

# Palmaris profundus and carpal tunnel syndrome: is it really a palmaris muscle?

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## SUMMARY

The palmaris profundus (PP) is a variable muscle present in the flexor muscle region of the forearms. Its implication in the etiopathogenesis of carpal tunnel syndrome has been discussed in the literature.

We present a case of a PP with a characteristic morphology, associated with a bifid median nerve (MN), found during surgery for a recurrence of carpal tunnel syndrome in a 51-year-old female patient.

The PP muscle was first described with this morphology by Frohse in 1908. Initially, this muscle was considered an anatomical variation of the palmaris longus, but since 1984 the existence of both muscles has been observed in the same forearm, so the PP is considered an accessory muscle.

Some authors associate the existence of a PP with compression of the median nerve in the carpal tunnel. Others, however, argue that it may be an aggravating factor but not the primary cause, or simply a casual finding during surgery. We believe that this tendon is not the primary cause of compression of the MN, but it can aggravate the situation in case of a reduced canal due to any other cause, so we recommend surgeons to resect it if it is found.

Furthermore, based on the embryological origin of the forearm muscles, we believe that this PP could actually be the radio-carpal, radio-palmar or short radial forearm muscle described as early as the 19<sup>th</sup> century.

**Key words:** Palmaris profundus – Median nerve – Carpal tunnel – Palmaris longus – Radio-carpian muscle

## INTRODUCTION

The palmaris profundus (PP) is a variable muscle present in the flexor muscle region of the forearms. It has been reported as originating from the lateral aspect of the middle third of the radius, deep to the pronator teres muscle and lateral to the flexor digitorum superficialis muscle. The distal tendon of this muscle passes through the carpal tunnel, deep to the flexor retinaculum and lateral to the median nerve (MN), and reaches the palm of the hand to insert into the deep aspect of the palmar aponeurosis (Tountas and Bergman, 1993).

This muscle was first described with this morphology by Frohse and Frankel (1908). It has subsequently been cited in the literature as a casual finding in cadaveric hands (Razik et al., 2012; Reimann et al., 1944), and in hands undergoing carpal tunnel surgery (Afshar, 2009;

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Afshar, 2014; Brones and Wilgis, 1978; Browne et al., 2015; Carstam, 1984; Chou et al., 2001; Dyreby and Engber, 1982; Fatah, 1984; Floyd et al., 1990; Gwynne-Jones, 2006; Kostoris et al., 2019; McClelland and Means, 2012; Pezas and Jose, 2021; Pirola et al., 2021; Razik et al., 2012; Sahinoglu et al., 1994; Server et al., 1995; Van Denmar et al., 2018).

This variable muscle has been associated with compressive neuropathy of the anterior interosseous nerve and the MN, in the distal forearm and the wrist (Brones and Wilgis, 1978; Dyreby and Engber, 1982; Fatah, 1984; Kostoris et al., 2019; Spinner, 1978).

We describe a case of a PP with a characteristic morphology, associated with a bifid MN. We will also discuss the clinical relevance of this finding and its association with the compressive pathology of the MN at the carpal tunnel.

## **CASE REPORT**

We present the case of an aberrant muscle found during a left-hand carpal tunnel recurrence surgery in a woman of 51 years old. The muscle found partially coincides with the description of the PP found in the literature.

The patient had undergone open carpal tunnel release surgery in another hospital, with favorable evolution. Four years after the intervention, the symptoms reappeared and the electromyographic study showed a severe subacute entrapment of the MN at the carpal tunnel level, so we proposed a new surgical intervention.

During surgery, an incision was made over the previous scar, with proximal and distal extension until healthy non-scar tissue was visualized. Longitudinal section of the transverse ligament of the carpus was performed, which was fibrosed, and when exposing the carpal canal, a bifid MN was visualized (Fig. 1) and a tendinous structure that ran longitudinally through the space between both median nerves was identified (Fig. 2). This tendon had a length of 5 cm and ended up inserting into the deep aspect of the palmar aponeurosis, distal to the flexor retinaculum.

Proximally, this tendon continued with an elongated muscle belly, located lateral to the MN,

which originated from fascia of the distal third of the flexor digitorum superficialis belly.

The tendon of this muscle was removed. Microsurgical neurolysis and a fatty flap was performed to cover the MN. At the 4-week review the symptoms had disappeared.

## **COMMENTS**

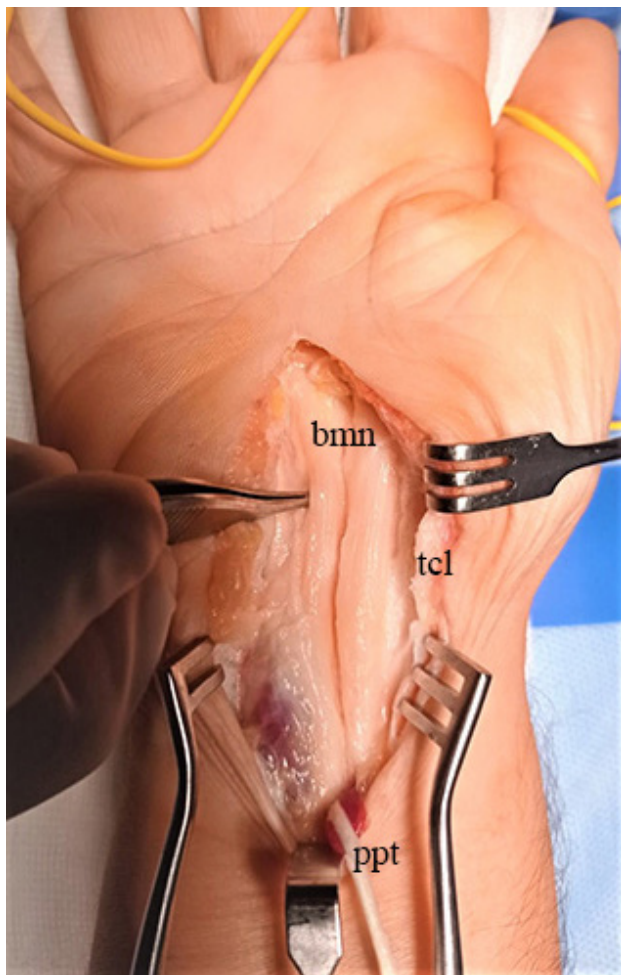
We present an unusual case of a palmaris profundus muscle with the distal portion of its belly located into the carpal tunnel, coexisting with a bifid median nerve, in a patient with compressive carpal tunnel symptomatology despite having already undergone surgery for this cause.

The PP is a variable muscle first described in 1908 (Fröhse and Fränkel, 1908). Years later Reimann found it in 2 forearms belonging to the same subject in a very huge sample of 1600 human cadavers, which would represent an incidence of 0.13% (Reimann et al., 1944).

Subsequently, the PP muscle has been described in the literature on several occasions, almost always as isolated cases or series of 2 cases (Table 1). On some subjects, this muscle has been found bilaterally (Fatah, 1984; Floyd et al., 1990; Razik et al., 2012; Reimann et al., 1944).

Initially, this muscle was considered an anatomical variation of the palmaris longus (Brones and Wilgis, 1978; Carstam, 1984; Fröhse and Fränkel, 1908; Reimann et al., 1944), being described in forearms where the palmaris longus muscle was always absent.

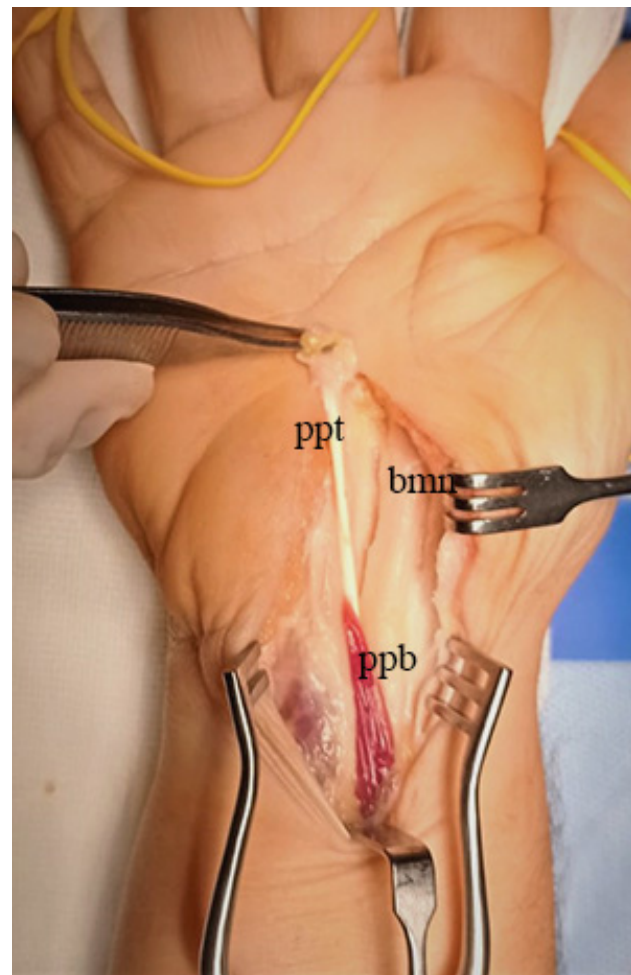
But since 1984 the existence of both muscles has been observed in the same forearm, so the PP is considered an accessory muscle and no longer an anatomical variation of the palmaris longus muscle (Afshar, 2009; Afshar, 2014; Browne et al., 2015; Dyreby and Engber, 1982; Fatah, 1984; Floyd et al., 1990; Gwynne-Jones, 2006; Pirola et al., 2009; Sahinoglu et al., 1994; Server et al., 1995). The PP has been described only in adults, not appearing in fetal studies on the variability of the palmaris longus muscle (Olewnik, 2018), although this is probably due to its very low incidence.



**Fig. 1.-** Intraoperative photograph of the patient's right hand showing a bifid median nerve (bmn) after the transverse carpal ligament (tcl) has been transected. The tendon of the palmaris profundus (pp) muscle has been disinserted and retracted proximally.

The muscle has been described in cadaver forearms and in patients in whom open carpal tunnel surgery has been performed (Table 1). Only once has it been described during endoscopic carpal tunnel surgery, which had to be reconverted to open surgery, because the instruments could not be advanced through the endoscopic portal (Mc Clelland and Means, 2012). The instruments probably collided with the PP muscle, making it impossible to continue with endoscopic surgery, which therefore does not seem to be an adequate technique for treating cases with anatomical variables of any type that increase the content of the carpal tunnel.

It has been seen that this muscle also presents certain variability in its attachments, course and morphology. The proximal attachments described are: middle third of the radius, fascia of the flexor digitorum superficialis, ulna (Pirola et al., 2009),



**Fig. 2.-** Intraoperative photograph of the patient's right hand showing a bifid median nerve (bmn) and palmaris profundus muscle in which the tendon (ppt) runs through the space between both median nerves, and the muscle belly (ppb) reaches the inside of the carpal tunnel.

epimysium of the flexor pollicis longus (Chou et al., 2001), palmaris longus muscle (Sánchez-Lorenzo et al., 1996) and common flexor origin (Sahinoglu et al., 1994). In our case, it originated from fascia of the distal third of the flexor digitorum superficialis belly.

The belly of this anomalous muscle is located proximally and its long tendon distally, presenting variable lengths according to the cases described, although there are only 2 cases reporting the approximate length of this tendon: 10 and 15 cm (Carstam, 1984). In our case the tendon was much shorter, 5cm, with the beginning of the muscle belly inside the carpal tunnel.

Within the carpal tunnel, the tendon of the PP may appear radial (Carstam, 1984; Chou et al., 2001; Fatah, 1984; Floyd et al., 1990; Pirola et al., 2009; Reimann et al., 1944), or ulnar to the

**Table 1.** Cases of the palmaris profundus muscle reported in the literature. Distribution by authors, date of publication, type and size of the sample, origin and insertion, presence or absence of the palmaris longus muscle, bilaterality and concomitant findings.

AUTHOR	YEAR	SAMPLE	N	ORIGIN	INSERTION	PALMARIS LONGUS	BILATERAL	OTHERS
Fröhse	1908	Cadaveric	1	Mid third radius	Palmar aponeurosis	Absent	No	-
Reimann	1944	Cadaveric	2/1600	Mid third radius	Deep surface palmar aponeurosis	Absent	Yes	-
Brones	1978	Patients	2	-	Palmar aponeurosis	Absent	No	-
Dyreby	1982	Patient	1	-	Palmar aponeurosis	Present	No	-
Carstam	1984	Patient	2	-	Deep surface palmar aponeurosis	Absent	No	-
Fatah	1984	Patient	2	Mid third radius	Distal border of flexor retinaculum	1 absent / 1 present	Yes	-
Floyd	1990	Patient	2	-	Deep surface palmar fascia	Present	Yes	-
Stark	1992	Patient	1	-	Palmar fascia	-	No	-
Sahinoglu	1994	Patient	2	Common muscle flexor tendon	Deep surface palmar fascia / Common muscle flexor tendon	Present	No	Median artery 1 case, Bitendinous palmaris profundus
Server	1995	Patient	1	-	Palmar aponeurosis	Present	No	-
Sánchez-L	1996	Patient	1	Dorsal epimysium of palmaris longus muscle belly	Deep surface palmar aponeurosis	Present	No	Bitendinous palmaris profundus
Chou	2001	Patient	1	Epimysium of pollicis longus	Deep surface of both the flexor retinaculum and the palmar aponeurosis	-	No	Division of the median nerve by the muscle belly
Gwynne	2006	Patient	1	-	Deep surface palmar aponeurosis	Present	No	Bifid median nerve
Afshar	2009	Patient	1	-	Deep surface palmar aponeurosis	Present	No	-
Pirola	2009	Patient	2	Flexor digitorum superficialis muscle in the distal forearm	Deep surface palmar aponeurosis	Present	No	Bifid median nerve 1 case
Mc Clelland	2012	Patient	1	-	Deep surface of transverse carpal ligament	-	No	Bifid median nerve + median artery
Razik	2012	Patient	2	-	-	-	Yes	-
Afshar	2014	Patient	1	Radius	Deep surface superficial palmar fascia	Absent	No	-
Browne	2015	Patient	1	-	Palmar aponeurosis	-	No	-
Van Denmark	2018	Patient	1	-	Palmar fascia	-	No	-
Kostoris	2019	Patient	1	-	-	-	No	Bifid median nerve
Pezas	2021	Patient	1	-	Deep surface superficial palmar fascia	-	No	-
Our case	2021	Patient	1	Flexor digitorum superficialis muscle in the distal forearm	Deep surface palmar aponeurosis	Present	No	Bifid median nerve Belly inside carpal tunnel

MN (Fatah, 1984; Sánchez-Lorenzo et al., 1996; Spinner, 1978), or also lie above the nerve itself (Afshar, 2009; Afshar, 2014; Browne et al., 2015; Dyreby and Engber, 1982; Gwynne-Jones, 2006; Razik et al., 2012; Stark, 1992). In one case, the tendon crossed over the MN from radial to ulnar within the carpal tunnel (Server et al., 1995).

In our case, the tendon of this variant muscle ran through the space between the two branches of a bifid MN, a finding also described previously (Afshar, 2014; Gwynne-Jones, 2006; Kostoris et al., 2019; Pirola et al., 2009). Mc Clelland in 2012 further found, associated with these 2 variations, a persistent median artery (Mc Clelland and Means, 2012).

The presence of a bifid MN in the carpal tunnel is caused by a high division of this nerve in the forearm, classified as group 3 within the anatomical variations of this nerve (Lanz, 1977), and described with an incidence of 2.6% (Henry et al., 2015).

Some authors associate the existence of PP with compression of the MN in the carpal tunnel, suggesting that this muscle should be resected to avoid the persistence of symptoms (Brones and Wilgis, 1978; Floyd et al., 1990; Server et al., 1995). Others however advocate that it may be an aggravating factor, but not the primary cause (Fatah, 1984; Pirola et al., 2009), or simply a casual finding during surgery (Sánchez-Lorenzo et al., 1996; Stark, 1992). We believe that this tendon is not the primary cause of compression of the MN. Otherwise, the pathology would appear in very young subjects, but it can aggravate the situation in case of a reduced canal due to any other cause, as in our case, such as; a bifid median nerve, scar tissue or a distal belly located within the tunnel that might produce compression of the bifid nerve during wrist flexion, so we recommend surgeons to resect it if it is found.

The anatomy of the carpal canal is highly variable, so surgeons should be aware of possible anatomic variations and be prepared to alter their surgical plan accordingly (Mc Clelland and Means, 2012).

The flexor muscles of the forearm appear in embryos of 11mm as a small superficial layer and a voluminous deep layer. In embryos of 16 mm.,

the deep layer splits off the flexor carpi ulnaris and the remainder of the deep flexor mass, a superficial flexor digitorum sublimis and a deeper flexor digitorum profundus. The superficial mass lies more on the radial aspect of the volar surface; later, this mass splits into the flexor carpi radialis and pronator teres, and the remaining portion of this superficial layer develops into the palmaris longus, which extends to the volar surface of the carpus (Lewis, 1910).

Therefore, based on this classical description about the development of the forearm muscles, we can suggest that the muscle reported as PP is not originated from the superficial mass of the forearm blastema, as the palmaris longus, but from the deep mass as the flexor sublimis. Therefore, it could be more appropriate look for another name that may not create such confusion of similar history with the palmaris longus. We believe that this PP muscle is actually the radio-carpian muscle described previously by Testut and Le Double, and that this denomination would be more correct, given its embryological origin (Le Double, 1986; Tèstut, 1884).

This radio-carpian muscle has also been called radio-carpal muscle, radio-palmar, radio-metacarpal, radio-carpo-metacarpal or posterior tibial of the forearm, given the great variability in its proximal and distal attachments. It is an accessory muscle of the anterior and inferior region of the forearm. Its proximal attachment is located on the anteroexternal aspect of the distal half of the radius, but proximal insertions have also been described in the epitrochlea, the pronator teres and the flexor digitorum muscles, the interosseous membrane and antebrachial aponeurosis. It is generally continued with a tendon that can pass deep or superficial to the transverse carpal ligament. The distal attachments described are the superficial or deep transverse carpal ligament, the palmar aponeurosis, the fascia of the thenar eminence, carpal bones such as scaphoid, capitate, trapezium and trapezoid, 2<sup>nd</sup>, 3<sup>rd</sup> or 4<sup>th</sup> metacarpal bones, flexor tendon sheath and anterior aspect of the radiocarpal joint (Le Double, 1986; Tèstut, 1884).

Le Double finds this muscle in 1/20 extremities. It can coexist or replace the palmaris longus (Le

Double, 1986; Tèstut, 1884). The first description of this muscle belongs to M. Fano (Bulletins de la Societè Anatomique de Paris, 1851).

Given the great variability of this accessory muscle, Le Double proposes to include all these possibilities as a unique accessory muscle named short anterior radial muscle. We purpose that the PP described by Fröhse and Reimann (Fröhse and Fränkel, 1908; Reimann et al., 1944), and the one found in our patient, could be included in this definition given their location, attachments and embryological origin.

### AUTHOR'S CONTRIBUTION

AO and EA were involved in the development of the project, photo documentation and where the surgeons of the patient. PA performed the data collection, processed the photographs for publication and edited the manuscript. JRS performed the protocol development and collaborated with manuscript editing.

### ETHICAL APPROVAL

The patient underwent surgery at the hand surgery unit of the Hospital Universitario Santa Cristina (Madrid), after signing the informed consent forms for surgery, anesthesia and hospitalization during the COVID19 pandemic. She also authorized verbally and in writing that photographs could be taken during the operation

### Consent to participate

Informed consent was obtained from the participant included in the study.

### Consent for publication

The authors affirm that human research participants provided informed consent for publication of the images in Figures 1 and 2.

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