	6.0 %	7.0 %	-
Lam et al; 1983	Dissection method	Unilateral 15 %		30 %	-
Ceyhan & Mavt; 1997	Clinical method	Unilateral 23 %		45.3 %	females
		Unilateral 19.5 %		42.1 %	males
Thompson et al; 2001	Clinical method	Unilateral 16 %		9.0 %	males

tendinous on the right side, whereas on the left side the tendon was 90% long with a very small muscle belly. In specimen no: 26, in a female cadaver, the Palmaris longus muscle was totally absent on the right side (unilateral absence), whereas, on the left side there was a small thick muscle belly, with thick short tendon, its distal part being fused with the tendon of Flexor Carpi Ulnaris, forming a conjoint tendon, getting attached to the proximal part of the flexor retinaculum, instead of the apex of the Palmar aponeurosis. In specimen no: 8, a female cadaver, there was bilateral absence. (See Fig.: a, b, c, d)

**Fig. a. Right forearm, bilateral absence of Palmaris longus muscle**

The observation made in the length of the tendon & muscles are as follows:

- Mean length of the tendon = 14.87 cms. (148.7 mm)
- Mean length of the muscle belly = 11.32 cms. (113.2 mm)
- Mean girth of muscle belly = 3.62 cms. (36.2 mm)

**Figure b. Left forearm, bilateral absence of Palmaris longus muscle**

DISCUSSION

It has been suggested that Palmaris longus muscle as phylogenetically degenerated metacarpo-phalangeal joint flexor, its main function appears to be as an anchor for the skin



Figure C. Right forearm, unilateral absence of Palmaris longus muscle

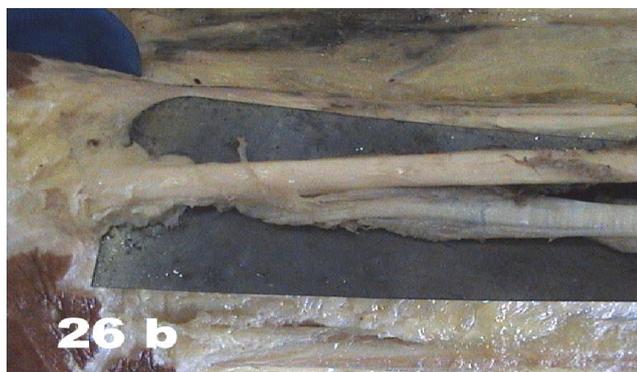


Figure d. Left forearm showing variation at the point of insertion, Palmaris longus tendon is thick, short and distal part is fused with Flexor carpi ulnaris tendon

and fascia of the hand in resisting horizontal shearing forces in a distal direction. Though the muscle has no importance from its functional point of view because of the very well developed flexors, the more tendinous part of this muscle comes to the rescue of the surgeons undertaking reconstructive surgeries. In the present day fast life the incidences of road accidents resulting in trauma of the various parts of the body is a well-known fact. In these cases many a times the surgeons need the graft material for repair, which has to be available immediately, should be less expensive, should not be rejected by the body. Hence, in many cases it is very desirable to have the tissues from the person undergoing reparative surgery; hence Autograft material is always preferable to Homograft or synthetic graft material. It is here the Palmaris longus muscle comes to the rescue of the surgeon. In 1912, free tendon grafts were apparently first used in the hand, the surgeons used grafts to repair ruptured flexor tendons, old lacerations and “hopeless cases” of ischaemic contractures. In 1918, the surgeons preferred the Palmaris longus tendon as the donor graft for the repair of ruptured flexor and extensor tendons. (Strickland, 1989). In 1975 it was revealed that there was an increased incidence of absence of the Palmaris longus muscle in patients suffering from manic-depressive psychosis and endogenous depression, it was stated that the defeat was genetically determined, inherited in a monofactorial way, and determined by an autosomal gene of a dominant character with incomplete penetrance.

The absence of the Palmaris longus muscle was a dominant trait, its presence a recessive trait. (Michel, 1978). The first free autogenous tendon graft removed & used at a different site was reported as early as 1889 wherein, the surgeon transplanted 4 1/2 inches of a flexor tendon from a damaged finger to restore extensor function in the index finger. The first series of free flexor tendon grafts in the hand was reported in 1912. For tendon material the surgeon used Palmaris longus tendon. (David, 1982). In 1987, the donor tendons for grafting, in order of preference, were the Palmaris longus, the Plantaris, the long extensors of the toes & the flexor digitorum sublimes. The Palmaris longus tendon was the tendon of choice because it fulfills the requirements of length, diameter, and availability without producing a deformity. The presence of this tendon was determined before any grafting procedure; its presence was demonstrated by having the patient oppose the tips of the thumb & little finger while flexing the wrist. The tendon was reported to be present in one arm in 85% of people & in both arms in 70%. The tendon was flat surrounded by paratenon & was long enough for an excellent graft of about 15 cms. in length.

The tendon could be removed by two methods:

- Two short transverse incisions were made one just proximal to the flexion crease of the wrist and another at the junction of the middle & proximal thirds of the forearm.
- Alternative method was by using a Brand tendon stripper. Anomalies of the Palmaris longus muscle should be known to the surgeons before adopting the above mentioned procedures to obtain a free tendon graft. (Crenshaw, 1987)

The incidence of velopharyngeal incompetence (VPI) following cleft palate surgery was fairly high in India. Surgeons performed circumferential sling pharyngoplasty using denervated Palmaris longus, since this procedure narrowed the port circumferentially. The result in such patients was gratifying, speech rating improved and electromyographic tracings after 6 months showed evidence of reinnervation of the Palmaris longus. (Ramakrishnan, 1988). In 1991, it was reported that from the past 15 years, free muscle transplantation was being performed in the treatment of anal incontinence in children. This method implied transposition of a striated muscle, usually the Palmaris longus muscle, which was used as a u-sling to the perirectal area around the rectum corresponding to the location of pubo-rectalis muscle. Free muscle transplantation offers a good chance of achieving acceptable continence in a majority of incontinent children. (Hakelius, 1991). In 1993, Palmaris longus abductorplasty for severe thenar atrophy secondary to carpal tunnel syndrome due to median nerve entrapment at the wrist was done. 94% of patients were satisfied, the transfer helped the thumb palmar abduction, and Palmaris longus was an expendable muscle for transfer. (Terrono, 1993). In 1995, tendo-Achilles reconstruction with composite Palmaris longus grafts was done. Full thickness defects of the posterior heel constituted a continuing reconstructive challenge, due to a relative lack of regional tissues in this area and the inherent avascularity of the tendo-Achilles. Wound closure & tendon reconstruction with composite flaps could potentially accelerate healing, reduce scarring, & improve tendon function.

A radial forearm Palmaris longus composite free flap was used to reconstruct full-thickness defects of the heel & tendo-Achilles. Rapid healing & return of function were obtained without significant donor site disability. (Isenberg, 1995). In 1995, the Palmaris longus tendon with a segment of Palmaris longus muscle was used to augment upper lip. The Palmaris longus tendon –muscle grafting was used exclusively to augment volume, while not interfering with motion normally present in the lip. (Barry, 1995). In 1996, a full-thickness reconstruction of cheek defect involving oral commissure from a T3 N1 M0 squamous cell carcinoma was done. First the labial function was reconstructed using a forearm tendinocutaneous flap of Palmaris longus & then the aesthetic appearance was obtained by using rotation flaps from the contralateral vermilion. Modified neck dissection was done with preservation of internal jugular vein, followed by full-thickness resection of the cheek including the angle of mouth with a 1 cm. safety margin. The defect was reconstructed using a forearm tendino cutaneous flap incorporating Palmaris longus. It was designed in such a way that the radial & ulnar skin could be folded around the tendon & used to reconstruct facial skin & oral mucosa, respectively. The two ends of the Palmaris longus tendon were passed through the tunnels in the orbicularis oris muscle & its cut ends were fixed by bolster dressing. After 2 months the vermilion was reconstructed under local anaesthesia. (Katou, 1996).

In 1996, it was observed that this tendon is best suited for use as sling material for frontalis suspension to correct ptotic eyelids in adults. Palmaris longus tendon is the best suited material for several reasons: Firstly, because of its superficial location & being relatively free from major surrounding structures along its course, easily identifiable, isolated & harvested safely & easily. Secondly, it is thin enough to be placed easily & discreetly inside the eyelid. Thirdly, it is sufficiently strong, tough & wide to allow splitting into two or more strips for providing more length if required. (Lam, 1996) In 1998, autogenous Palmaris longus tendon was used as a sling material in frontalis suspension surgery for ptosis correction in children. In a prospective study, it was evaluated that 15 frontalis sling suspension surgeries were done using Palmaris longus tendon in 14 consecutive children with congenital ptosis. All Ptotic eyelids were successfully corrected with good final lid position. No recurrence of ptosis was encountered. There were no complications associated with the Palmaris longus tendon donor site. It was concluded that the frontalis suspension with autogenous Palmaris longus tendon was an effective treatment for congenital ptosis with poor levator function in children. Its use as an alternative material to fascia lata for sling surgery in children can be considered. (Dennis, 1998). In 1999, modification of the “wrap around” tendon anastomosis of fascia lata graft with a slim double tendon of Palmaris longus is being performed from many years. In the case of ulnar paralysis in leprosy, active intrinsic replacement was often required. The Palmaris longus. many – tailed graft has several advantages among the commonly used surgical procedures. It was observed that the Palmaris longus was often very thin & not suitable for the “wrap around” tendon anastomosis, therefore, a modified suture technique was developed to join a relatively wide graft to a slim (but functionally normal) Palmaris longus tendon stump.

Good results were achieved after completion of surgeries. (Beine, 1999). In 1999, it was found out that the Palmaris longus tendon was subjected to a wide range of variations, hence, the identification & determination of its length & thickness was of importance for the pre-operative planning of ligament reconstructive surgery. Thirty healthy volunteers (age group between 6 – 50 years) were examined using high – resolution 10 – 12 MHz US probes. The length & thickness of the tendon was determined & its relationship to the median nerve. The Palmaris longus tendon was accurately identified by ultrasound in both children & adults. Ultrasound was highly suitable for identification of the Palmaris longus tendon and aids the pre – operative planning of ligament reconstructions. (Grechenig, 1999).

In 2003, Palmaris longus tendon was constantly used for correction of hand deformities in leprosy. Even though several anomalies have been reported, it is frequently used, because of its accessibility, as a graft & also as motor to restore function in cases having paralytic hand deformities. By simple manoeuvre of opposing the thumb to little finger with wrist flexed its presence can be ascertained clinically unlike plantaris, which requires surgical exploration to confirm its presence. Palmaris longus tendon has been used for correction of claw-finger deformities because it is long enough (12 – 15cms.) & its tendon fibres are parallel & loosely held, the Palmaris longus tendon can be spread like a sheet, this “tendon sheet” is thicker, relatively stronger & does not require much cleaning in comparison to fascia lata. Palmaris longus tendon has been used in opponensplasty and radial palsy, the Palmaris longus muscle has been found to be of adequate strength to substitute for paralyzed lumbricals.

The attributes that make the Palmaris longus suitable for the above said procedures are:

- Palmaris longus muscle belly is less bulky & corresponds to that of lumbricals;
- The muscle lies in direct line of required pull & gives a mechanical advantage;
- Being superficial it can be easily dissected;
- It passes through soft tissues avoiding congruity to fixed structures and
- Palmaris longus muscle can be spared without a significant deficit. (Malaviya, 2003)

Tendon transfer/graft and reconstructions are being done by orthopaedic surgeons, plastic surgeons, ophthalmologists & onco-surgeons. In the present day scenario, where road accidents are on high rise, use of Palmaris longus in trauma centers are on the rise, in addition to planned surgeries. For its extensive use as auto graft material, Palmaris longus tendon is the most preferred tendon, because of its easy approach & availability. Knowledge of the variations of the muscle has important clinical significance

Conclusion

The Palmaris longus muscle, which was once thought to be a vestigial and degenerating structure, can be of maximum use as a graft material in various plastic & reconstructive surgeries as mentioned above, without producing any residual defects in the donor.

This study will help to update the knowledge of variations of this muscle & its tendon not only to surgeons, but also to the radiologists and anatomists.

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